3.3.2 Number of research papers per teachers in the Journals notified on UGC website during the year

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal
Investigation on photocatalytic activity of ZnS/NiFe2O4 NCs under sunlight irradiation via a novel two-step synthesis approach	I.J.Isaac Premkumar	Mechanical Engineering	Inorganic Chemistry Communication	2020-2021	1387-7003/10.1016	Journal no. 21220
Design and material characteristics of hybrid electric vehicle	I.J.Isaac Premkumar	Mechanical Engineering	Materials Today: Proceedings	2020-2021	10.1016	Journal no. 49021
Effect of Silicon Carbide on the Mechanical and Thermal Properties of Snake Grass/Sisal Fiber Reinforced Hybrid Epoxy Composites	M.Vijayakumar	Mechanical Engineering	Journal of New Materials for Electrochemical Systems	2020-2021	10.14447	Journal no. 24863
A Multi-objective Optimum Distributed Generation Placement Using Firefly Algorithm	S. Anbuchandran	Electrical and Electronics Engineering	Journal of Electrical Engineering and Technology	2020-2021	945–953	journal no. 7260
Public Auditing Scheme For Intergrity Verification In Distributed Cloud Storage System	Chandragandhi	Computer Science And Engineering	Hindawi Scientific Programming	2020-2021	8533995	Journal no. 35610
An Iot And Machine Learning-Based Routing Protocol For Reconfigurable Engineering Application	Chandragandhi Et Al.,	Computer Science And Engineering	IET Communications	2020-2021	2394-1588	Journal no. 30081
Analysis Of Protein-Ligand Interactions Of SARS-Cov-2 Against Selective Drug Using Deep Neural Networks	Chandragandhi Et Al.,	Computer Science And Engineering	IEEE -Big Data Mining And Analytics	2020-2021	2096-0654	--------
Transport Vehicle Maitananance Using Smart Phone Application	Rajiv Suresh Kumar	Computer Science And Engineering	International Advanced Research Journal In Science, Engineering And Technology	2020-2021	2393-8021	--------
Student Placement Prediction Using Support Vector Machine Algorithm	Rajiv Suresh Kumar	Computer Science And Engineering	International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering	2020-2021	2321-2004	--------
Brain Tumour Prediction System	Biju Balakrishnan	Computer Science And Engineering	International Journal Of Advanced Research In Computer And Communication Engineering	2020-2021	2278-1021	--------

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Cloud Data Auditing Using Hashing Algorithm	Biju Balakrishnan	Computer Science And Engineering	International Journal Of Advanced Research In Computer And Communication Engineering	2020-2021	2278-1021	-------
Secure Encrypted Data With Authorized Deduplication In Cloud	G.Deeban Chakkarawarthi	Computer Science And Engineering	International Advanced Research Journal In Science, Engineering And Technology	2020-2021	2394-1588	-------
Plant Leaf Disease Detection System Using Convolutional Neutral Networks	Mr. M. Ravikumar	Computer Science And Engineering	International Journal Of Advanced Research In Computer And Communication Engineering	2020-2021	2319-5940	-------
Detecting Fake Online Reviews Using Supervisied Learning	Mr. M. Ravikumar	Computer Science And Engineering	International Journal Of Advanced Research In Computer And Communication Engineering	2020-2021	2278-1021	-------
College Networking Using PHP And MYSQL For Social Connection Between College Students And Faculties	S.Swathi	Computer Science And Engineering	International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering	2020-2021	2321-5526	-------
Real Time Translation Of Sign Language To Speech And Text	Chandragandhi	Computer Science And Engineering	International Advanced Research Journal In Science, Engineering And Technology	2020-2021	2394-1588	-------
Secure Message Transmission Using Base 64 Algorithm	Chandragandhi	Computer Science And Engineering	International Advanced Research Journal In Science, Engineering And Technology	2020-2021	2394-1588	-------
Jewellary Management Of Softwear System	S.Swathi	Computer Science And Engineering	International Advanced Research Journal In Science, Engineering And Technology	2020-2021	2394-1588	-------
Surface modification polymer magnetic algae nanocomposte for the removal of chromium equilibrium and mechanisam studies	Venkateshbabu.S	Petroleum Engineering	Environmental Research	2020-2021	2021-111626	Journal no. 19828
Facile synthesis polymer and characterization of polypryrrole iron oxide seaweed nanocomposite and its exploration for adsorptive removal of Pb(II) from heavy metal	Venkateshbabu.S	Petroleum Engineering	Chemosphere	2020-2021	2021-130400	Journal no. 5539
Selection of suitable adsorbent for the removal of Cr(VI) by using objective based multiple attribute decision making method	Kavitha Mohanasundaram Surendran Ganesan Saroj Sundar Baral	Petrochemical Engineering	Journal of Preparative Biochemistry & Biotechnology	2020-2021	10826068	Journal no. 38361
Morphology, optical, thermal and antimicrobial studies of ibuprofen-based hyperbranched polyester	Swaminathan Prabhu, Sultan Nasar A, Chickiyan Sivakumar	Chemistry	Bulletin of Materials Science	2020-2021	0250-4707	Journal no. 9568

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Inorganic Chemistry Communications
Volume 126, April 2021, 108481

Short communication

Investigation on photocatalytic activity of $ZnS/NiFe_2O_4$ NCs under sunlight irradiation via a novel two-step synthesis approach

C. Dharmaraja [a], P. Emmanuel Nicholas [b], P. Ramya [c], I.J. Isaac Premkumar [d], V. Vijayan [e], N. Senthilkumar [f]

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Highlights

- A simple two-step process, $ZnS/NiFe_2O_4$ NCs were fabricated for photocatalytic activity.
- The band-gap values are 1.50 eV and 1.89 eV respectively for pure and $ZnS/NiFe_2O_4$ NCs.
- The seed like morphologies were achieved from the prepared $ZnS/NiFe_2O_4$ NCs.
- The degradation efficiency of $ZnS/NiFe_2O_4$ NCs were found 93% for MB and 72% for RhB.

Abstract

This work focuses on the facile two-step approach of Zinc Sulphide (ZnS)/ Nickel Ferrite ($NiFe_2O_4$) nanocomposites (NCs) were developed for the first time. The PXRD pattern reveals that the survival of spinel cubic and cubic symmetry phases were obtained by synthesized $ZnS/NiFe_2O_4$ NCs. The optical band-gap values of synthesized NCs were achieved to be 1.50 eV

ScienceDirect

Materials Today: Proceedings

Volume 37, Part 2, 2021, Pages 351-353

Design and material characteristics of hybrid electric vehicle

S. Baskar [a], V.Vijayan [b], I.J. Isaac Premkumar [c], D. Arunkumar [d], Dowhi Thamaran [a]

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Abstract

The environmental pollution has turn into a serious problem in the country, especially in countries where urbanization lead to crowded atmosphere with stuck traffic in the road. Very big amount of pollutants are emitted from the vehicles day by day. Engineers initiated to monitor various technologies to deal with the pollution issues. The electric vehicles (EV) are enable full consumption of energy and produce almost zero emission. Hybrid power system is conceived to give back for underperformance in the battery. A HEV consists of I.C engine vehicle with battery and electric motor. The benefits of HEVs comprise good fuel economy and less emission. The natural flexibility of HEVs will permit them to be utilized in wide range of applications. A HEV provides increased fuel efficiency and emissions are decreased. HEVs can minimize dependence on fossil fuels. Global automobile giant are research and developing the concept HEVs.

Previous Next

Keywords

EV; Electric motor; Zero emissions; Battery; HEV

Journal of New Materials for Electrochemical Systems
Vol.24, No.2, April, 2021, pp. 120-128
http://new-mat.org
http://iieta.org/journals/jnmes

Effect of Silicon Carbide on the Mechanical and Thermal Properties of Snake Grass/Sisal Fiber Reinforced Hybrid Epoxy Composites

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ABSTRACT

In this study, an attempt was made to develop and characterize Snake Grass Fiber (SGF)/Silicon Carbide (SiC)/epoxy and Snake Grass Fiber/Sisal Fiber (SF)/Silicon Carbide/epoxy hybrid composites using a compression moulding technique. Mechanical characteristics of the produced hybrid composites such as tensile, flexural, and hardness tests were analyzed. Also experiments have been carried out to predict the thermal stability of the fabricated composite samples. The interface between fiber and matrix was examined by using Scanning Electron Microscopy (SEM). Among SGF/SiC/epoxy and SGF/SF/SiC/epoxy composites, it has been observed that hybrid composite SGF/SF/SiC/epoxy exhibits the higher hardness of 82 Shore-D, tensile strength of 51 MPa and flexural strength of 73 MPa. In contrast to the mechanical properties, the percentage of water absorption was lower in the SGF/SiC/epoxy hybrid composite. It is proven from the results that the SGF/SF/SiC/epoxy hybrid composites will enhance the strength of the composites. This composite material is also a potential candidate for the hardware of energy devices including electrochemical energy along with Fuel Cell systems.

Keywords: *hybrid composite, snake grass fiber, sisal fiber, SiC, mechanical properties, water absorption, thermal properties*

Received: January-25-2021, Accepted: April-15-2021, https://doi.org/10.14447/jnmes.v24i2.a09

1. INTRODUCTION

Natural fiber reinforced polymer composites have attracted considerable interests especially in automotive, energy, including electrochemical energy hardware devices construction and furniture applications. The Natural fibers are low density, high strength, biodegradability and lightweight fibers which are extracted from plants, suitable for fabricating low cost, non-toxicity, high strength to weight ratio and good wear resistance polymer Composites [1].

Sathiskumar et al. [2] extracted the snake grass fiber, tested its properties like density, diameter, tensile strength and % elongation. Also prepared the composites with snake fiber reinforcement and isophthalic unsaturated polyester resin for different volume fractions. They reported that the 25 % volume fraction composite exhibited the highest tensile strength and flexural strength. Ganeshan et al. [3] investigated the effect of fiber length and fiber content on the mechanical properties in the madar fiber reinforced polyster composites. It is found that Mechanical properties increase with the increase in fiber length (5 mm to 10 mm) and fiber wt% (20 to 25). Likewise Higher madar fiberwt % composites strength decreased with the increased in fiber length (15 mm and 20 mm). de Andrade Silva et al. [4] studied the tensile strength of the sisal fiber reinforced FRP composite with different fiber length and concluded that short length of the fiber imparts notable tensile strength in the composite. Sathish et al. [5] prepared the hybrid composites of different volume fractions using flax and bamboo fibers and epoxy resin by compression molding technique. They reported that the tensile and flexural strength was high for the sample contains 30% bamboo fiber.

However, proper fiber surface treatment is required to improve the interface between the fibers and matrix. Various methods used are Acetylation treatment, alkaline treatment, Benzoylation, furfuryl alcohol (FA) treatment, Peroxide treatment and Permanganate treatment. Alkaline, heat and coupling agent treatments are necessary to overcome the poor interfacial bonding between sisal fiber and the matrix [6]. Bakare et al. [7] analyzed the water treated and untreated sisal fiber reinforced polyurethane composite for its mechanical behavior. Li et al. [8] investigated the adhesion behavior between sisal fiber and the matrix by using Silane and KMnO4 treated sisal fiber reinforced to high density polyethylene (HDPE) composites. Because of the hydrophilic nature of cellulose and the hydrophobic properties of HDPE the interaction between sisal fibers and the HDPE matrix was poor. But KMnO4 surface treatment method is more helpful in adhesion bonding between fibers and the HDPE resin. Proper selection of fibers, epoxy resin and surface treatments of the natural fibers plays an important role in fiber reinforced polymer based composites. Rong et al. [9] studied the effect of various chemically treated sisal fibers in the epoxy composites to predict the relationship between mechanical properties and adhesion property. It is found that achieved higher fiber stiffness and the adhesion between fiber bundles. Also the matrix has increased flexural strength. Sathiskumar et al. [10] studied the influences of two different combinations natural fibers in the hybrid polymer matrix.

Hybrid composites are reinforced with snake grass/banana fibers and snake grass/coir fibers fabricated to compare its

Journal of Electrical Engineering & Technology
https://doi.org/10.1007/s42835-021-00946-8

ORIGINAL ARTICLE

A Multi-objective Optimum Distributed Generation Placement Using Firefly Algorithm

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Received: 26 July 2020 / Revised: 16 October 2020 / Accepted: 21 October 2020
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Abstract
Nowadays, the power systems face several environmental and economic challenges and Distributed Generations (DGs) will be an effectual solution for them. The integration of DGs may result in power system volatility and losses. The optimal allocation of DGs will resolve the aforesaid issues. This study aims to implement multi-objective firefly algorithm for siting and sizing of DGs by optimizing six dissimilar objective functions such as minimization of power losses, improvement of voltage profile, enhancement of Voltage Stability Index, reduction of pollutant emission and elimination of average voltage Total Harmonic Distortion. Besides, fuzzy decision-making methodology has been deployed to choose one of the Pareto-optimal solutions as the Best Compromise Solution. The studies have been conducted on standard IEEE 33-bus system and a practical 62 bus Indian Utility System namely Tamil Nadu Generation and Distribution Corporation Limited as a real-world distribution network. The outcomes of the proposed work have been compared with related past studies and prominent improvement has been experienced.

Keywords Distributed generations · Optimal placement · Firefly algorithm · Power losses minimization · Voltage profile improvement · Pollutant minimization · Total harmonic distortion minimization · IEEE33-bus system · TANGEDCO

1 Introduction

In recent times, DGs have gained more consideration in power systems for handling the environmental and financial challenges instigated by fossil fuel based power plants. DGs are known as the electric power generations that can be directly connected to loads or DS [1]. The DGs such as wind turbines, solar photovoltaic (PV), full-cells, biomass can mitigate the emission of greenhouse gases (GHG) and climate changes. Moreover, the DS are facing several defies due to the increasing electricity consumption and operational constraints [2]. The DS have been enforced to deliver power to the customer continuity. Owing to low voltage level and high currents, DS have been suffered from severe power losses and voltage volatility. Consequently, the incorporation of DGs have been considered to overwhelm the aforesaid problems [3, 4]. So as to preserve the high efficiency and to enhance the performance of the DS, the placement of DGs should be optimal. Furthermore, the optimal allocation and sizing of DGs will minimize the power losses, energy cost, pollutant emission and THD_v. Similarly, it increases the voltage profile and VSI. These concerns have stimulated the research effort towards the development of accurate and

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Published online: 02 November 2020

Hindawi
Scientific Programming
Volume 2021, Article ID 8533995, 5 pages
https://doi.org/10.1155/2021/8533995

Research Article

Public Auditing Scheme for Integrity Verification in Distributed Cloud Storage System

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Received 25 October 2021; Revised 8 November 2021; Accepted 6 December 2021; Published 22 December 2021

Academic Editor: M Pallikonda Rajasekaran

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Cloud storage provides a potential solution replacing physical disk drives in terms of prominent outsourcing services. A threaten from an untrusted server affects the security and integrity of the data. However, the major problem between the data integrity and cost of communication and computation is directly proportional to each other. It is hence necessary to develop a model that provides the trade-off between the data integrity and cost metrics in cloud environment. In this paper, we develop an integrity verification mechanism that enables the utilisation of cryptographic solution with algebraic signature. The model utilises elliptic curve digital signature algorithm (ECDSA) to verify the data outsources. The study further resists the malicious attacks including forgery attacks, replacing attacks and replay attacks. The symmetric encryption guarantees the privacy of the data. The simulation is conducted to test the efficacy of the algorithm in maintaining the data integrity with reduced cost. The performance of the entire model is tested against the existing methods in terms of their communication cost, computation cost, and overhead cost. The results of simulation show that the proposed method obtains reduced computational of 0.25% and communication cost of 0.21% than other public auditing schemes.

1. Introduction

The cloud storage behaves as a modern paradigm in cloud computing services that is considered proven to deliver extraordinary services to the management and data storage capabilities. The individuals and cloud enterprises tend to outsource their personal or official data to the cloud server via a pay-as-you-go model. The storage services developed to collect the outsourced data reduce their services greatly that affects the local storage essentialities of users. The integrity of data while verifying it is considered as a significant challenge in case of cloud computing [1, 2].

The data offloading and downloading, on the contrary, are often considered as a major consideration for testing the integrity of outsourced data, and this will increase dramatically the processing and connection overhead. The cloud devices used for storage, on the contrary, are often attacked by the hackers, where the data might get stolen while it is been outsourced. Hence, it is essential for the cloud service provider (CSP) to conceal the outsourced data against loss or corruption in order to maintain the trust of the users. The CSP further may reserve more storage spaces by proper removal of redundant information or the data that are accessed less [3] in order to avoid data leaks or leak of private confidential information. It is hence necessary for the CSP to develop an effective protocol that should validate the data integrity in cloud storage environment.

Various methods are developed in conventional literatures that support the verification of private and public information in handling large data. The verification of data allows the cloud users to validate the integrity of their outsourced data. However, such substantial computing poses a serious burden to the CSP, where the cloud resources are of constrained one. The publication verification of outsourced data reduces the computing cost of the client with the optimal usage of third-party authority (TPA) that helps in checking the data integrity. With such optimal processing and reduced user of resources, the public verification in recent past gained an increased attention [4–14].

In order to support the update of dynamic data, the researchers developed several models [3, 15–18] to update the outsourced data without affecting the completion of download. Certain techniques allow the data to be update dynamically using the cryptographic encryption model, and this requires optimal usage of cloud resources. This would increase the computational and communication cost in significant manner.

There exist various pitfalls that still need to be identified. There exist multiple storage spaces that are explicitly required for the storage of the outsourced data. The storage activities involve the deletion and insertion of the data that may result in increased cost of computation and communication since the movement of data in dynamical way cannot be forfeited. Furthermore, the lack of communication links poses a serious challenge in locating the required outsourced data. This system poses increased severity over forgery attack, replay attack, and replacement attack. In order to mitigate such challenges, an integrity verification is suitably designed in the proposed method that uses cryptographic algorithm to verify the sources.

In this paper, an integrity verification mechanism is formed that enables the utilisation of cryptographic solution with algebraic signature. The model utilises elliptic curve digital signature algorithm (ECDSA) to verify the data outsources. The study further resists the malicious attacks including forgery attacks, replacing attacks, and replay attacks. The symmetric encryption guarantees the privacy of the data.

The outline of paper is as follows. Section 2 provides the related works. Section 3 discusses the proposed method. Section 4 evaluates the entire works, and Section 5 concludes the work with possible direction of future work.

2. Related Works

Wang et al. [6] developed an auditing model combining privacy-preserving approach. The model is developed with a homomorphic random mask in order of preventing the TPA from obtaining the data collection without the outsourced data.

Shacham et al. [12] develop an integrity model using public verification scheme that consists of a BLS signature. The BLS [13] tends to use limited resources for its communication and processing requirements.

Chen et al. [14] developed an algebraic solution that is developed to check the integrity of the model. This model improves the efficiency of verification without a public key.

Sookhak et al. [18], on the contrary, develop a limitless verification model, but it suffers mostly from the security flaws. This model computes the secret key based on the signature with the tags and data blocks even if the tags gets attacked.

Juels et al. [19] proposed an identity verification model that helps in preserving the data privacy, where the cloud leverages the user identity to validate the integrity.

Ateniese et al. [20] developed a model that checks the data integrity in the cloud with a technique that combines the block tags with the homomorphic encryption.

3. Proposed Method

We begin by illustrating the system model with ECDLP algorithm.

3.1. System Model. The suggested public verification approach uses a three-party model, as depicted in Figure 1. The following are the roles in this model:

(i) Users who rely on the cloud to store the data

(ii) A CSP is a company that sells users a lot of storage and computing power

(iii) TPA checks the data integrity in response to user requests

In Figure 1, the proposed verification scheme shows the communication between the third-party administrator and cloud service provide in terms of proof information and challenge information between them. The user and TPA process between the version information and verification request and result. The data are only transmitted to CSP after a confirmation is obtained from the TP to CSP.

We present each user ability to implement the proposed paradigm. To begin with, the TPA is thought to be trustworthy yet suspicious. The TPA is truthful in its data integrity checks. Furthermore, the CSP is untrustworthy since it has the option of concealing data loss or corruption in order to maintain the user trust. As a result, the CSP can carry out the following attacks: forgery attack, replay attack, and replacing attack.

A data structure is designed in this part to facilitate dynamic data updating. It combines the benefits of a linked list and hash table in TPA. The ECC is made up of a hash

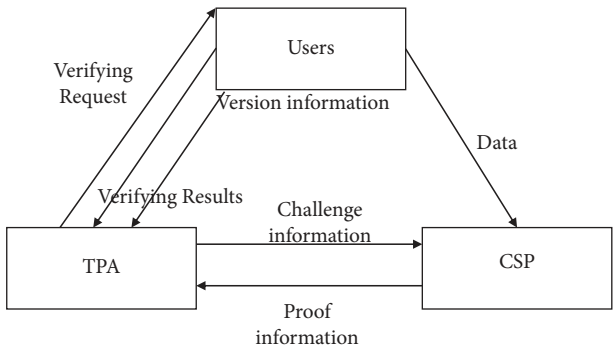

Figure 1: Proposed verification scheme.

table and several linked lists. The user organises the data into groups that compute the group based on its length. Each group index and length are saved in the hash table. Pointers are linked to data version information.

3.2. Verification Scheme. To begin, the TPA merely has to change the list pointer when inserting and deleting items. Second, the group index may be stored and managed using only a continuous space, which is very practical in practise. Third, if operations such as insertion or deletion are considered frequent, the TPA can change the ECDSA flexibly. As a result, the data format can lower the computational and communication costs of updating procedures dramatically.

3.2.1. Key Initiation. For encrypting data blocks, the user first produces a symmetric key dk. He then chooses $x\ Zq$ at random and calculates

$$\mathrm{GA} = xG, \tag{1}$$

where G is an element that is known by TPA and user.

The public key is computed as follows:

$$Q(x, y) = d \times G(x, y), \tag{2}$$

where d is the scalar.

A two different integers, namely, s and r, are used to compute the signature with proper computation of integer r from a base point G (x, y) and random number k:

$$\begin{aligned} (x_1, y_1) &= k \times G(x, y) \mathrm{mod} p, \\ r &= x_1 \mathrm{mod} n. \end{aligned} \tag{3}$$

Meanwhile, with an algebraic signature, the user selects a secure element. The secret key is (dk, x) and the public key is GA in this case.

In order the signature to be a valid one, the integer r should be treated as null. This helps in the generation of a random number (k), and after this, the integer r is computed again. Once the successful completion of integer r, the integer s is computed as below:

$$s = (k - 1\,(h(m) + d * r) \mathrm{mod} n, \tag{4}$$

where $h\,(m)$ is the message digest, d and r are the private key, and k is the random number.

3.2.2. Data Blocks' Encryption. To encrypt each data block Mi, the user uses the symmetric encryption method Enc () with the key dk to acquire the encrypted Mi.

3.2.3. Tag Initiation. For each encrypted data block, the user computes the data block tag i:

$$Mi\sigma i = \mathrm{Sig}\,\alpha\,(x\,(Mi + H\,(vi\,kti))). \tag{5}$$

The user then deletes the information that was previously saved locally. The TPA is in charge of launching a verification challenge to ensure that the outsourced data are accurate. It is worth to note that the technique uses dk for data protection and tag initiation using x which is used for public verification. It is difficult for attackers to extract x and the public key GA by exploiting an ECDSA characteristic:

$$x\,(Mi + H\,(vi\,kti)). \tag{6}$$

3.2.4. Challenge. The user tends to forward the verification request to TPA. The TPA selects the data from the pool of data blocks. The TPA further forwards the challenge information to CSP, which initiates a challenge.

3.2.5. Proof Generation. Once receiving the information on challenge, the CSP estimates the following:

$$M0 = \sum Mi \text{ and } \sigma = \sum \sigma i. \tag{7}$$

3.2.6. Proof Verification. The TPA is used to estimate the hash value sum.

3.2.7. Signature Verification. The verification of signature is considered as a counterpart while computing the signature. This verifies the authenticity of the message after proof verification using the public key of the authenticator. A secure has algorithm in the formation of signature and helps in computation of authenticator's signed message digest. This is essentially computed using the components of digital signature r and s and public key Q (x, y).

4. Results and Discussion

In this section, the simulation is conducted in a CloudSim software tool on a high-end computing engine that consists i9 processor with 8 GB RAM. The study transferred image files from the user module to CSP module after getting a verification from TPA. The CSP consists of 10 Virtual Machine (VM) running with 24 cores. The simulation has taken place to assess the communication and computation cost at various ends.

Figure 2 shows the storage computational cost between the proposed public auditing scheme and other methods. The results of simulation show that the proposed method achieves reduced storage cost than other methods. The use of ECDSA helps in reducing the computation cost than other methods.

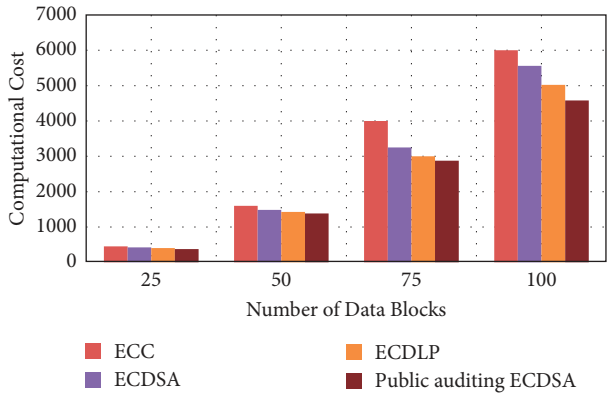

Figure 2: Storage computational cost.

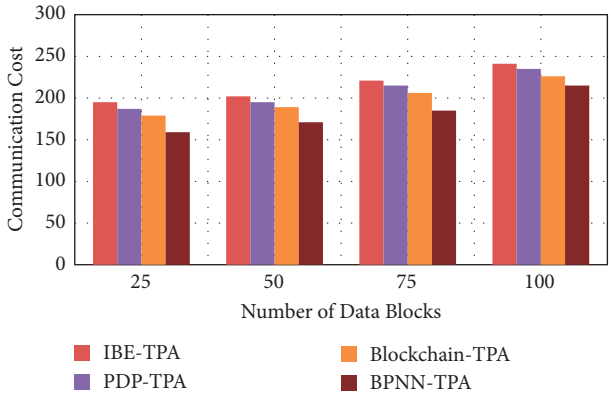

Figure 3: Storage communication cost.

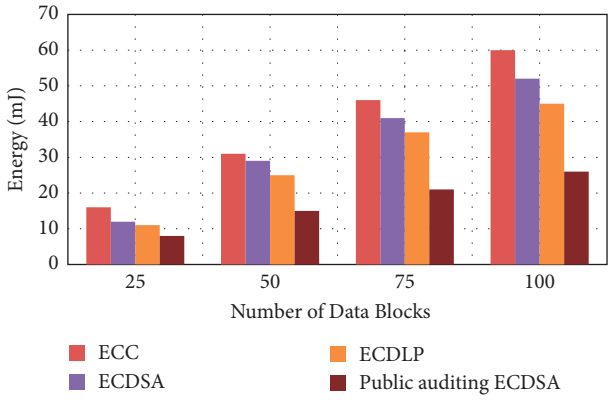

Figure 4: Data communication cost.

Figure 3 shows the storage communication cost between the proposed public auditing scheme and other methods. The results of simulation show that the proposed method achieves reduced storage communication cost than other methods. The use of ECDSA helps in reducing the computation cost than other methods.

Figure 4 shows the data communication cost between the proposed public auditing scheme and other methods. The results of simulation show that the proposed method achieves reduced data communication cost than other methods.

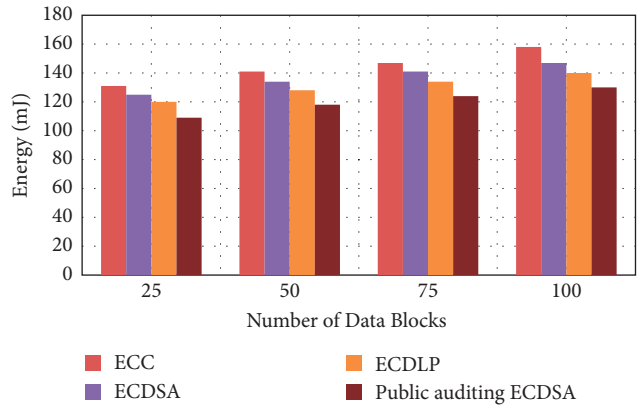

Figure 5: Data computation cost.

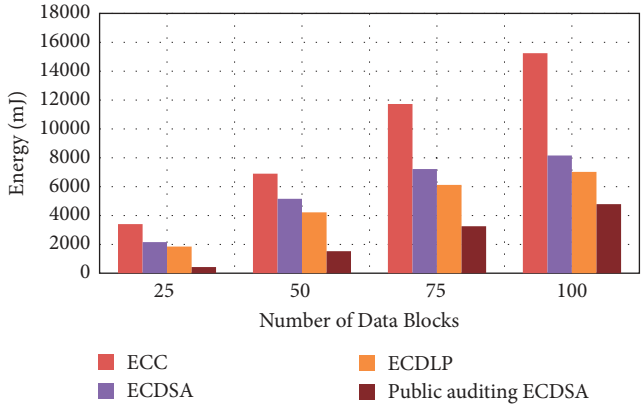

Figure 6: Control overhead cost.

The use of ECDSA helps in reducing the communication cost than other methods.

Figure 5 shows the data computation cost between the proposed public auditing scheme and other methods. The results of simulation show that the proposed method achieves reduced data computation cost than other methods. The use of ECDSA helps in reducing the computation cost than other methods.

Figure 6 shows the control overhead cost between the proposed public auditing scheme and other methods. The results of simulation show that the proposed method achieves reduced control overhead cost than other methods. The use of ECDSA helps in reducing the overhead cost than other methods.

5. Conclusions

In this paper, we develop an integrity verification mechanism that enables the utilisation of cryptographic solution with algebraic signature. The model utilises elliptic curve digital signature algorithm (ECDSA) to verify the data outsources. The study further resists the malicious attacks including forgery attacks, replacing attacks, and replay attacks. The symmetric encryption guarantees the privacy of the data. The simulation is conducted to test the efficacy of the algorithm in maintaining the data integrity with reduced

cost. The results of simulation show that the proposed method obtains reduced computational and communication cost than other public auditing schemes. In future, the utilisation of advanced cryptographic encryption models is deployed to improve the rate of reducing the computational and communication cost in cloud systems.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Approval

No participation of humans has taken place in this implementation process.

Disclosure

No violation of human and animal rights is involved.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Received: 2 February 2021 | Revised: 30 June 2021 | Accepted: 7 July 2021

IET Communications

DOI: 10.1049/cmu2.12266

The Institution of Engineering and Technology WILEY

ORIGINAL RESEARCH PAPER

An IoT and machine learning-based routing protocol for reconfigurable engineering application

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Funding information
Government of the Russian Federation

Abstract

With new telecommunications engineering applications, the cognitive radio (CR) network-based internet of things (IoT) resolves the bandwidth problem and spectrum problem. However, the CR-IoT routing method sometimes presents issues in terms of road finding, spectrum resource diversity and mobility. This study presents an upgradable cross-layer routing protocol based on CR-IoT to improve routing efficiency and optimize data transmission in a reconfigurable network. In this context, the system is developing a distributed controller which is designed with multiple activities, including load balancing, neighbourhood sensing and machine-learning path construction. The proposed approach is based on network traffic and load and various other network metrics including energy efficiency, network capacity and interference, on an average of 2 bps/Hz/W. The trials are carried out with conventional models, demonstrating the residual energy and resource scalability and robustness of the reconfigurable CR-IoT.

1 | INTRODUCTION

Wireless networks reconfigurable (RWN) is mainly an adaptive network firmware developed to satisfy the demands of modern applications, changing network topologies and changing network conditions. In particular, the RWM can be reconfigured throughout all protocol stack tiers (i.e. physical, media access, network, transport and application layers). In order to promote high mobility of time scenarios, this reconfiguration imposes the burden on their transport layer routing protocol with a reconfigurable approach to building high-quality service (QoS) in heterogeneous networks or with the application requirement [1].

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The new communication technology cognitive radio (CR) tends to make the secondary or CR understand its environment intelligently and, depending on the information received with respect to (w.r.t.) the rising usage of spectrum resources, then the parameters are appropriately modified. It can also be construed to give CRs the ability to detect the available spectrum from the environment, then the channel sets are divided in order to optimize the selection of the channel that gives up interference with secondary users (SU) [2]. The SU holds the responsibility of finding the range of transmission of the primary user (PU) and also avoids interference with PUs [3]. Further, the intelligent SU senses the optimal spectral resource thereby reducing the interference even during the transmission over PU. The spectral sensing by the intelligent SU offers more opportunities for spectral access. Depending on optimal spectral sensing, optimal quality assessment on available channels and optimal PU detection, the data can be sent in a reliable way using a transport layer [4]. It further supports congestion control with proper strategies and transmission rates.

In recent times, the paradigm shift to CR and internet of things (IoTs) plays a major role in many RWN applications. However, to improve the capability of IoT, it must be equipped with CR capability. This led to a new research dimension called CR-IoT [5]. To accommodate this integration and to mitigate the challenges associated with congestion control, quality assessment, PU detection and spectral sensing, it is necessary for a network layer protocol to enhance the CR-IoTs functionalities. The consideration of congestion, switching and queuing increases the delay and interference at relay nodes, which causes spectrum fluctuation in CR-IoT [6]. To resolve such challenges, it is necessary for a routing protocol to take these parameters into consideration and design a routing protocol design. The cross-layered design is hence necessary to develop an energy-efficient design that avoids routing issues [7]. The combination of network with MAC layer offers an imperative solution for routing. This combination supports improvements on higher layers by optimal integration of services in lower-layers that includes: spectrum mobility, spectrum access, congestion-free control, reliability and routing decision [8].

The cross-layered routing for CR-IoTs [13–18] is often developed with dynamic spectrum allocation and its utility. It often increases the throughput of CR-IoT by optimal routing by customizing scheduling, spectral resource and transmit power control. The design consideration should offer dynamic resource allocation that increases the capacity of the transmission link without providing interference to the PUs. This inconsistent routing often leads to increased delay of packets and it causes increased interference with reduced throughput. On the other hand, the routing algorithms often suffer from uneconomical (meaning more routes) path selection [20] between the source and destination node. An optimal strategy for finding a path without such inconsistencies can point better routing of paths from source SU to destination.

To adapt with the limitations associated with routing in the CR-IoTs due to spectral resource allocation, and to adapt with reconfiguring networks, it is very essential to develop a highly robust routing model that utilizes machine learning (ML) [9, 10]. The optimal routing decision in CR-IoTs can be initiated with an ML in the network layers [11] in association with the constraints associated with the MAC layer. Hence, ML can be considered suitable for a cross-layer routing protocol design that can provide information and services from other layers [12]. The ML can hence be trained with various factors of routing that includes: node speed, hop count, node energy, channel capacity, channel quality, buffer occupies, network congestion, window size, and so forth, which establishes smart routing [10, 11].

The reconfiguration in CR-IoT operates in a dynamic way based on the characteristics of CR-IoT, hence the deployment of the ML method is required to cooperate with the reconfiguration of CR-IoT and selection of better paths by sensing its environment [33–41]. It is essential for the present study to check the consistency of the ML method in acting as a prominent approach on analysing the entire characteristics of CR-IoTs. In this context, smart adaptation is possible with ML on CR-IoTs that operates as a robust mechanism in expediting the selection decision based on acquired information from CR-IoT characteristics. The consideration of cross-layered design further optimizes the routing performance using ML on the selection of multi-path/channel. Thus, it is seen that the ML engine acts in a smart way based on the deployment of complete information of cross-layered design for training the ML for routing purposes. The training of ML with complete information enables the future prediction of optimal paths in CR-IoTs.

With the aim of (1) improving the energy efficiency, (2) maintaining the trade-off between seamless connectivity and energy savings, and (3) optimized resource utilization, the present study models an ML-assisted routing in CR-IoT.

In this paper, a resource-efficient optimal routing scheme is devised for CR-IoT is proposed, where the controllers in CR-IoT aims to support the CR-IoT network architecture using ML optimization to obtain an optimal routing. The employability of routing capability [21–24] using artificial neural networks [25–27] enables CR-IoT to select optimal paths for actual data transmission. The ANN routing addresses various constraints of CR-IoT in a dynamic way, where the resources are allocated without prior information in relation with the network dynamics. Hence, the application of ML on cross-layer design in CR-IoT provides intelligent routing with optimal routing decision.

The outline of the paper is given below: Section 2 discusses the related work with relevance to various cross-layered routing schemas in CR-IoT. Section 3 provides the problem formulation and the system model of CR-IoTs. Section 4 provides a brief overview of machine learning for route optimization on CR-IoTs. Section 5 shows the proposed reconfigurable CR-IoT routing policy. Section 6 evaluates the proposed ML assisted cross-layered routing. Section 7 concludes the work with possible directions for future scope.

2 | RELATED WORKS

In this section, existing methods for ML routing protocols are discussed in various aspects including the selection of channel,

routing, routing metrics, and so forth. Also, various routing protocols related to the cross-layered design are dealt in this section to find the optimal strategy for route decisions.

Du et al. [13] used reinforcement learning in CR for the cognition engine construction. It addresses two challenges that includes: First, interacting with the environment takes a long time before making smart decisions. Second, through trials and errors, the agents improve their performance, but some of the CR applications cannot afford extensive latency and power expenses. To solve the problems mentioned above, an apprenticeship learning system is adopted based on expert demonstrations. The first is to improve efficiency in power allocation by making the transmission power transition to multi-level levels. A Bregman ball model adaptive radius will be presented in order to avoid failure to identify expert nodes due to SU remote location. In addition, a multi-teacher deep-Q study is proposed in order to speed up the process of learning from expert nodes. The validation shows reduced training time while increasing transmission quality in relation to conventional algorithms. In addition, the newly added nodes can perform better than the experts.

Chitnavis and Kwasinski [14] presented a cross-layer assigning resource scheme in CR networks for the allocation of dynamic spectrum with the goal of improving the Quality of Experience measured by Mean Opinion Score. The solution for the spectrum scarcity problem is to share the resources between SUs and PUs. The solution allows resource allocation in CR to physical and network layers by observing the environmental variables. It takes actions aimed at updating its own parameters to maximize the optimal cross-layered mechanism, which only adapts the physical layer, often improving the one-grade scale of the MOS.

Du et al. [15] proposed the cross-layer routing protocol for CR where the knowledge of spectrum statistics and topology is considered difficult to obtain increased gain based on the multi-agency quasi-cooperative learning to reduce latency and increase energy efficiency. A utility function creates a trade-off between end-to-end delay and energy efficiency together. Experience replay is used to upgrade conjecture to break down the correlations and to reduce update variance in order to further improve performance.

Du et al. [16] proposed an energy-efficient cross-layer routing apprenticeship training scheme. First, a new concept is laid down as the dynamic adaptation rate which regulates the efficient transmission of power with a multi-level transition mechanism in order to guarantee energy efficiency and compress enormous areas of activity. In addition, the prioritized memories deep demonstration Q-learning is provided for accelerating convergence and reducing storage. This method improves power efficiency and reduces routing latency in a cross-layer routing design. The results of the simulation confirm that this method is more efficient than traditional algorithms, shortened routing latency and higher package delivery ratio.

Shah et al. [17] developed a cross-layer framework for QoS related constraints for cognitive communication. The proposed framework utilizes CR to mitigate and congested bands and noise by increasing the capacity of channels for improved communication. The optimization of Lyapunov shift is considered a problem to maximize the weighted services of various classes of traffic. In order to support the QoS via flow and channel control, decisions on routing are presented. Dynamic spectrum access mitigates the channel impairments, defines the priority classes of multi-attribute systems and creates a distributed data delivery control algorithm that maximizes the QoS tool. Evaluations of performance reveal the necessary QoS communication.

Kakkavas et al. [18] developed a resource allocation model in CR to reduce the limitations in SDR deployments. The resource for SU of CR-IoT is allocated based on the Markov random field (MRF) framework. The framework implementation proposed consists of independently developed modules for radio that perform cognitive functions.

Finally, spectral sensing in CR-IoT facility is proposed by Ahmed [19] using a machine learning algorithm namely support vector machine that enables joint spectrum sensing to alleviate the spectral scarcity in wireless networks. The proposed study operates on the similar principle of considering CR-IoT for spectral resource allocation.

From the above literature, it is seen that no sincere attempts are carried out to study the routing of data packets in CR-IoTs. This is visualized in terms of employing the ML in CR-IoTs for smart routing to support the cross-layer design.

3 | SYSTEM MODEL

CR-IoT is a non-standardized radio communication, that offers a cognitive facility to IoT objects in order to enable smart decisions on spectrum allocation based on network conditions. The CR-IoT deals with the elimination of meaningless data using its data management function and decision-making ability. The data management function does not lie within the scope of the paper. First, the sensor object (SO) layer consists of data acquisition from sensors and embeds context information. The SO consists of sensors, controllers, a central hub, a server, and a user layer. Second, the composite sensor object (CSO) represents the collection of SO with cognitive ability and semantic interoperability. This layer enables decision making based on the network conditions and on available resources. Third, the consumer level offers interaction with the users in order of application usage. This three-layered architecture allows the addition of several heterogeneous devices and further, it provides service provisioning via smart decisions [5].

The system is modelled as a hexagonal shaped cell with a network of users and CR unit as shown in Figures 1 and 2. The users are allocated with a similar level of spectrum as in CRs.

Consider an index of PU, where the set of indices B in PU is denoted as, $B \in \{1, 2,\ldots, B\}$. The CRs or (SU) is indicated in terms of the indices $M \in \{1, 2, \ldots, M\}$ and the CRs are indicated in terms of the indices $K \in \{1, 2, \ldots, K\}$. The indices of users and the CRs are associated with the BS of primary users (BS-PU) and BS of CRs (BS-CR or BS-CR-IoT), respectively. The architecture of CR-IoT with respect to spectral allocation is given in Figure 1.

For simplicity, a single BS-PUs are deployed with PU and the BS-CR is designed with the cognitive intelligence that senses

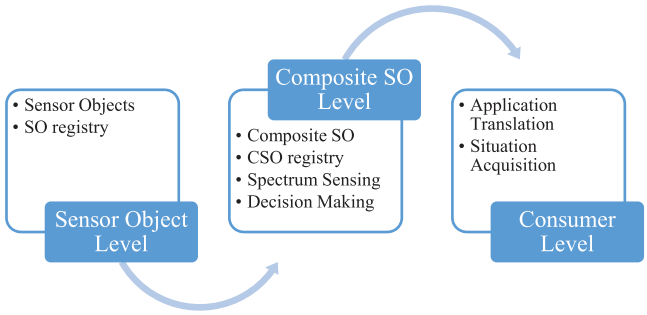

FIGURE 1 CR-IoT layers

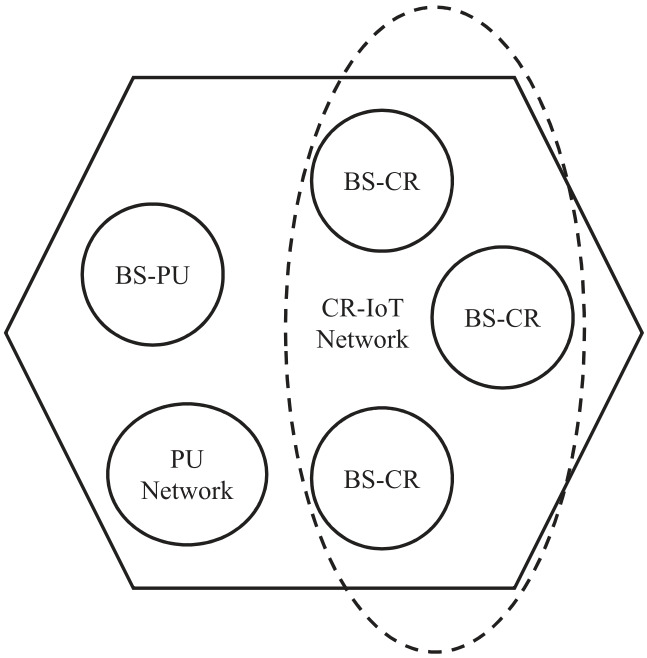

FIGURE 2 Architecture of CR-IoT model

the channel state information (CSI). Depending on the channel quality, the spectrum of PU gets allocated to CR through CR-BS.

Assume $N \in \{1,2,\ldots N\}$ as the orthogonal resources set that operates with a bandwidth W. Let $c_{b,k}(n)$ is considered as the allocation resource having a binary indicator b. The $c_{b,k}(n)$ value is assumed as unity upon the allocation of nth resource to kth CR, which is associated with bth BS-CR. In decentralized operation, the communication with CR is made possible without a central controller, where a local controller is assigned to achieve the objectives of the system.

The bth CR-BS serves kth CR on nth resource, where the signal to interference and noise ratio (SINR) on CR is represented as:

$$\xi_{b,k}(n) = \frac{h_{b,k}(n) P_{b,k}(n)}{I_k(n) + \sigma^2}$$

where $h_{b,k}(n)$ is the channel gain between BS-CR (bth) and CR (kth) on nth spectral resource, $P_{b,k}(n)$ is defined as the transmit power of bth BS-CR on nth spectral resource that is allocated to kth CR, σ^2 is defined as the noise power and $I_k(n)$is defined as the interference and it is expressed as follows:

$$I_k(n) = \sum_{m=1}^{M} P_{u,m}(n) h_{u,m}(n) + \sum_{i=1, i\neq k}^{K} \sum_{l \in \frac{B}{\{b\}}}^{K} P_{l,i}(n) h_{l,i}(n)$$

where $P_{u,m}(n)$ is the total transmit power of uth BS-PU on nth spectral resource allocated to mth PU, $h_{u,m}(n)$refers to the channel gain between uth BS-PU on nth spectral resource allocated to mth PU. The transmission rate of a resource (n) the CR (k) is given by the following expression:

$$d_k(n) = c_{b,k}(n) \log_2\left(1 + \xi_{b,k}(n)\right)$$

The capacity of a CR (k) is given by the following expression:

$$C_k = \sum_{n=1}^{N} d_k(n)$$

Finally, the energy efficiency (E_k) is estimated in terms of the fraction of capacity with respect to the consumed power at CRs. Assume $c_{b,k}(n) = 1$ and hence the energy efficiency of a CR (k) is given by the following expression:

$$E_k = \frac{1}{P_k} \sum_{n=1}^{N} c_{b,k}(n) \log_2\left(1 + \xi_{b,k}(n)\right)$$

The overall energy efficiency is expressed as:

$$E = \sum_{k=1}^{K} E_k$$

Finally, the problem of energy-efficient routing is formulated in terms of a machine learning optimization that is subjected to constraint associated with the QoS of PU and CR in a CR-IoT and it is expressed as follows:

$$P : \max E$$

The energy-efficient based routing mechanism in CR-IoT is designed with various constraints, which are modelled below:

The constraint a denotes the constraint associated with power limitation, which is represented as:

$$a : P_{b,k}(n) \leq c_{b,k}(n) (\max P_b), \quad \forall k = K, \forall b = B$$

The constraint b denotes the constraint associated with the interference at the BS-PU, interference threshold (I_m) on a mth user U $\forall m = M$, which is represented as:

$$b : \sum_{k=1}^{K} \sum_{n=1}^{N} P_{b,k}(n) c_{b,k}(n) I_{n,m} \leq I_m$$

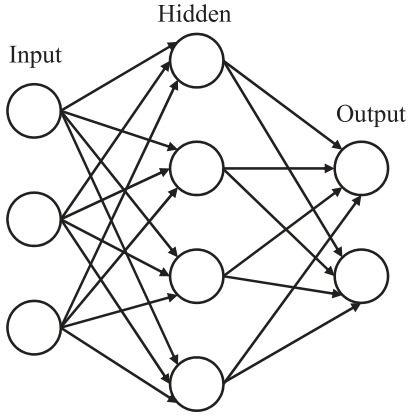

FIGURE 3 Layers in artificial neural network

The constraint c denotes the QoS at the entire CRs, which is represented as:

$$c : \sum_{n=1}^{N} c_{b,k}(n) \log_2 \left(\xi_{b,k}(n) + 1\right) \geq \min C_k$$

In case of constraints (d and e), the resource is utilized by one CR only and it is not shared with other CRs, which is represented as:

$$d : c_{b,k} \in \{0, 1\}, \quad \forall n = N, \forall b = B,$$

$$e : \sum_{n=1}^{N} c_{b,k}(n) = 1, \quad \forall n = N$$

4 | MACHINE LEARNING FOR ROUTE OPTIMIZATION

The ML often plays a major role in optimizing the decision of routing by optimal utilization of network resources [98]. In reality, the ML routing protocols tend to learn based on input features and it tends to reconfigure the entire services based on its adaptation with the dynamic resource. With the increasing learning ability of ML routing schemes, the intelligent services in CR-IoT are thus enabled intelligently [100].

In general, the ANNs impersonates the human brain operation that aids in optimal recognition of recognizing non-linear relationship in any model. ANN's are designed with artificial neurons or nodes that often compute the required output(s) in relation with the non-linear inputs. The non-linear function originates from the other nodes. Figure 3 shows the architecture of a single-layered ANN.

ANN is built with 128 input layers, 160 hidden layers and one output layer. The study uses a multi-objective routing decision using ANN algorithm with a controller that is developed for the prediction of probable routes for actual data transmission. It further assists in the case of disconnection of PU/SU for optimal route attainment. The information on routing is quantized in the form of blocks or discrete states and it is stored for a particular state. ANN explicit a behaviour of exception convergence and speedy learning, hence it is utilized in the study for optimal route establishment.

5 | RECONFIGURABLE CR-IOT ROUTING POLICY

This section provides the enhancement of network routing in reconfigurable CR-IoT in a distributed manner with its network design. The network model is equipped with multiple CR-IoT controllers in a distributed manner that collects the key characteristics of CR-IoT at the MAC and network layer. It provides distributed coordination at the MAC and network layer using multiple controllers. With additional network resources of the network layer, the MAC and network layer are coupled with BS that helps in reducing the energy resources and computational resources at the forwarding BS.

The scalability of the network is increased with dense network resources and the network architecture, which is given in Figure 1. The network responses are sent to the controllers equipped with ML approach, which are utilized for path selection at the network layer. The ML controller formulates the reconfiguration of periodic routing based on the information retrieved from the MAC and network layer. The information on network heterogeneity and network topology is acquired with the ML protocol that operates in a crucial way. At the MAC layer, various network parameters or features like node speed, hop count, node energy, channel capacity, channel quality, buffer occupies, network congestion, window size are collected for optimal routing path selection. The controller in CR-IoT is enabled with ML algorithm that further considers the constraints like limited computational capacity and insufficient memory in association with the energy-efficient constraints (a,b,c,d,e) mentioned in Section 3.

5.1 | Network layer network modelling

The initial network layer settings of CR-IoT network define the pattern of reconfiguration requirements in a periodic manner through its network operation. Initially, the BS-PU is located at the outer region of CR-IoT. The controllers at the BS-CR are designed for processing capacity and heterogeneity. The PU and SU are scattered with different levels of heterogeneity and it is categorized into normal, advanced and super zones with ascending energy order.

5.2 | Reconfigurable routing

In this section, we developed a CR-IoT based reconfigurable routing to select the optimal path with proper collection of input features from the CR-IoT in a periodical manner. The routing

reconfiguration in a periodic manner is carried out to manage the sensed information by the CR-IoT at its cross-layers considered for the study. At times, the reconfiguration in routing mechanism considering more features leads to increased computational overhead and it strictly reduces the data transmission time. To mitigate such challenges, the reconfigurable network modelling using ML optimizes the strategy of CR-IoT reconfiguration by rescheduling the periodicity till 10 iterations, until the heterogeneity index remains stable. The distributed controllers uphold the computational threshold on this reconfiguration model over a time t that is current period, which is given by:

$$R(t) = \begin{cases} D\left(\frac{1}{1-D\times\left(q \bmod (D)^{-1}\right)}\right) & \text{if } r > 0 \\ 0 & \text{otherwise} \end{cases}$$

where, $R(t)$ is considered as the threshold settings for CR-IoT reconfiguration over a time t, D is the probability of users in an idle model, where D is assumed as 0.1, which is the initial settings, $r > 0$ represents the computational criteria that can be implemented over the idle node. The reconfiguration based on the threshold levels offers an additional level of heterogeneous optimization to the CR-IoT network that enables smarter reconfiguration.

The implementation of the reconfigurable CR-IoT is divided into three phases that include: Topology management, settling, and forwarding phase. The details of which are given in the following subsection.

5.2.1 | Topology management

The routing algorithm assisted by the ML formulation offers coordination between the MAC and network layer to select an optimal path that enables reconfiguration of devices to attain an optimal solution. The CR-IoT topology is thus reconfigured and it demands for periodic update using topology discovery. The frequent CR-IoT update helps the ML-based routing mechanism in the precise generation of responses related to routing path establishment. The extraction of CR-IoT information is generated using hello messages from the network layers that include: Distance to BS, residual energy, distance between BS-PU and BS-CR, epoch information, operating frequency between the CR-IoT controller in licensed and unlicensed band. The controller of the BS in PU and SU/CR responds to the hello message in an iterative way making the entire CR-IoT updated with current network-related information.

The network devices in the CR-IoT are designed with heterogeneous residual energy resources and this ensures that the distributed controllers collect the information from the idle cells and broadcast the status periodically. The data from the distributed controllers about the CR-IoT information is combined into a database table and missing entries at the previous epoch ensures that the cells are in sleep mode. Then a wake-up message is sent to the sleep mode cell in the mobility-based environment that requires rapid information on localization. The frequency of exchange rate of routing messages in the static cell depends entirely on a single period. The ML is initiated to alter the interval rate of routing and its iteration in accordance with the network stability.

5.2.2 | Settling phase

The settling phase computes the reconfiguration of clusters of PU and SU in given CR-IoT topology. Also, it computes mainly the coordination between the controllers to CR-IoT stability. The optimal clustering of cells delivers the routing path assisted by ML based on the sensed information from CR-IoT. The ML further considers the heterogeneity of cells to efficiently utilize the residual resources in CR-IoT. For the attainment of higher-level throughput in the selected reconfigurable network, the study delays the task of reconfiguration deliberately up to 10 iterations.

The distributed controllers collect the information of CR-IoT heterogeneity at the maintenance phase. It is then utilized by the settling phase to estimate the average energy level of the network resources using the following equation:

$$E'_R\left(c_{b,k}(n)\right) = \left(\frac{1}{B} + \frac{1}{M}\right) \sum_{i=1}^{f(B,M)} E_R\left(c_{b,k}(n)\right)$$

where B, M represents the total number of PU and SU. The network resource tends to accumulate the average energy obtained from the network resources $E'_R(c_{b,k}(n))$, where each PU and SU have $E_R(c_{b,k}(n))$ as its residual or remaining energy.

The distributed controllers corresponding to PUs for all idle cells ($1 \leq i \geq N$) shares with BS, the routing table database that leads to potential cluster formation and then the path formation. Here, the SU acts as a cluster head (CH) and the CR-IoT controllers set the initial criteria to lead the optimal role for CHs that is, $E \geq E'_R(c_{b,k}(n))$. If the PU adheres to this condition of $E \geq E'_R(c_{b,k}(n))$, then the PU is considered as the forwarding primary units (FPUs). The CR-IoT also holds the responsibility of selecting the optimal CH that is, SU based on the estimation of distance factor of FPUs, where $1 \leq j \geq$ FPUs) with PU-BS and neighbouring cells. The distance factor given in the following equation estimates the minimum distance criteria with respect to PU-BS:

$$\min\left(D_{FPU}\right) = \sum_{j=1}^{B_{FPU}} \sqrt{(X - x(j))^2 + (Y - Y(j))}$$

where B_{FPU} is the total number of FPU, $\min(D_{FPU})$is the minimum distance between jth FPUs and the BS. The location coordinates are represented as $x(j)$ and $y(j)$ for jth FPUs and X and Y are considered as the location coordinates for BS.

The controllers use ML to maximize the FPU centrality while formulating the clusters. For the computation of FPU centrality, the study uses parameters of PU cell values with CR-IoT network parameters as discussed prior and then the centrality degree. The higher degree centrality is selected in order to optimize the process of clustering. The FPUs are allowed to form the indexing rate of centrality in order of obtaining the suitable position of FPUs. Then the centrality is considered as an average ratio of the message from the source PU that passes through other FPU (either FPU or non-FPU) to each its destination SU and it is estimated as follows:

$$C_{FPU} = \sum_{S \neq FPU \neq D} \frac{S-D_{FPU}}{S-D}$$

where *S-D* is the possible shortest path between the PU and SU, $S\text{-}D_{FPU}$ represents the shortest path between the FPUs. In this regard, the distributed controllers arrive at suitable clustered FPUs that are subjective to PU, which accommodates the potential members in cluster. C_{FPU} with $(E \geq E'_R(c_{b,k}(n))$is ranked with highest indexing rank by the controller is selected as CH. The distributed layer is built at the network layer, which is viable to broadcast the impending C_{FPU} to assist the ML in the selection of final optimal routing paths. The most potential C'_{FPU} selects the CH based on the following condition, which is expressed as below:

$$\bar{C}_{FPU} = \begin{cases} \dfrac{P(j)}{1-P(j)d*\left(r \bmod \frac{1}{P(j)}\right)} & \text{if } n \in C_{FPU} \\ 0 & \text{otherwise} \end{cases}$$

where $\bar{C}_{FPU}$ is the potential C_{FPU} and $P(j)$ is probability of selecting the final CHs.

While $n \in C_{FPU}$ is considered as the group of PU that enables the selection of $\bar{C}_{FPU}$. Finally, $\bar{C}_{FPU}$ broadcasts its status and the status of non-FPUs in selecting the optimal CHs based on minimum distance criteria, computational capacity and memory in association with the energy-efficient constraints (*a*,*b*,*c*,*d*,*e*).

The proposed ML routing protocol follows the same process of reconfiguration formulations in all iterations over the entire CR-IoT. The analytical cost of the CR-IoT is estimated using the distributed controllers while optimizing the formulation for cluster formation. The estimation is carried out after the 10th [32] iteration and the most cost-effective settings are devised for CR-IoT reconfiguration. The major consideration while finding the cost-effective settings is the even distribution of loads across PUs with minimal resource utilization and minimal energy consideration.

The optimization of communication load in PU is associated with intra and inter-cluster communications. The PUs in the cluster initiate the sensed information and it is denoted as δ with $\delta \in [1, \Delta]$ information. The δ sensed information of an *i*th PU (cluster member) is defined as Γ_{if} to the leading *j*th PU of $\bar{C}_{FPU}$, while the sensed information from other cluster members neighbouring to *i*th PU is thus represented as Ψ_{jf}. The communication cost associated with intra and inter-cluster is represented as Z_{ij} and Z_{js}, respectively. The distributed controllers realize the status on CR-IoT topology by ML routing protocol. With such information, the analytical estimation of residual resources in each PUs is estimated on all reconfiguration settings at each iteration. *b* as the binary variable or indicator helps in reporting the sensed value obtained from the PU. Hence, the communication cost for the intra-cluster is estimated as follows:

$$C_a = \sum_{i=1}^{N}\sum_{j=1}^{N}\sum_{\delta=1}^{\Delta} \Gamma_{jf} Z_{ij} \Psi_{jf} b_f$$

Likewise, the communication cost for the inter-cluster of $\bar{C}_{FPU}$ is estimated as follows:

$$C_e = \sum_{j=1}^{N}\sum_{\delta=1}^{\mathrm{A}} Z_{js} \Psi_{jf} b_f$$

The total communications cost of the CR-IoT network is estimated as follows:

$$C = C_a + C_e$$

$$C = \sum_{i=1}^{N}\sum_{j=1}^{N}\sum_{\delta=1}^{\mathrm{A}} \Gamma_{jf} Z_{ij} \Psi_{jf} b_f + \sum_{j=1}^{N}\sum_{\delta=1}^{\mathrm{A}} Z_{js} \Psi_{jf} b_f$$

$$C = \sum_{j=1}^{N}\sum_{\delta=1}^{\mathrm{A}} \Psi_{jf} \left(b_f \mathrm{Z}_{js} + \sum_{j=1}^{N} \Gamma_{jf} \mathrm{Z}_{ij} \right)$$

where

$$\sum_{j=1}^{N} \Psi_{jf} = 1$$

The $\sum_{j=1}^{N} \Gamma_{jf} \mathrm{Z}_{ij}$ is considered as a constant for any *i*th PU that tends to transmit the to transmit sensed information to *j*th $\bar{C}_{FPU}$, and hence it is replaced by a constant, which is represented as follows:

$$C = \sum_{j=1}^{N}\sum_{\delta=1}^{\Delta} \Psi_{jf} \varsigma_{jf}$$

The distributed controllers tend to coordinates with one other for reducing the communication cost, and the following inequalities represent the minimal communication cost:

$$\min C = \sum_{j=1}^{N}\sum_{\delta=1}^{\Delta} \Psi_{jf} \varsigma_{jf}$$

ALGORITHM 1 Algorithm on ML assisted network settling phase

Input: All PU

Output: FPU and non-FPU

Initialization:

Estimate the residual resource in each PU

if $E \geq E_R$ then

Select C_{FPU}

Else

Find all the Member PU

else if estimate the clustered distribution then

Calculate centrality for the clusters

End

if centrality ≥ threshold centrality then

$\bar{C}_{FPU} = C_{FPU}$

Else

Member SU

End

$$\text{s.t.} \quad \begin{cases} \sum_{j=1}^{N} \Psi_{jf} = 1 \;\; \forall \delta \in [1,0] \\ \Psi_{jf} = 0,1 \quad \forall j \in [1,N] \end{cases}$$

The above inequality describes the formulation associated with a binary integer problem, which is of the NP-Hard type. The study uses the executions from greedy algorithm [29] to test the possible solution. At this instant, the study focuses entirely on the processing ability by a particular quantitative value $\Delta_{\max}$. This restricts the analytical operation of the CR controller and it is expressed as:

$$\min C = \sum_{j=1}^{N} \sum_{\delta=1}^{\Delta} \Psi_{jf} \varsigma_{jf}$$

$$\text{s.t.} \quad \begin{cases} \sum_{\delta=1}^{\Delta} \Psi_{jf} \leq \Delta_{\max} \;\; \forall j \in [1,N] \\ \sum_{j=1}^{N} \Psi_{jf} = 1 \qquad \forall f \in [1,0] \\ \Psi_{jf} = 0,1 \qquad \forall j \in [1,N] \end{cases}$$

Thus, the settling phase using the ML algorithm highly achieves a maximum reduction in communication costs to prolong the network lifetime with increased residual resources in a cost-effective way. The Algorithm 1 shows the efficiency of the settling phase with the number of PUs deployed over CR-IoTs with optimal selection of FPU.

Estimate the reconfiguration threshold to find the sensed information of CR-IoT

Reconfigure the ML routing policy;

Find the threshold value

Reconfigure the routing path for optimal data transmission

5.2.3 | Forwarding phase

After the reconfigured forward rules are settled for FPUs in the settling phase, the actual data transmission takes place in the forwarding phase for traffic. The PUs then receive the overall sensed information of CR-IoT from the controller using its multi-sensing utilities. Upon the deployment of the controller, the PU configures its preferences for communication. The controllers check iteratively the exchange of hello packets and the actual data transmission. The controller with a threshold value sets the analytical operation for routing based on the sensitivity of PUs. The SU chooses the threshold value and compares it with the generated random number. The threshold value decides the generation of PU sensed reports. The critical data is then analysed during this phase and transmitted over other PUs without delays. The study upholds the property of data transmission in an inter-cluster multi-path communication. At times, the transmission is enabled directly to the BS-SU to avoid delays in times of ad-hoc nature or in case of secured or critical data. The threshold value generation based on the priority of the critical data is carried out at the settling phase, if the sensed data reports consider the priorities to be reconfigured. Finally, it is seen that the MAC layer guides the controller for possible latent free transmission.

6 | PERFORMANCE EVALUATION

In this section, the performance of ANN assisted cross-layered routing in CR-IoT is evaluated using residual energy, capacity and energy efficiency over different scenarios. Here, the simulation is conducted in a MATLAB environment on a high-end computing system.

The study does not consider any dataset but the video streaming data is transmitted between the sender and the receiver. The simulation is carried out with one BS-PU/2 BS-CR as per the system model. In this system, several CRs are allowed to share its resource with the PUs. In CR-IoT, the CR and SU are randomly distributed in a coverage area of $\frac{1}{\sqrt{2}}$ km, which is the transmission range of a BS-PU. The Rayleigh fading channel is designed for the CR having a channel gain of $G = d^{\frac{1}{c}}$, where d is the distance of transmission between the current location of CR and current location of BS-CR, and c is the path-loss factor, which is considered as four and the bandwidth $W = 200$ kHz. The ANN learning rate is chosen as 0.7 [30] for faster convergence of the solutions. Since, higher learning rate factor leads to falling in local optima. The greedy method for exploration sets its exploration rate closer to unity at each iteration. Higher the rate than unity will lead to improper exploitation of routes with premature convergence. On another case, ANN does not fall at any premature convergence and hence the outputs of ANN are

TABLE 1 Model and system parameters

Parameter	Value
Bandwidth (W)	12.4 MHz
Total resources	50
Transmit power of BS-PU	43.2 dBm
Transmit power of BS-CR	20.5 dBm
SINR threshold	10 dB
Threshold Inference of PU	5×10^{-12} W
Model parameters	
Step size	0.00001
Neuron update threshold	10^{-4}
Neurons count	12,000

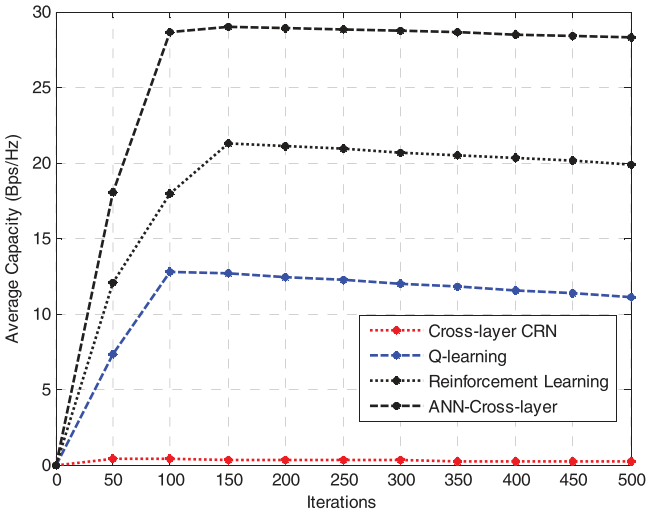

FIGURE 4 Network capacity for Case 1 having fixed BS-PU and mobile BS-CR using ML and benchmark methods

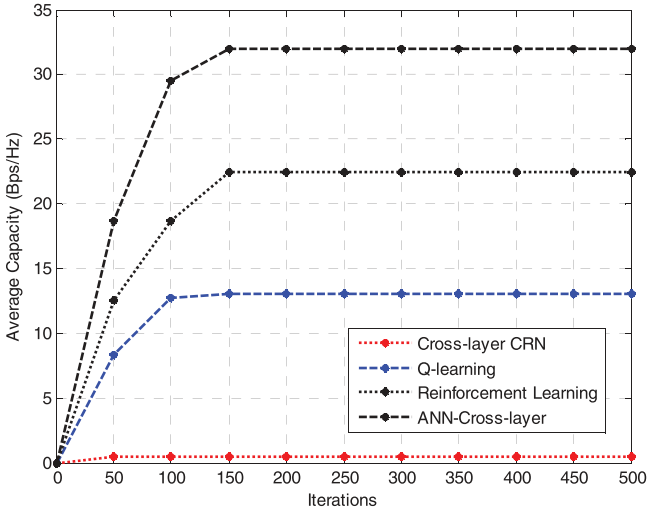

FIGURE 5 Network capacity for Case 2 having mobile BS-PU and fixed BS-CR using ML and benchmark methods

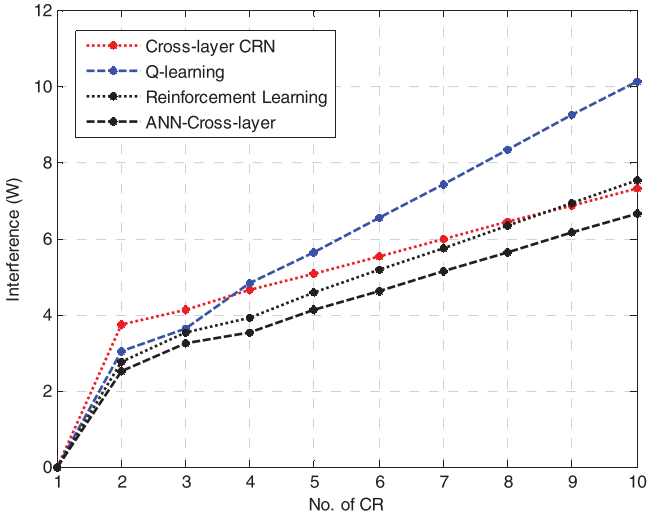

FIGURE 6 Interference for Case 1 having fixed BS-PU and mobile BS-CR using ML and benchmark methods

measured based on the error measurement at each PU. The simulation parameters used for the study are presented in Table 1.

6.1 | Average network capacity

In this subsection, the average network capacity is estimated, where the results are illustrated in Figures 4 and 5. Two different case studies are handled in the study: Case 1 – fixed BS-PU and mobile BS-CR [31] and Case 2 – mobile BS-PU and fixed BS-CR. Case 1 condition is illustrated in Figure 4 and Case 2 condition is illustrated in Figure 5. It is seen that higher average capacity is achieved in fixed BS-CR that is, at Case 2 than Case 1. As the computations in the controller embed with ANN due to mobile BS-CR falls at slow convergence due to mobility and with higher mobility, the average network capacity tends to degrade. Thus, it is seen that none of the solutions falls at premature convergence and it provides optimal paths in delivering the packets between source and destination nodes. On the other hand, there exist an increased in interference (as in Figures 6 and 7) with increasing CRs with increased mobility ranges and on the other hand, the fixed BS-CR enables lesser interference than Case 2.

The machine learning assisted routing protocol in CR-IoT enables the collaboration of controllers with primary or SUs at the forwarding plane for the formulation of clustering that pave the way for data packet routing with sensed information about the CR-IoT. The controllers with machine learning assist the routing mechanism to map the resources of PU to enable optimal data transmission with a high level of network heterogeneity.

In case of fixed BS-CR, no slow convergence is reported as the BS-CR is static and offers high data rate communication with other BS-CR and mobile/static BS-PU. The fixed BS-CR further supports the ANN model to update the sensed information of the network at each iteration.

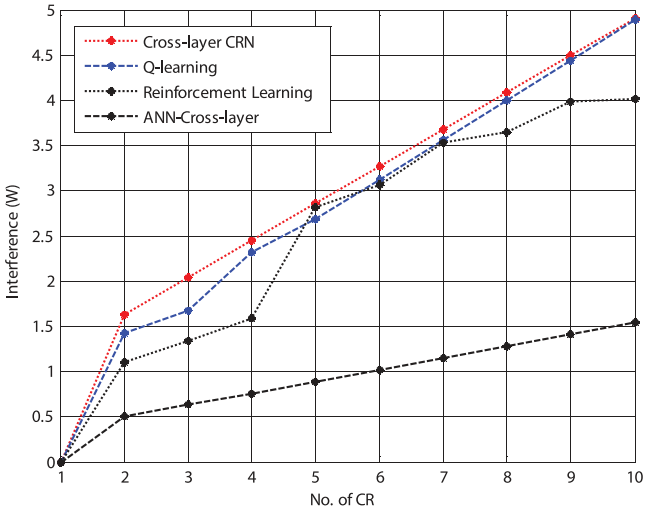

FIGURE 7 Interference for Case 2 having mobile BS-PU and fixed BS-CR using ML and benchmark methods

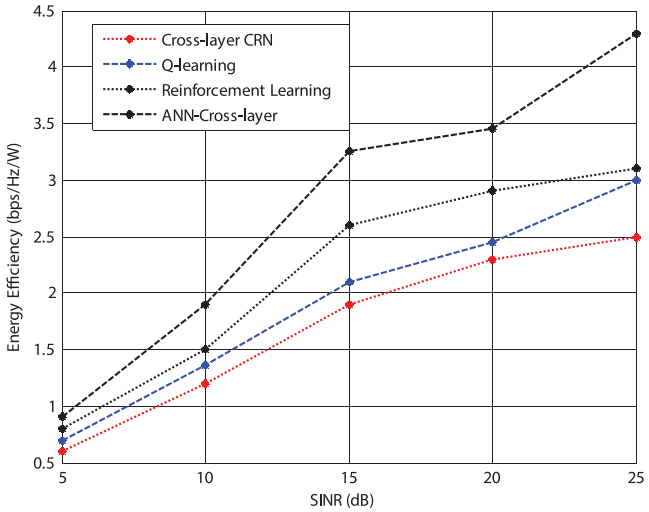

FIGURE 8 Energy efficiency for Case 1 having fixed BS-PU and mobile BS-CR w.r.t to SINR

6.2 | Energy efficiency

In this subsection, the average energy efficiency is estimated, where the results are illustrated in Figures 6 and 7. Similar to the previous subsection, two different case studies are considered for evaluating the CR-IoT assisted by ANN routing. The average efficiency is estimated using SINR and the results of Case 1 are illustrated in Figure 8 and likewise Case 2 is given in Figure 9. Higher energy efficiency is achieved in fixed BS-CR that is, at Case 2 than Case 1. Even in lower SINR, the ANN assisted routing performs better than other methods. The separation of three different operations and that the assistance of ANN enables the CR-IoT to improve its performance than other methods.

On the other hand, with an increasing number of CRs, the energy efficiency is illustrated for both the cases in Figure 10,11. The simulation results show that with increasing CRs, the energy efficiency reduces. The number of CRs tends to

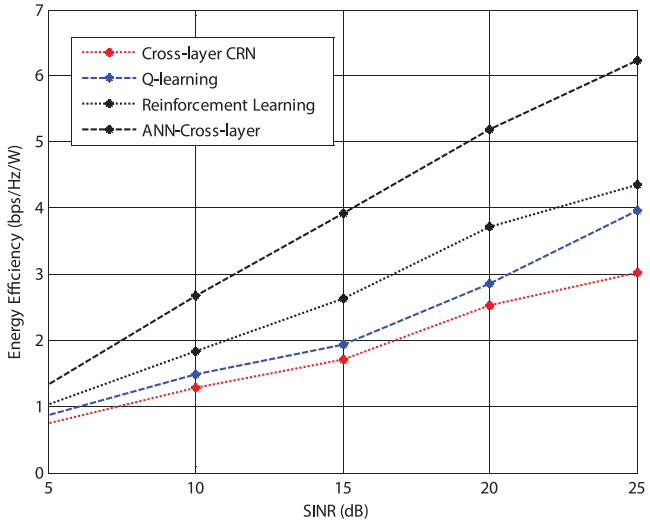

FIGURE 9 Energy efficiency for Case 2 having mobile BS-PU and fixed BS-CR w.r.t to SINR

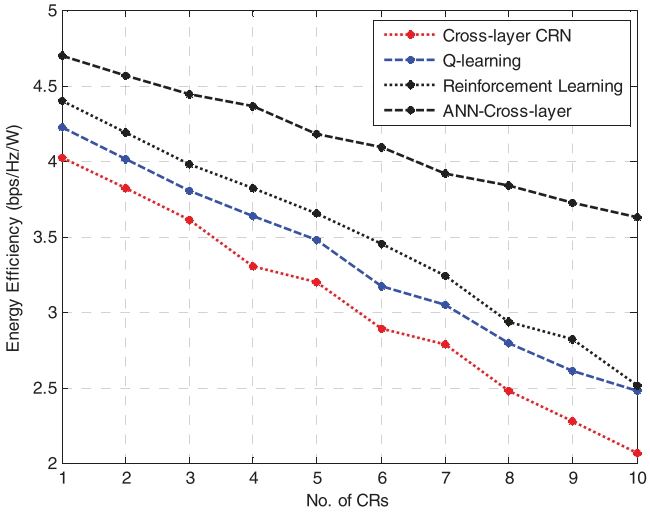

FIGURE 10 Energy efficiency for Case 1 having fixed BS-PU and mobile BS-CR w.r.t to increasing CR

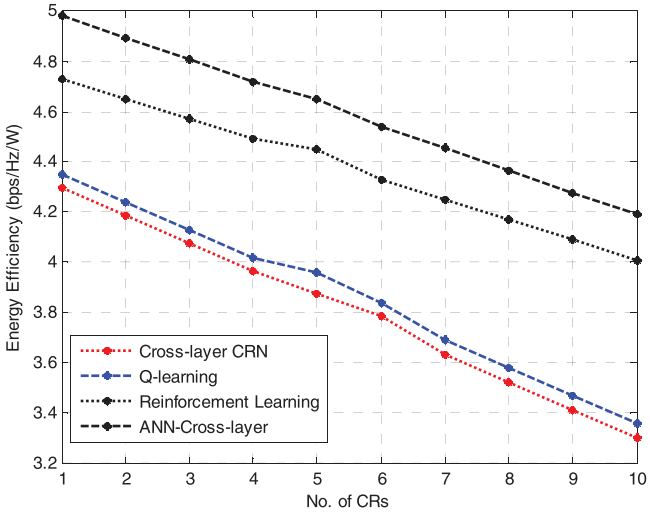

FIGURE 11 Energy efficiency for Case 2 having mobile BS-PU and fixed BS-CR w.r.t to increasing CR

cause a high range of interference and it consumes more power and resources to achieve the task of routing between the source and destination.

7 | CONCLUSION

In this paper, we designed a machine learning assisted cross-layer routing in a reconfigurable CR-IoT application. The distributed controller senses the whole environment and generates the reports of CR-IoT to make an optimal decision on cluster member selection, cluster head selection and routing path selection. Such optimal selection enables the actual data transmission by considering the entire nature of CR-IoTs that is, its characteristics.

The utilization of three phases with the assistance of ML further boosts this selection with reconfiguration of clusters, threshold and CR-IoT based on the network requirement. The merits involve the utmost utilization of CR-IoT network with a controller to enable optimal data transmission with higher network level heterogeneity. The cross-layered mechanism enables the coordination between the layers with periodic reconfiguration during the process of routing. The distributed controllers with mutual coordination optimize the operations at the settling phase and hence the routing paths are deployed. This cross-layer approach on network routing operation offers better energy efficiency, network stability and resource utilization.

Furthermore, the study is extended with the routing operation with the channel imperfection effects in heterogeneous cooperative CR-IoTs. Further, the ability of adding cloud storage for routing operation would no longer be a constraint considered for updating the routing table.

ACKNOWLEDGMENTS

This work was financially supported by the Government of the Russian Federation through the ITMO Fellowship and Professorship Program.

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How to cite this article: Natarajan, Y., et al.: An IoT and machine learning-based routing protocol for reconfigurable engineering application. IET Commun. 16, 464–475 (2022).
https://doi.org/10.1049/cmu2.12266

BIG DATA MINING AND ANALYTICS
ISSN 2096-0654 02/07 pp76–83
Volume 4, Number 2, June 2021
DOI: 10.26599/BDMA.2020.9020007

Analysis of Protein-Ligand Interactions of SARS-CoV-2 Against Selective Drug Using Deep Neural Networks

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Abstract: In recent time, data analysis using machine learning accelerates optimized solutions on clinical healthcare systems. The machine learning methods greatly offer an efficient prediction ability in diagnosis system alternative with the clinicians. Most of the systems operate on the extracted features from the patients and most of the predicted cases are accurate. However, in recent time, the prevalence of COVID-19 has emerged the global healthcare industry to find a new drug that suppresses the pandemic outbreak. In this paper, we design a Deep Neural Network (DNN) model that accurately finds the protein-ligand interactions with the drug used. The DNN senses the response of protein-ligand interactions for a specific drug and identifies which drug makes the interaction that combats effectively the virus. With limited genome sequence of Indian patients submitted to the GISAID database, we find that the DNN system is effective in identifying the protein-ligand interactions for a specific drug.

Key words: Deep Neural Network (DNN); coronavirus; protein-ligand interactions; deep learning; clinical healthcare system

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Manuscript received: 2020-06-04; accepted: 2020-06-18

1 Introduction

The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has increased the mortality across globe. The prevention of anti-drugs is essential in reducing the mortality rate at a quicker rate so as to effectively combat the virus globally[1].

On one hand, with the advent of computationally intensive methods, the protein sequencing is made less expensive and faster. On the other hand, high-cost experiments and technical difficulties have led to poor accuracy in finding the protein-ligand interaction, where the smaller structural details are found[2]. The primary protein structure (amino acid sequence) and its binding residue help in direct determination of tertiary protein structure. Therefore, the binding residues are found easily through the protein properties, but it fails to reveal the complex nature of protein structure and binding residues from the primary structures[3].

In the field of bioinformatics, the utilization of deep learning algorithm in recent years helps in the prediction of binding residues using complex structural mappings.

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It further varies from predicting the RNA-protein binding, secondary protein structure, and compound interaction of proteins and contact mapping[4]. The conventional computation methods using structural sequencing for the protein-ligand interaction assist in predicting the binding residues[5]. The deep learning architectures fit well to work on 3D-structure templates for binding and mapping. It extensively reduces the cost associated with template matching in distributed environment. The other major problem involves the higher order of 3D protein structure leading to poor utilization of 3D-structural data, thereby limiting the prediction of protein binding residues. With deep learning as the protein structure prediction model, we model the present study to find the relative drugs most suitable for treating the SARS-CoV-2 viral infection. Hence, in this paper, a Deep Neural Network (DNN) model is designed to find the protein-ligand interactions of selective drugs, which include ketoamide, lopinavir, nelfinavir, remdesivir, and ritonavir[6]. We analyze the protein-interaction behavior of COVID-19 with all the five drugs using DNN training and testing module.

The main contributions of this work involve the following:

(1) We develop a deep learning model that involves in finding the potential drugs against the formation of protein-ligand interactions of SARS-CoV-2 virus from the asymptomatic Indian patients based on the limited datasets collected.

(2) The study is supported by testing the patients against various drugs reported in Ref. [6], which include ketoamide, lopinavir, nelfinavir, remdesivir, and ritonavir.

(3) The optimal protease inhibitors are studied using the DNN model to find the negative dock value. Among all the selective inhibitors, the DNN with its repeated iteration confirms which of the utilized drugs is allowed to report the most effective binding value in comparison with the past binding results from Ref. [6].

The outline of the paper is presented below: Section 2 provides the related work. Section 3 discusses the proposed DNN protein-ligand interaction system. Section 4 evaluates the entire work. Section 5 provides the result and discussion. Section 6 concludes the work with possible directions of future scope.

2 Related Work

Upon reviewing various literatures on finding the COVID-19 drugs, we found that most of the existing methods[3–10] were operated on screening the patients using the CT and X-ray images of chest regions to detect the COVID-19 symptoms. In addition, with the image screening process, the authors in Ref. [11] used the nucleic acid testing (and polymerase chain reaction[12]) of SARS-CoV-2 for final identification of COVID-19 related symptoms. The authors in Ref. [13] aimed to develop a deep trained neural network model for finding the effective protein-ligand interaction from three different datasets, which include homology modelling and virtual screening on chimdiv database and tri-peptide database. The process involves alignment of protein sequence, virtual screening against four small compounds, and tri-peptides.

There exist several deep learning algorithms[14] on predicting the protein structure using deep learning algorithms, which include feed-forward neural networks[15], deep neural networks[16], recurrent neural networks[17], and convolutional neural network[18]. These methods show the protein structure annotations that help in describing the structure of proteins based on the extraction of protein sequence with local and global conformations to guide the protein folding[19]. The introduction of deep learning model produces higher representations by reducing the input dimensionality and aids in complex protein structures. With such motivation, the present study predicts the protein structure of SARS-CoV-2 patients using DNN, thereby providing insights on drug development process.

3 Material and Method

Dataset: The RNA sequences are collected from GISAID database, where they are translated into protein sequences for building the 3D model for possible DNN prediction. The RNA strands are collected from Indian citizens to study the effect of drugs on the SARS-CoV-2 virus.

Drugs considered: The study reports five different drugs including ketoamide, lopinavir, nelfinavir, remdesivir, and ritonavir. The binding energy of each drug with bond length is given as an input to the DNN model for drug prediction based on protein-ligand interaction, as shown in Table 1.

Definition of ligand binding residues: Protein-ligand interactions were studied extensively in Refs. [20–24] including drug interaction, carbohydrate recognition, and DNA binding. In addition, the drug discovery process considers the ligand binding regions prediction as an essential component, and DNN is used for such

Table 1 Binding energy and bond length of COVID-19 protease inhibitors.

Ligand	Binding energy (kcal·mol^{-1})	Bond length (Å)
Ketoamide	−5.80	2.8
Lopinavir	−6.08	2.7
Nelfinavir	−7.54	3.0
Remdesivir	−5.51	2.7
Ritonavir	−5.96	2.7

Note: 1 cal≈4.18 J; Å = 0.1 nm.

prediction purposes. To reduce the adverse effects of the drugs utilized for the study, we find the location of the binding sites based on predicting the distance between the atoms or residues that facilitates in optimizing the drug discovery process with selective structural features. These features highly influence the binding selectivity for limiting the adverse effect of drugs. There exist several methods on predicting the ligand binding sites using machine learning methods[25–28] with amino acids residues as their residues[29–31]. In the present study, the understanding on ligand interaction with protein membrane is limited due to unavailability of literatures as compared with globular proteins.

In this paper, we carry out the protein-ligand interaction to study the interaction of drugs on protein structure, which is analyzed by DNN model over several iterations. We assume the ligand atoms are intact with residual atoms. If the distance existing between these two kinds of atoms is less than the cut-off level (4.5 Å), then the atoms are said to be in binding state. From the dataset of several residues, we collect protein sequence of SARS-CoV-2 and then identify the sequence as a ligand binding residue.

Description of DNN: The architecture of DNN is given in Fig. 1. DNN is used frequently in several applications. The performance of DNN network entirely depends on the optimal selection and arrangement of network layer. The network training for DNN is carried out using the learning task. A requirement-based

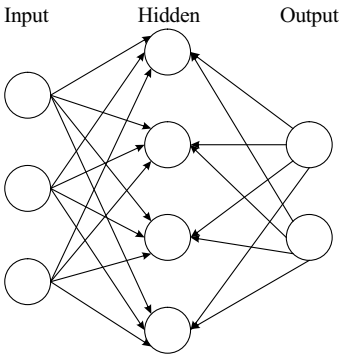

Fig. 1 Architecture of DNN.

pre-trained network is modified and the new protein sequence dataset is formed into transfer learning.

The general neural network architecture shown in Fig. 1 consists of an input layer, a hidden layer, and an output layer. Each layer is selected and arranged on the basis of the size of output, when a DNN network is designed from scratch. Initial convolutions are made based on the various filter sizes. The convolution layer extracts the protein sequences from the 3D models. The feature maps are formed and then sub-sampled using pooling layer, and then the size of feature map reduces for propagation over upcoming layers.

The activation function in DNN is a Rectified Linear Unit (ReLU). To reduce the simplicity of computations, it operates more like a linear activation function than other activation functions. The rectified linear unit as an activation function exploits improvements in training the multi-layered networks with reduced complexity in contrast with a nonlinear activation function. The nonlinearity of the DNN model is added in order to perform more effectively at training for the network.

The DNN layer is completely connected and it includes an input layer, multiple hidden layer, and an output layer. The neural network functions consistently, as each DNN neuron layer is connected to next layer of a neuron. The result of classification is calculated using the connected DNN layer based on cut-off value (as discussed earlier) calculated with softmax layer for finding the distance between the residuals. Here, after classifying scores are obtained, the 3D image is classified into different classes.

Artificial Neural Networks (ANNs) consist of several artificial neuron nodes that emulate human brain neurons. In contrast to the biological neurons, there is only one kind of link between a neuron and others. The neurons collect input data, which are simple to be operated. These operations lead to the transmission of other neurons. The activation function determines if the result has been passed. The activation function plays an important role for both extraction and classification of features.

A multi-layer neural network (Fig. 2) could be considered stacked. As name suggests, when DNN contains over a hidden layer and the system moves to a layer, it is called the Multi-Layer Perceptron (MLP). These neural networks can be classified and forecast. When the DNN is used as classification, the input and output nodes match input and output classes.

The input layer $x = \{x_1, x_2, \ldots, x_p\}$ (with activation

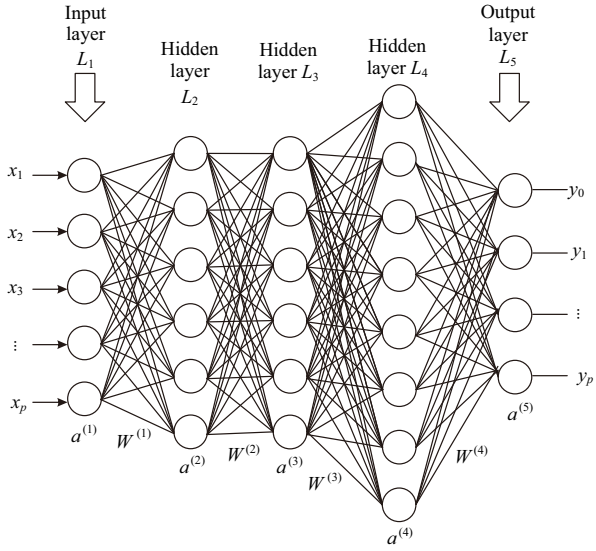

Fig. 2 Feed-forward DNN with 3 hidden layers.

function $a^{(1)}$ of weight $W^{(1)}$) consists of four elements that can be used to classify one result from another and identify a pattern in the input entities. For this purpose, we design a series of hidden units ($a^{(2)}$, $a^{(3)}$, and $a^{(4)}$) with activation functions and weights ($W^{(2)}$, $W^{(3)}$, and $W^{(4)}$), respectively. Active unit pattern is utilized by ReLU and other nonlinear activations.

As shown in Fig. 2, the output layer $y = \{y_1, y_2, \ldots, y_p\}$ is activated in hidden layer $a^{(5)}$. Weight and distortion are adjusted for hidden nodes to activate. Initially, weights and biases are randomly changed. Then we train our network for the tens of thousands of inputs. The test uses retrospective error propagation to change biases and weights in order to activate hidden neurons at suitable values.

The set or kernel of functions is the set of weights and partialities, which is used to identify a specific output. DNN will be assumed to be the key to the solution when the pattern for discrimination is complex enough to prevent traditional statistical and numerical approaches.

Pretrained network. The pre-trained network is amended to match the output requirements, which is one of the most common methods of learning. There are a lot of pre-trained user training networks. These pre-trained networks tend to face a range of training challenges when they are trained over millions. A comparison of Alexnet, ResNet-18, and GoogLeNet is discussed. Each of the three kinds of pre-trained networks brings together two kinds of layers: convolutional and pooling layers.

4 Proposed Method

In this section, as shown in Fig. 3, the prediction of protein

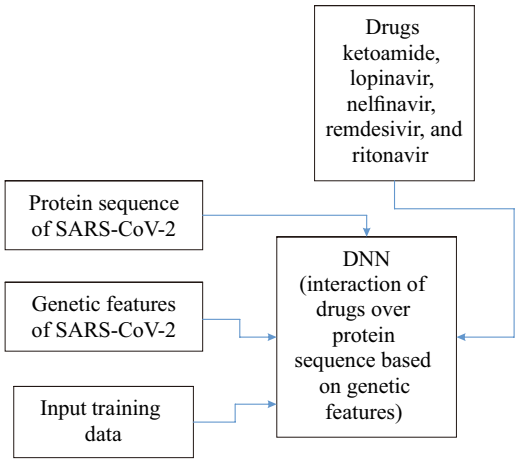

Fig. 3 Feature extraction of protein structure using artificial neural network.

structure from the repository is carried out to virtually screen the drugs for finding suitable curable drug. The complexes of protein-ligand are considered as positive and cross-docking is considered as negative for the input training datasets. The DNN is a fully connected network that has the ability to learn more abstract features from the input training data.

The DNN is modelled as a distance measure to predict the actual distance between the residual pairs within the protein-ligand interaction. It directly estimates the candidate structure's accuracy and generation of protein structure. The DNN operates as a template modelling that sets main protease of SARS-CoV-2 as its template to perform the prediction of sequence alignment.

The DNN is responsible for sequentially analyzing the SARS-CoV-2 proteins obtained from the RNA sequences, where the sequences are initially translated from the amino acid sequences. The DNN predicts the proteins by focusing entirely on the ligand binding region and S protein regions.

Then the virtual screening against all the selected drugs was performed based on the homology model. This model consists of the ligand binding region from the protease of SARS-CoV-2 as its template. The cut-off distance between the residual pair is set as 1 nm based on the template setting. The ligand database with millions of components is used as input feature by the DNN algorithm to perform virtual screening of drugs. The scalability of the model is regularised by considering the mean and standard deviation of the datasets used during normalization of input training data. With the features collected from the input training sets, the validation of DNN model is carried out with docking simulation. The validation provides the results

of compound list that can bind potentially with the protein-ligand structure. The compounds are then ranked and the one with high validation score is considered as an inhibitor for validation of suitable drug to battle the SARS-CoV-2.

Depending on the input training datasets, the validation is carried out by the DNN model. It finds the accuracy of drug interacting with protein sequences based on the genetic features and input training data. The results of validation are thus presented in the following section.

5 Result and Discussion

The protein sequence dataset[32] is used for the design and evaluation on diagnostic validation of drugs interaction over SARS-CoV-2 virus. The synthesis of protein sequence from ProteinNet[32] and its interaction behaviour with the drug used in the present study are noted at each iteration while training the DNNs. The simulations of DNN are conducted on Matlab simulator on a high-end computing machine.

The validation of the trained DNN is carried out by comparing the test results with existing methods. The protein synthesis interaction in the validation is carried out by the test dataset and the classified output is finally obtained from DNN.

If the accuracy of the prediction is not obtained well, then the network is altered until the prediction results are obtained to be precise. This helps to achieve higher validation accuracy of drug interaction with the protein synthesis with training progress. The performance of deep learning algorithm is presented via confusion tables.

The performance of the proposed method is tested in terms of accuracy, precision, recall, and F1-score as in the following equations:

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \tag{1}$$

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \tag{2}$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{3}$$

$$\text{F1-score} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \tag{4}$$

where TP represents true positive, TN represents true negative, FP represents false positive, and FN represents false negative. The performance of different pre-trained systems is thoroughly analyzed as an early stage in the development of a DNN for the classification of protein synthesis. The performance is comparable by three pre-worked networks: Alexnet, GoogLeNet and ResNet-18. In test datasets, the network is initially loaded, altered, and trained. The networks tend to achieve a better performance comparison with other performance parameters once the training has been completed.

The DNN is set with same options to compare them with parameters and same dataset for specific network architectures. The networks are trained up to 40 iterations and then the protein data are shuffled and validated over multiple iterations.

In this paper, we present the frequency of validation to be five iterations. The set of options can also accurately trace the training progress and display the validation accuracy after all three iterations. The modified pretrained network is trained for the same number of epochs. Figure 4 presents the classification accuracy of the three networks.

After training the DNN, the performance of network is evaluated under different performance metrics and confusion matrix determines all the performance of target classes, i.e., drugs interaction. The performance of DNN is then compared with other algorithms that include Deep Belief Network (DBN), ANN, Feed-Forward Neural Network (FFNN), and Back Propagation Neural Network (BPNN). The performance of the proposed DNN AlexNet is chosen for final simulation of finding the accuracy, precision, recall, and F1-score. The results are evident as shown in Tables 2–6.

The results show that the proposed DNN is effective in finding the drug interaction with protein sequence. Out of all the five drugs, the results show that remdesivir drug is effective in interacting with the protein sequence

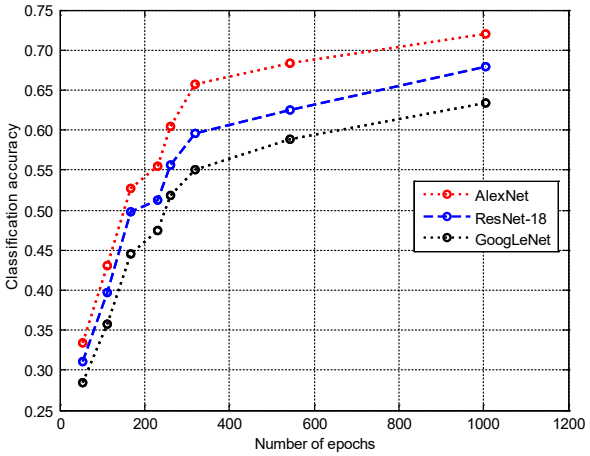

Fig. 4 Classification accuracy of training models of DNN with three pre-trained networks.

Table 2 Performance of ketoamide drug interaction with SARS-CoV-2 virus over Indian datasets.

Algorithm	Accuracy	Precision	Recall	F1-score
DNN	0.9208	0.9389	0.6064	0.7356
DBN	0.9210	0.9394	0.6100	0.7369
ANN	0.9211	0.9395	0.6152	0.7421
FFNN	0.9220	0.9398	0.6313	0.7529
BPNN	0.9222	0.9399	0.6363	0.7597

Table 3 Performance of lopinavir drug interaction with SARS-CoV-2 virus over Indian datasets.

Algorithm	Accuracy	Precision	Recall	F1-score
DNN	0.9460	0.9568	0.6968	0.6256
DBN	0.9442	0.9564	0.6786	0.6103
ANN	0.9436	0.9559	0.6751	0.6057
FFNN	0.9429	0.9558	0.6662	0.6024
BPNN	0.9414	0.9542	0.6589	0.5844

Table 4 Performance of nelfinavir drug interaction with SARS-CoV-2 virus over Indian datasets.

Algorithm	Accuracy	Precision	Recall	F1-score
DNN	0.9665	0.9762	0.9642	0.8958
DBN	0.9587	0.9761	0.9638	0.8956
ANN	0.9452	0.9760	0.9571	0.8854
FFNN	0.9403	0.9758	0.9553	0.8854
BPNN	0.9382	0.9758	0.9544	0.8643

Table 5 Performance of remdesivir drug interaction with SARS-CoV-2 virus over Indian datasets.

Algorithm	Accuracy	Precision	Recall	F1-score
DNN	0.9969	0.9984	0.9443	0.9155
DBN	0.9968	0.9982	0.9438	0.9151
ANN	0.9961	0.9973	0.9364	0.9015
FFNN	0.9961	0.9973	0.9351	0.9012
BPNN	0.9954	0.9963	0.9270	0.8806

Table 6 Performance of ritonavir drug interaction with SARS-CoV-2 virus over Indian datasets.

Algorithm	Accuracy	Precision	Recall	F1-score
DNN	0.9822	0.6963	0.9999	0.8197
DBN	0.9820	0.6913	0.9998	0.8129
ANN	0.9811	0.6752	0.9995	0.8021
FFNN	0.9810	0.6700	0.9994	0.7969
BPNN	0.9808	0.6664	0.9989	0.7956

and hence it can be treated as an effective drug for neutralizing the SARS-CoV-2 virus. The remdesivir has shown increased molecular interaction due to multiple active site residues in protease structure. There exists a single active site residue in protease structure for remaining ligand. This helps the protease inhibitors to show more molecular interactions by the remdesivir than other compounds.

6 Conclusion

In this paper, we design a DNN model for the potential identification of drugs against the protein-ligand interaction of SARS-CoV-2 virus, specifically in Indian patients. The results of DNN are accurate and it is quick in finding the antidote among the selective drugs using virtual drug screening process. The DNN assists the drug screening process by generating possible compound and tripeptide list on asymptotic Indian patients. The rich antiviral property in the nucleic acid analogue of adenosine and nucleotide analogues used in remdesivir is found to be effective in combating the viral property of SARS-CoV-2 infections. The experiments on protein-ligand interaction provide possible cure by the remdesivir drug than other selective drugs. The results are accurate with repeated iterations with the negative dock value and binding energy value. Depending on the molecular interaction with protease inhibitors, it is found that the remdesivir drug provides the instant relief against the COVID-19 symptoms and possible cures against the viral infection. In the future, the study may be developed with a possible combination of reinforcement learning and deep learning algorithm to deeply analyze the peptide structure from protein-ligand interaction.

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8407

TRANSPORT VEHICLE MAITANANANCE USING SMART PHONE APPLICATION

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Abstract: The TVM project is designed to provide easy access of maintaining the bus details like time scheduling and maintenance. Using mobile application this project is very useful for the in charge of transports in every concern. Especially it is useful for the institutions .By using this project we can maintain the details of drivers, students, staffs, and other users. Also we can maintain the details of particular bus.

We can use this project for the following maintenance.

Bus Details : RC details, F C details , fuels refilling, mileage and servicing.
Driver Details : posting driver and acting driver name , address ,mobile number ,licence number and attendance.
Route Details : Stoppings in particular route, particular time of particular stoppings.
Students Details : Register number, department ,name, address, fees instalments, and boarding Point.
User Details : Details and boarding point of faculties , nonteaching staffs, office employees, Housekeeping.

INTRODUCTION

Transport management is the management of a college transportation fleet. This includes commercial motor vehicles such as bus, vans, as well as cars. Transport management has a range of functions, such as vehicle financing , vehicle telemetric .Transport management is a function which allows companies which all transportation in business to remove or minimize the risks , associated with vehicle investment thus improving efficiency ,productivity and reducing their overall transportation and staff costs and providing 100 % compliance with government registration .

In order to get good support from customer, bus company need to perform good service and facilities. Therefore, to generate to the best bus services, the college management should be more effective and efficient. By computerized the manual system and bus operation. the management of the transport company can become more effective and good performance of service might be increased.

Bus management system is a standalone system. This computerized management system if for the admin to manage driver and operations. There are two part of management consist in the system such as driver management and bus management , driver management consist of driver profile ,leave, salaries and licences record while bus management consist of bus profile, maintenance schedule , road tax and insurance ,route and student boarding point.

RELATED WORK

1. **Digital bus passes checking using QR- code**

This project provides a good resolution for the managing bus pass information. Their system has 3 logins that is user, admin and conductor. This method provides internet application in addition to Robert application for individuals to induce their bus pass on line.

This method is help to scale back to paper work time consumption and the user gets the refill their account and extends the validity of card once the pass goes to expire. This method provide partiality like accessing basic info of user for authentication and supply bus pass for the user while not putting them in long queues . The conductor in bus would be security possibility for user. The conductor in bus would be able to verify the location scanning the QR code provided on the system would be send to the user in type of message like once wherever and what the Pass with a counselled device .The notification generated by the system would be send to the user in type of message like once wherever and what time the cardboard was use.

2 .**Advanced college bus management with the help of ASP.NET and CSHARP**

The here within proposed bus management software system project may be a desktop care of bus flexibility throughout these processes .The system generates complete reports associated with the bus management i.e. fees paid , dues , rout no.& bus stop .The reports highlight varied bus service and option of the faculty administration to improve the bus

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8407

transport system . The system need a relatively touch of resources like memory, input/output devices, and space. The system overall keep approach in highlight key option of the bus services.

3. **Smart college bus tracking management system and its application**

The bus pursuit system may be value effective and economical system. In addition to other method proposed this method includes four applications that are going to be developed. 1st application that is buy system that is capable of between school server and relating to the present location of buses. Second application is causation a gaggle message i.e. alter message to the student waiting at consequent stop, changes in current route, bus number etc., thus its save the time of waiting for the student buses time.

Third application is generation of e-bus pass system that is monitoring eco-friendly as there no necessity for the generation of plastic bus passes. Last application is developing associate in monitoring emergency handling system which can send alert message at the same time to varsity, police and motorcar surveillances just in case of accidents.

MODULES DESCRIPTION

In this project have 5 main modules

- Admin
- Student
- Staff
- Bus-In charge
- Driver

METHODOLOGY

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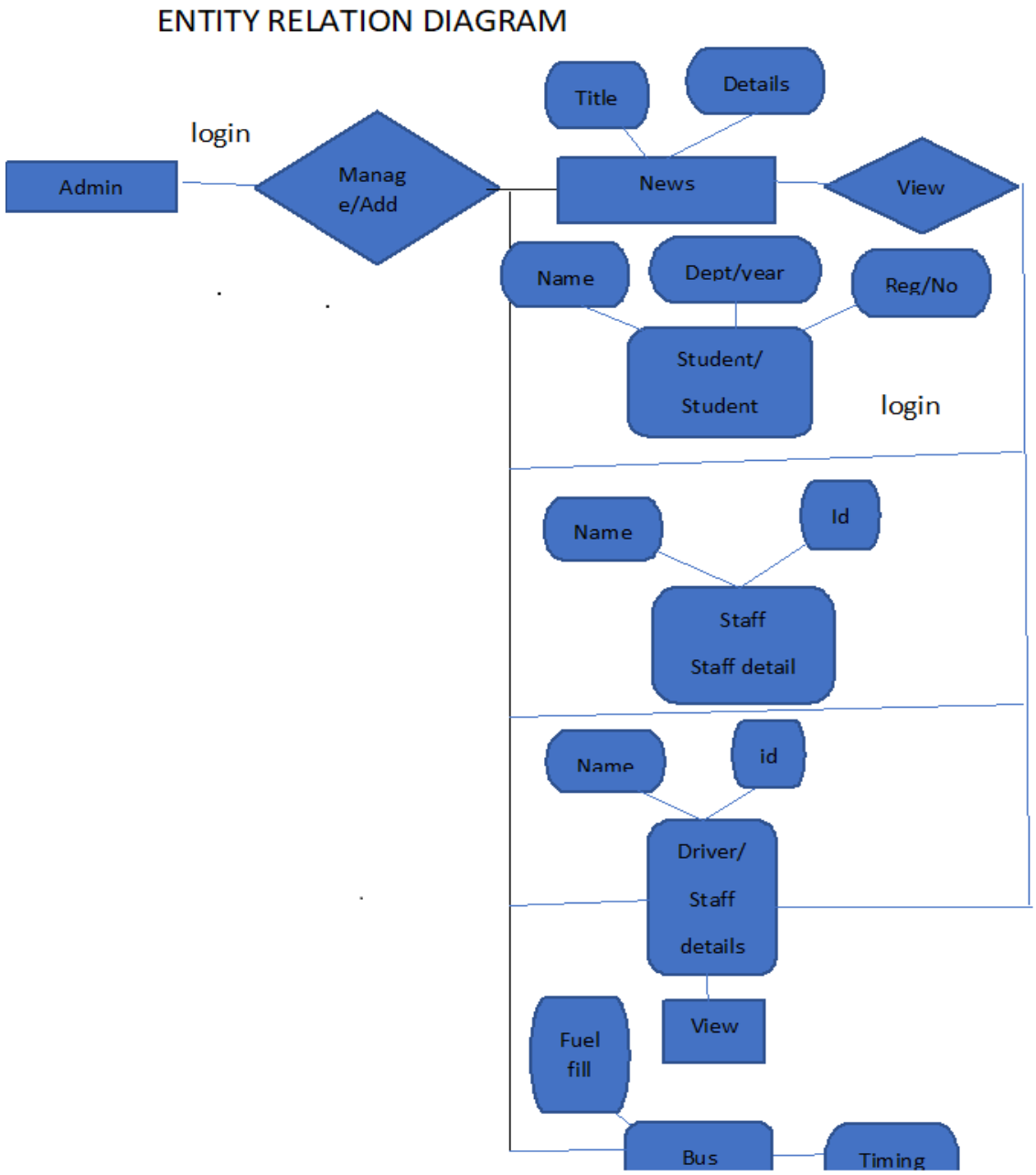
IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8407



Admin

❖ Admin can long to the admin account after authentication and authorization .the can enter new road can view the details and also he can select the route from the last routes and the corresponding stop are displayed.

❖ He can also enter the new student details and can view the last of student .He has the operator to add and remove a student details figure below the home page of admin.

TRANSPORT VEHICLE MAINTANANCE USING SMART PHONE APPLICATION	Notification | user name | student |staff |driver

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8407

SIGN IN
User Name : admin
Password : *******

Submit

LOGIN

A) Staff and student

Student and staff has enter there particular register number and mobile number to login page. Student or staff at long page using there password and register number, he has can show the bus details, fees details, route details etc…..

TRANSPORT VEHICLE MAINTANANCE USING SMART PHONE APPLICATION

user name | student | staff | driver |

Student Login here

Register No: 677876
Name : ANU

V TESTING

Software testing is a process used for the verifying the correctness, completeness and quality of the development software .

The sequence of the testing activities performed for the tracking system is below:

- Unit testing
- Integration testing
- System testing

FUTURE ENHANCEMENT

After analyzing the test result of the developed system, the following issues are still open which can be take up as future enhancement .As android phone are widely used everywhere, it is obvious that application like these offer simple solutions to do our daily activity. These the android application can be used in future to manage not only college bus but also vehicles that belong to the institution. these application can be also used in any other domain to carry out fleet management efficiently.

CONCLUSION

Despite the ingenuity show by many transportation in developing their individual maintenance monitoring programs . the college maintenance clearly lacks guidance and direction in this perform important area .NTD report ,useful as basic assessment of overall agency performance ,are not being used widely by maintenance personnel.

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IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9507

Student Placement Prediction Using Support Vector machine Algorithm

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Abstract: Campus placement plays a vital role in every educational institution in helping students to achieve their goals. All students dream to obtain a job offer in their hands before they leave their college. In this paper, a predictive model is designed which can predict whether a student get placed or not. The main objective of this project is to analyze the student's academics data, aptitude data and predict the placement possibilities of students to have an idea about where they stand and what to be done to obtain a good placement. Which also aids to increase the placement percentage of the institutions? The data has been collected by the institution for which prediction is going to be done and by applying suitable data pre-processing techniques. The model is built by both training and test set which gives accuracy in prediction. Here we use a single supervised machine learning algorithm named support vector machine algorithm. This algorithm independently predicts the results and we then compare the efficiency of the algorithm, which is based on the dataset. This model will help the placement cell to focus on the potential students and help them to improve their technical and other skills.

Keywords: Prediction, SVM, Data mining, Logistic Regression, Decision tree, Random Forest.

I. INTRODUCTION

According to statistics 1.5 million engineers are graduating each year in India. The demand and need for qualified graduates in field of IT industry is rising day by day. But most of the students are unaware about the needs of the IT industry. The number of the student graduates who satisfies the requirements and quality of a company is very low. Placements are one of the biggest challenge faced by a student in the lifetime. It is the responsibility of the institutions to provide maximum placement chance to its students. Also the placement cell and teachers of an institute should take proper steps inorder to produce a set of students suitable for each company's requirements. A placement prediction system can be used to identify the capability of a particular student for the specified job.

All companies in the IT sector spends a large amount of its total capital in recruiting the students to its company. Thus it is necessary to find an alternative process of filtering to reduce the capital cost that is used for this process. Effective filtering of students could be performed by applying various data mining and machine learning tools on the student details. Luan [1] defined the meaning of data mining in the field of education as a method of identifying, discovering and capturing the unknown similarities or patterns from a dataset by using an ensemble combination of various analytical approaches.

II. RELATED WORK

A. Prediction using Logistic Regression

This paper [2] presents the design of a placement predictor using the predictive analysis model called as Logistic Regression. Logistic regression is one of the most commonly used statistical model which is used as a classifier in the field of machine learning. The tool designed here predicts the probability of a student being placed and classifies the dataset based on prospect of getting recruited into a company or not. The dataset for the work consists of variables such as various marks obtained in secondary and graduation examinations along with demographic details such as resident status and gender of student. The dataset also comprises of a placement indicator variable to identify the placement status. An optimization technique Gradient Descent Algorithm is applied on the training data to obtain the minimum values of the parameter that is used for classification. The minimization process is repeated until the decrease in the value of weight become negligible. The iterative step is given in (1)

$$\theta_j = \theta_j - \alpha \frac{1}{m} \sum_1^m \left(h_\theta\left(x^{(i)}\right) - y^{(i)}\right) x_j^{(i)} \quad (1)$$

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IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9507

The general formula to get the value of prediction for each parameter is given below in (2).

$$p = \theta^T x \quad (2)$$

Sigmoid function is applied on predictions inorder to obtain probabilities of classifier in the range of 0 and 1. This paper [3] proposes a placement analyzer system that recommends students with the best suitable placement status depending upon their capabilities. The probability chances of students from different departments are predicted in this work. The five different placement statuses considered in this work are

Dream Company (Companies with CTC ≥10 lpa), Core Company (Companies with CTC ≥4.5 lpa & CTC < 10 lpa), Mass Recruiters (Companies with CTC < 4.5 lpa), Not Eligible and Not Interested in Placements. The prediction is performed using Logistic Regression by using the biglm package in R tool. The dataset for the work includes basic details of student (such as gender, location), marks obtained and board of study in secondary examinations, graduation examination details (such as department, grade points and arrear history). The minimal value of each variable is computed using the regression analysis of different data for the variables found in the dataset. The required probability chance of the system is computed using the (3).

$$P(Y) = e^L/(1+e^L) \quad (3)$$

B. Prediction using Decision Tree Algorithm

This paper [5] proposes a model that predicts the probability of placement of a student in a company using ID3 decision tree algorithm. This system analyses the given dataset to identify the most relevant parameters required for placement prediction from the student dataset. Entropy and Information gain values of all parameters in the dataset is measured and the parameter with suitable measurement value is selected as split variable while building the decision tree. The Weka Tool generates an optimized decision tree with leaves representing the placement prediction chance of the student. The dataset comprises of marks obtained in secondary examinations, graduation grade points, arrear history and department type, details of various skills such as programming skill and communication skill, internships attended and details regarding interests in future studies. Let the selected parameter has c different values and be the associated probability value for each respective parameter, then the formulae for entropy measurement of each parameter is given in (4).

$$Entropy\ (s) = \sum - Pi\ log_2 Pi \quad (4)$$

The equation for information gain is given in (5) as the difference between entropy of original dataset and entropy of the subdivided dataset after selecting the spilt attribute.

$$Gain = H(D) - \sum P(Di)\ H(Di) \quad (5)$$

This paper [6] proposes a system to predict the possibilities of student placement selection using various decision tree algorithms. The most common decision tree algorithms such as ID3, CHAID, C4.5 and CART algorithms were applied on the dataset using the Rapid Miner Tool. The analysis is to figure out the most suitable algorithm for the given dataset. From the result analysis and measurements they found ID3 algorithm as the one with highest accuracy.

C. Prediction using classification and clustering techniques

This paper [9] proposes a system that predicts the type of the company such as Consultancy or IT Company and the specific name of the company a student have chances to be placed based on their academic performance. The dataset comprises academic details of students including their grade points and performance details of the selected subjects as well as the recruited company details. Classification and clustering techniques are implemented using the J48 decision tree algorithms using the WEKA data mining tool. J48 is an extension of ID3 algorithm with some added features. A Naïve Bayes classifier model is also implemented using the WEKA tool. This supervised

learning classifier is a statistical method based on the Bayesian theorem. This classifier is mostly used when the dataset is small with large dimensionality. Equation (6) states the Bayesian Theorem [10].

$$P(A/B) = P(B/A)\ P(A)/P(B) \quad *$$

Where A is the hypothesis to be tested and B is the evidence associated with A. From the result analysis process, the system could identify the most featured attributes of the dataset in the recruitment process.

measure is a procedure that is performed in order to obtain a pattern from The given dataset. The dataset is collected by conducting a survey among students and obtaining their details. Dataset comprises of personal details such as gender and category; academic details including grade obtained in various such as 10th, 12th, graduation and post-graduation exams, arrear history and gaps in between academic life; communication skills; details regarding the attended technical courses and placement status. A priority value is set for each attribute in the dataset and a combination of most required attributes are selected for prediction. Using the sum of difference method, a reference value is computed corresponding to the selected attributes. If a student scores above this value indicates that student will get placed in the recruitment.

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IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9507

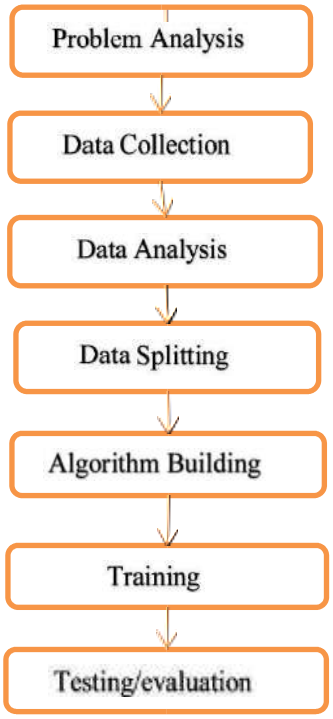
D. Prediction using Job Competency Modeling

This paper [12] proposes a system that builds a Job competency model which consists of two phases. Initially all the domain fields required for each specific job are recognized and then a job competency score is calculated for students by analyzing their academic score in the domains recognized. If the computed score is greater than a threshold score indicates the student suites for the job designation. The input to the system includes the job designation, areas and course title required for job as well as the students marks obtained in graduate curriculum examinations. For each student, a competency profile is formed as a graph by assessing the student's academic results. The root node of the graph is the job title followed by domains related to the job as the succeeding layers of the graph. The edges in the graph represents the relevance factor of each domain corresponding to the job and then the domain score is computed. Suppose node P is the starting node with n nodes, named as Qi, connected directly to the start node with weight Wi. Each node among n nodes is associated with a score Si and total score of the succeeding nodes at node Qi is Ti. The total score obtained by the student for the specific job designation can be obtained using (7).

$$S = \Sigma_{i=1}^{n} \left(Wi/100\right) * Si/Ti \quad (7)$$

III. METHODOLOGY

In this paper we use machine learning techniques to predict the placement status of students based on a dataset. The parameters in the dataset which are considered for the prediction are Quantitative scores, Logical Reasoning scores, Verbal scores, Programming scores, CGPA, internal marks, external marks, list of students placed in a company The placement prediction is done by machine learning Algorithm using SVM.



1. Data Collection sample data has been collected from college placement department. As an input for model prediction, which consist of all the required dataset.

2. Data Preparation & Pre-processing

Data preparation is a step in a data analysis process in which data from one or more sources is cleaned, transformed and enriched to improve the quality of data prior to its use. The collected data were then pre-processed to fill the missing data and made compatible for further processing.

3. Data Splitting

Splitting the Dataset into Training set and Test Set ,Now the next step is to split our dataset into two. Training set and a Test set. We will train our machine learning models on our training set, i.e our machine learning models will try to understand any correlations in our training set and then we will test the models on our test set to examine how accurately it will predict. A general rule of the thumb is to assign 80% of the dataset to training set and therefore the remaining 20% to test set.

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IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9507

4. Algorithm Building

SVM algorithm is appied on the dataset. SVM stands for Support Vector Machine. It is also a supervised machine learning algorithm that can be used for both classification and regression problems. However, it is mostly used for classification problems. A point in the n-dimensional space is a data item where the value of each feature is the value of a particular coordinate. Here, n is the number of features you have. After plotting the data item, we perform classification by finding the hyper-plane that differentiates the two classes very well. Now the problem lies in finding which hyper-plane to be chosen such that it is the right one. The Support Vector Machine (SVM) helps in identifying the hyperplane for classifying the data samples. In the case of multiple hyperplanes, the one which has maximum distance from the data points was chosen for better classification.

Advantages:

This algorithm performs best when there is a clear margin of separation.

- Effective in high dimensional spaces .
- If the number of dimensions is greater than the number of samples, the algorithm would be able to perform better
- It is memory efficient

5. Evaluation and Testing:

The performance measurement of the model was evaluated with the help of various metrics like accuracy, sensitivity, F1-score and precision. The performance visualization of the multi-class classification problem was analyzed using a graphical plot AUC (Area under the Curve) ROC (Receiver Operating Characteristics) curve that reveals the analytical ability of a binary classifier system as its discrimination threshold. The ROC curve is generated by plotting the true positive rate against false-positive rates at various threshold rates. The best algorithm based on the performance parameters was selected to predict the placement category of students. Based on the details provided by the students, the placement category could be predicted and the result would be displayed along with the suggestions for further improvement.

IV.CONCLUSION

From the study it is clear that the student dataset containing academic and placement details are a potential source for predicting the future placement chances and It is clear that SVM gives an accuracy of 100. This prediction can enlighten students to identify their capabilities and improve accordingly. This system also helps in the academic planning of an institution to prepare proper strategies and improve the placement statistics for the future years.

V. FUTURE SCOPE

The future enhancements of the project are to focus on adding some more parameters to predict better organized placement status. We can also enhance the project by predicting some solutions or suggestions for the output generated by the system.

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

Brain Tumour Prediction System

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Abstract: Brain Tumour segmentation is one of the most crucial and arduous tasks in the terrain of medical image processing as a human-assisted manual classification can result in inaccurate prediction and diagnosis. Moreover, it is an aggravating task when there is a large amount of data present to be assisted. Brain tumours have high diversity in appearance and there is a similarity between tumour and normal tissues and thus the extraction of tumour regions from images becomes unyielding. In this paper, we proposed a method to extract brain tumour from 2D Magnetic Resonance brain Images (MRI) by Fuzzy C-Means clustering algorithm which was followed by traditional classifiers and convolutional neural network. The experimental study was carried on a real-time dataset with diverse tumour sizes, locations, shapes, and different image intensities. In traditional classifier part, we applied six traditional classifiers namely Support Vector Machine (SVM), K-Nearest Neighbour (KNN), Multilayer Perceptron (MLP), Logistic Regression, Naïve Bayes and Random Forest which was implemented in sickest-learn. Afterward, we moved on to Convolutional Neural Network (CNN) which is implemented using Keras and Tensor flow because it yields to a better performance than the traditional ones. In our work, CNN gained an accuracy of 97.87%, which is very compelling. The main aim of this paper is to distinguish between normal and abnormal pixels, based on texture based and statistical based features.

INTRODUCTION

Medical imaging refers to a number of techniques that can be used as non-invasive methods of looking inside the body [1]. Medical image encompasses different image modalities and processes to image the human body for treatment and diagnostic purposes and hence plays a paramount and decisive role in taking actions for the betterment of the health of the people. Image segmentation is a crucial and essential step in image processing which determines the success of a higher level of image processing [2]. The primary goal of image segmentation in medical image processing is mainly tumour or lesion detection, efficient machine vision and attaining satisfactory result for further diagnosis. Improving the sensitivity and specificity of tumour or lesion has become a core problem in medical images with the help of Computer Aided Diagnostic (CAD) systems. According to [3], Brain and other nervous system cancer is the 10th leading cause of death, and the five-year survival rate for people with a cancerous brain is 34% for men and 36% for women. Moreover, the World Health Organization (WHO) states that around 400,000 people in the world are affected by the brain tumour and quality of images. The contrast adjustment and threshold techniques are used for highlighting the features of MRI images. The Edge detection, Histogram, Segmentation and Morphological operations play a vital role for classification and detecting the tumour of brain. The main objective of this paper is too studied and reviewed the different research papers to find the various filters and segmentation techniques, algorithms to brain tumour detection. The various steps of MR imaging like; pre-processing, feature extraction, segmentation, post-processing, etc. which is used for finding the tumour area of MRI-images 120,000 people have died in the previous years [4]. Moreover, An estimated 86,970 new cases of primary malignant and non-malignant brain and other Central Nervous System (CNS) tumours are expected to be diagnosed in the United States in 2019 [5]. A brain tumour occurs when abnormal cells form within the brain [6]. There are two main types of tumours- Malignant and Benign. Malignant brain tumours originate in the brain, grows faster and aggressively invades the surrounding tissues. It can spread to other parts of the brain and affect the central nervous system. Cancerous tumours can be divided into primary tumours, which start within the brain, and secondary tumours, which have spread from elsewhere, are known as brain metastasis tumours. On the other hand, a benign brain tumour is a mass of cells that grow relatively slowly in the brain. Hence, early detection of brain tumours can play an indispensable role in improving the treatment possibilities, and a higher gain of survival possibility can be accomplished. But manual segmentation of tumours or lesions is a time consuming, challenging and burdensome task as a large number of MRI images are generated in medical routine. MRI, also known as Magnetic Resonance Imaging is mostly used for brain tumour or lesion detection. Brain tumour segmentation from MRI is one of the most crucial tasks in medical image processing as it generally involves a considerable amount of data. Moreover,

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

the tumours can be illdefined with soft tissue boundaries. So it is a very extensive task to obtain the accurate segmentation of tumours from the human brain.

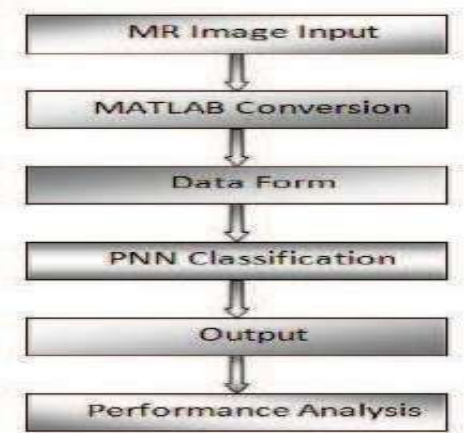
PROBLEM ANALYSIS

Image segmentation has been identified as the key problem of medical image analysis and remains a popular and challenging area of research. Image segmentation is increasingly used in many clinical and research applications to analyse medical imaging datasets; which motivated us to present a snapshot of dynamically changing field of medical image segmentation.

A computer system has been design to recognize the typical feature of the tumour from the digital images of the brain. The basic concept is that local texture in the images can reveal the typical regularities of the biological structures. Thus, the textual features have been extracted using a co-occurrence matrix approach. The level of recognition, among three possible types of image areas are: tumour, non-tumour, non-tumour and back ground. We are focusing on tumour image segmentation.

RELATED WORK

In recent years, interest in designing tools for diagnosing brain tumors has been increasing. The work of Gopal and Karnan [1] uses image processing clustering algorithms to classify images into a group that has a brain tumor and another group which does not. The dataset used in this work is composed of 42 MRI images obtained from the KG hospital database. In the preprocessing phase, the authors remove the film artefact‘s (labels and X-ray marks). They also use the filter Median to remove high frequency components in the MRI image. The authors then use an algorithm called Fuzzy C Means (FCM) as an image clustering algorithm, in addition to using a Genetic Algorithm (GA) as an intelligent optimization tool. The results of the experiments showed that, the classification algorithm FCM achieved a classification accuracy of 74.6% with less than 0.4% error rate. To enhance the accuracy, the authors used an optimization technique called Particle Swarm Optimization (PSO). They managed to reach an accuracy level of 92%. In [3], Othman and Ariffanan propose a new system for brain tumour automatic diagnosis (shown in Figure 1). The Probabilistic Neural Network (PNN) provides a solution to pattern classification problems [4]. The paper uses a dataset from University Teknologi Malaysia (UTK) and the dataset goes through a pre-processing phase as follows. The MRI images are first converted to matrices by using MATLAB. Then, the classification algorithm PNN is used to classify the MRI images. The results show that the proposed system achieves a diagnosis accuracy of more than 73%. The accuracy level can even be higher than that depending on what the authors call ―a smoothing factor‖ [3]. Finally, Najadat at al. [2] design a classifier to detect abnormalities in CT brain images caused by the following diseases/cases: Atrophic, Hemorrhage, Hematoma, Infract and Craniotomy



PROPOSED SYSTEM

The brain tumour is cancerous or maybe non-cancerous mass or abnormal cell growth in the brain. Abnormal cell growth in the brain results in the brain tumour and affect a person‘s life. The early and accurate detection of such disease can help the patient in medical healing. Imaging is an important side of bioscience is to picture the diagnosed structures or shape of the human body, which helps in medical diagnosis. This project is divided into two main parts:

Proposed Methodology of Tumor Segmentation and Classification Using Traditional Classifiers In our first prospective model, brain tumor segmentation and detection using machine learning algorithm had been done, and a comparison of the classifiers for our model is delineated. Our proposed Brain image segmentation system consists of seven stages: skull stripping, filtering and enhancement, segmentation by

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

Fuzzy C Means algorithm, morphological operations, tumor contouring, feature extraction and classification by traditional classifiers. The results of our work accomplished satisfactory results. The main stages of our proposed model (Fig. 2) will be illustrated in the following sections.

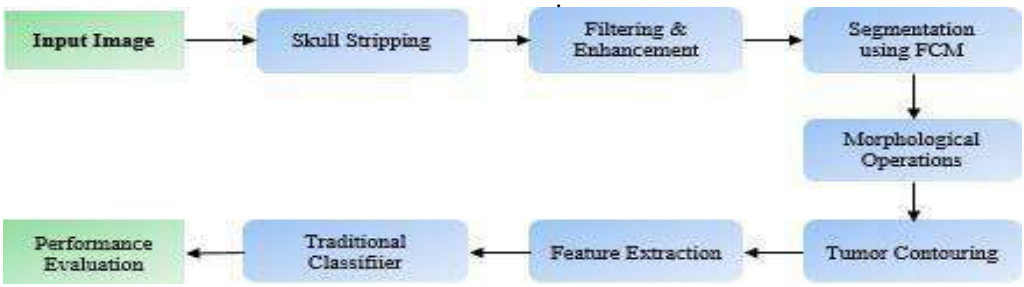

Fig. 2. Proposed methodology for classification using Traditional Classifiers

Proposed Methodology of Tumor Segmentation and Classification Using Traditional Classifiers

In our first prospective model, brain tumor segmentation and detection using machine learning algorithm had been done, and a comparison of the classifiers for our model is delineated. Our proposed Brain image segmentation system consists of seven stages: skull stripping, filtering and enhancement, segmentation by Fuzzy C Means algorithm, morphological operations, tumor contouring, feature extraction and classification by traditional classifiers. The results of our work accomplished satisfactory results. The main stages of our proposed model (Fig. 2) will be illustrated in the following sections.

1) Skull Stripping: Skull stripping is a very important step in medical image processing because of the background of the MRI image not containing any useful information, and it only increases the processing time. In our work, we removed the skull portion from the MRI images in three steps. These three steps are:

Otsu Thresholding*:* For skull removal, at first we used Otsu's Thresholding method which automatically calculates the threshold value and segments the image into background and foreground. In this method, the threshold that is selected minimizes the intra-class variance, defined as a weighted sum of deviations of the two classes.

Connected Component Analysis: At the last stage of our skull stripping step, we used connected component analysis to extract only the brain region and as a consequence the skull part was removed.11

2) Filtering and Enhancement: For better segmentation, we need to maximize the MRI image quality with minimized noise as brain MRI images are more sensitive to noise than any other medical image. Gaussian blur filter was used in our work for Gaussian noise reduction existing in Brain MRI which prevailed the performance of the segmentation.

3) Segmentation using *FCM:* Fuzzy C-Means clustering algorithm was used for segmentation, which allows one piece of data to belong to two or more clusters. We got the fuzzy clustered segmented image at this stage, which ensured a better segmentation.

4) Morphological Operation: To segment the tumor, we only need the brain part rather than the skull part. For this, we applied morphological operations in our images. At first, erosion was done to separate weakly connected regions of the MRI image. After erosion, we will get multiple disconnected regions in our images. Dilation was applied afterwards.

5) Tumor Contouring: Tumor cluster extraction was done by an intensity based approach which is thresholding. The output of this image is the highlighted tumor area with a dark background.

6) Feature Extaction: Two types of features were extracted for classification. Texture-based features such as-Dissimilarity, Homogeneity, Energy, Correlation, ASM and Statistical based features including- Mean, Entropy, Centroid, Standard Deviation, Skewness, Kurtosis were extracted from the segmented MRI Images.

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IJARCCE
ISSN (Online) 2278-1021
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Vol. 10, Issue 3, March 2021
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7)Traditional Classifiers*:* We used six traditional machine learning classifiers which are K-Nearest Neighbor, Logistic Regression, Multilayer Perceptron, Naïve Bayes, Random Forest, and Support Vector Machine to get the accuracy of tumor detection of our proposed model.

*8)*Evaluation Stage: Implementing other region-based segmentation methods and comparing it to our proposed segmentation technique, our model segments the ROI and segregates the tumor portion most accurately. An illustration of the whole process is depicted in Fig. 5. After segmentation and feature extraction from the tumor, we applied six classification techniques. Among them, we got the best result from SVM and obtained an accuracy of 92.42%.

Proposed Methodology Using CNN:

Convolutional Neural Network is broadly used in the field of Medical image processing. Over the years lots of researchers tried to build a model which can detect the tumor more efficiently. We tried to come up with an exemplary which can accurately classify the tumour from 2D Brain MRI images. A fully-connected neural network
A Five-Layer Convolutional Neural Network is introduced and implemented for tumor detection. The aggregated model consisting of seven stages including the hidden layers provides us with the most prominent result for the apprehension of the tumor. Following is the proposed methodology with a brief narration-

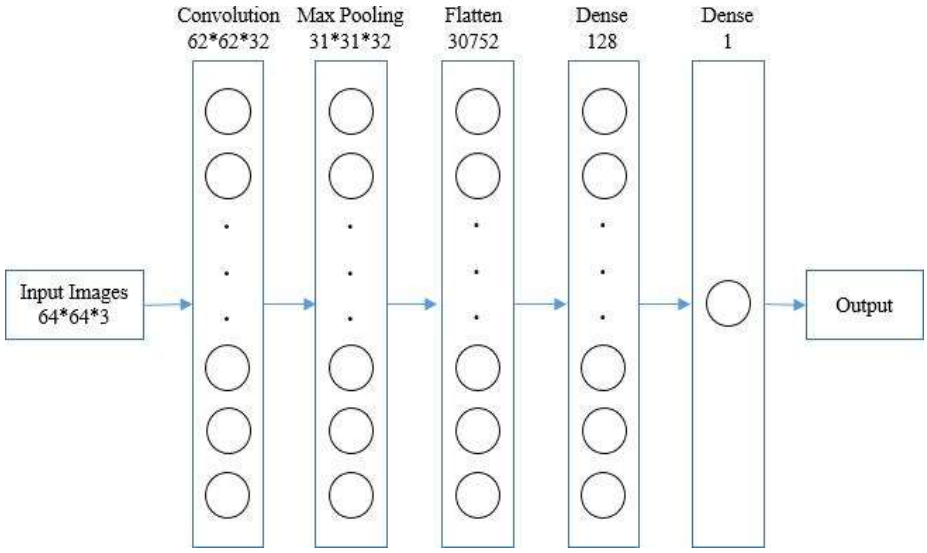

Fig. 3. Proposed Methodology for tumour detection using 5-Layer Convolutional Neural Network

Experimental Dataset

For Performance Evaluation of our proposed model, we used the benchmark dataset in the field of Brain Tumour Segmentation, and that is BRATS dataset [16], consisting two classes'— class-0 and class-1 represents the Non-Tumour and Tumour MRI images. 187 and 30 MRI Images containing tumour and non-tumour respectively classified as class-1 and class-0. All the images are MRI images from different modalities like- T1, T2, and FLAIR. For traditional machine learning classifiers, we obtained the superlative result splitting the dataset by 70 to 30 in terms of training to testing images, and for CNN, we divided the dataset in both 70 to 30 and 80 to 20 formations and compared the Segmentation using Image processing techniques
Based on our proposed methodology, we segmented the tumour without loss of any subtle information. We removed the skull because for tumour segmentation the role of skull is approximately null and ambiguous in this process.

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IJARCCE
ISSN (Online) 2278-1021
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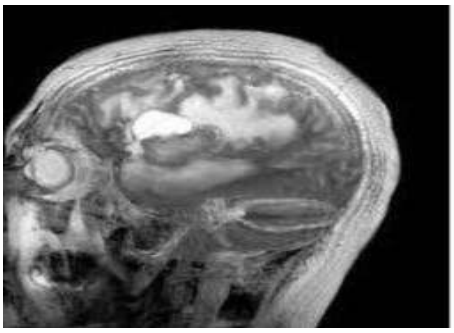
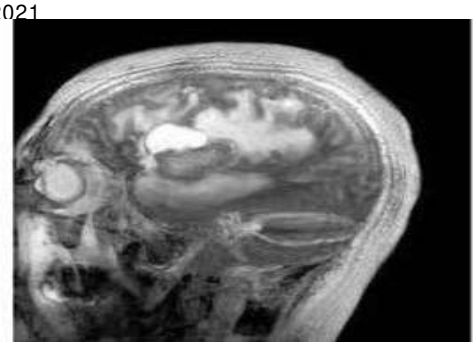
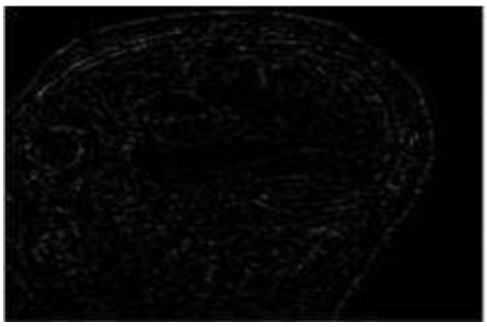
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 10, Issue 3, March 2021



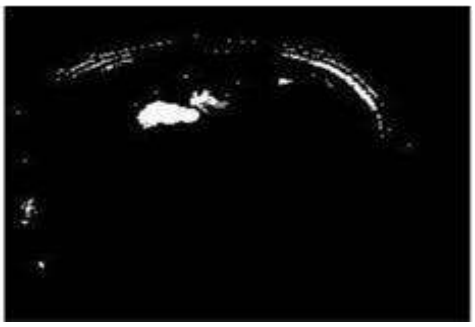
Mri image of tumour



Grayscale image



Median Filtered



Threshold Segmented

Morphological operation applied image

Final tumor detected image

Classification Using Machine Learning

Texture and Statistical based features are more popular for detecting the Region of Interest (ROI). Based on these features we can segregate the tumorous and non-tumorous MRI. We used texture and statistical based features for classification. Texture-based features like- Dissimilarity, Homogeneity, Energy, Correlation, ASM and Statistical based features including- Mean, Entropy, Centroid, Standard Deviation, Skewness, Kurtosis were extracted from the segmented Brain tumour. Further, we extracted the Area, Convex Hull Area and Diameter of the tumour. Extrapolating Convex Hull Area and Diameter of the tumour. Extrapolating these features from the segmented MRI, we classified the image as the existence of normal and abnormal tissue.

Classification Using CNN

The five-layer proposed methodology gives us the commendable result for the detection of the tumor. Convolution, Max Pooling, Flatten, and two dense layers are the proposed five layer CNN model. Data augmentation had been done before fitting the model as CNN is translation invariance.

We evaluate the performance in two ways based on splitting the dataset. We accomplish 92.98% of accuracy for 70:30 splitting ratio where the training accuracy is 99.01%. Then at the second iteration, 80% of the images assigned for training and the rest of the images accredited for testing where we concluded 97.87% of accuracy and 98.47% of training accuracy. So our proposed model gives the best result when the division is 80:20.

We got 97.87% as accuracy which is remarkable in terms of using five-layer CNN. We analyzed with a different number of layers but the divergent of the outcomes were not very significant in terms of using this five-layer CNN model. Some of the aspects that we obtained when we increase the number of layers is-

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10322

computation time, the complexity of the method batch size and steps per was immensely high. Further, we used 0.2 as the dropout value but did not commensurate the model as the accuracy flattened.

FUTURE ENHANCEMENT

Gaussian reduces the noise; enhance the image quality and computationally more efficient than other filtering methodology. After the several image quality improvement and noise reduction discussion here, some possible segmentation methodology like intensity based binarized segmentation, Region based, classification based, texture based, clustered based, neural network based, fuzzy, edge based, atlas, knowledge based, fusion, probabilistic segmentation has been described above with short description, advantage and disadvantage to detect or segment a brain tumor from MRI of brain image. In the threshold intensity based binnarized segmentation Kapur method is best methods and produce very effective results. Most of the binarized fails due to large intensity difference of foreground and background i.e. the black background of MRI image.

CONCLUSION

In this paper, we present a machine learning approach to detect whether an MRI image of a brain contains tumour or not. This has to be done with no human intervention. Here, several existing brain tumor segmentation and detection methodology has been discussed for MRI of brain image. All the steps for detecting brain tumour have been discussed including pre-processing steps. Pre-processing involves several operations like non local, Analytic correction methods, Markov random field methods and wavelet based methods has been discussed. Quality enhancement and filtering are important because edge sharpening, enhancement, noise removal and undesirable background removal are improved the image quality as well as the detection procedure. Among the different filtering technique discussed above, median filter suppressed the noise without blurring the edges and it is better outlier without reducing sharpness of the images, mean filter are much greater sensitive than that of median filter in the context of smoothing the image.

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10319

Cloud Data Auditing using Hashing Algorithm

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Abstract: Cloud computing is an important part of any small or large organization. With cloud storage service users can remotely store their data to the cloud and realize the data sharing with others. Data outsourcing possess the risk of sensitive data getting breached. Remote data integrity auditing is proposed to guarantee the integrity of data stored in the cloud. In some common cloud storage systems such as Electronic Health Records (EHR) systems, the cloud file might contain some sensitive information which must not be altered. This project proposes a novel privacy-preserving mechanism that supports auditing on shared data stored in the cloud. In particular, hashing algorithm are used to compute verification metadata needed to audit the correctness of shared data. A signature is generated for each file by the data owner and then it is uploaded. After a file is uploaded to the database by the data owner, the auditor re-computes it's signature and compares with the local copy signature of the file in data owner side. If suppose an intruder or a user breaches the security and modifies the public cloud data, the Hashing algorithmisperformed, and the intruder or user is terminated from further accessing of the cloud data. This method ensures data integrity in shared cloud data particularly for EHR systems, much more efficient and less computation cost compared to the existing system. As a result, the data in the cloud are reliable and authentic.

Keywords: Cloud storage; Hashing Algorithm Auditing mechanism; Data Integrity; Storage Auditing

I. INTRODUCTION

In Today's Technological world, Cloud storage is an important service of cloud computing [9].Organizations produce a huge volume of sensitive data; the speed of data generation increases and overtakes the storage capacity of the organizations [10]. Particularly, there is an increase in the number of EHR (Electronic Health Record) System files in the hospital sector. Therefore, more hospital sector would like to store their data in the cloud, which reduces the heavy burden of storing them in their unzipped format and further it can be easily accessed by the researcher from remote location. However, there is a chance for the data stored in the cloud to get corrupted or lost due to software bugs, hardware faults, intruders and human errors in the cloud. This paper proposes an efficient RDC (Remote Data Checking) method which audits the integrity of the data in cloud using Hashing algorithm.

II. PROBLEM ANALYSIS

A signature is a string of a few bytes intended to identify uniquely the contents of a data object. Different signature proves the inequality of the contents while same signatures indicate their equality. Objects are signed using 4 bytes instead of 20-bytes standard SHA-1 which leads to more frequent collisions[1]. In this hashing algorithm technique, MD-5 of 32-byte is used which has lesser probability for collision.

Auditing of the documents on the remote side is important. But data originator checks only chunks of the storage server for verification [2]. In this project auditing after update scheme is used to verify all the updated documents in the public cloud storage to ensure data integrity and protection from alternation,

Remote data checking (RDC) schemes allows a client that has stored data at an untrusted server to verify that the server possesses the original data without retrieving it. The data is representation as a file spilt in blocks and is distributed among multiple servers [4,10]. RDC for distributed system becomes more costly since it is harder to ensure the correctness of algorithms, especially operation during failures of part of the system and recovery from failures that does not arise in centralized system such as this project.

III. RELATED WORK

Hashing Algorithm

STEP:1

A) Assign 64 constant values to array constant X. Assign Initial hash value for H. Now convert the string message into 512 blocks using the following equations. $L = \frac{Message\ Length}{4} + 2$

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10319

B) Number of 16-integer (512 bit) block required

$$N = ceil\frac{L}{16} = \lceil \frac{L}{16} \rceil$$

C) Message M is N x 16 array of 32-bit integer

$$Array\ of\ M = M\ [\ N \times 16\ ]$$

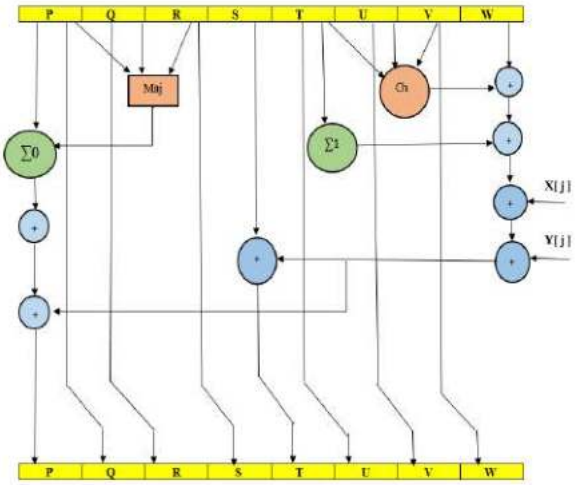

Fig. 1. Single iteration in SHA-256 compression

STEP:2 Encode 4 character per integer (64 per block), big-endian encoding

STEP:3 Hash Computation

STEP:3.1 Prepare message schedule ' Y '

$$Y_0^{\{16\}}(j) = M(i)(j)$$

$$Y_{16}^{\{64\}}(j) = \sigma_0(\,Y[\,j-2\,]) + Y[\,j-7\,] + \sigma_0(\,Y[\,j-15\,]) + Y[\,j-16\,]$$

Where,

$$\sigma_0(c) = ROTR^7\,(c) \oplus ROTR^{18}\,(c) \oplus SHL^3\,(c)$$

$$\sigma_1(c) = ROTR^{17}\,(c) \oplus ROTR^{19}\,(c) \oplus SHL^{10}\,(c)$$

STEP:3.2 Initialize the buffer p, q, r, s, t, u, v, w with previous hash value. The below function is a rotation function

$$\sum_0^{\{256\}}(c) = ROTR^2\,(c) \oplus ROTR^{13}\,(c) \oplus ROTR^{22}\,(c)$$

$$\sum_1^{\{256\}}(c) = ROTR^6\,(c) \oplus ROTR^{11}\,(c) \oplus ROTR^{25}(c)$$

This is the main looping function which loops from 0 < j < 64

$$B1 = W + \sum\nolimits_1(t) + ch(t,u,v) + X[\,j\,] + Y[\,j\,];$$

$$B2 = \sum\nolimits_0(p) + maj(p,q,r);$$

$$w = v;$$

$$v = u;$$

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10319

$$v = t;$$

$$t = (s + b1);$$

$$s = r;$$

$$r = q;$$

$$q = p;$$

$$p = (B1 + B2);$$

STEP :3.3 Compute Intermediate hash value

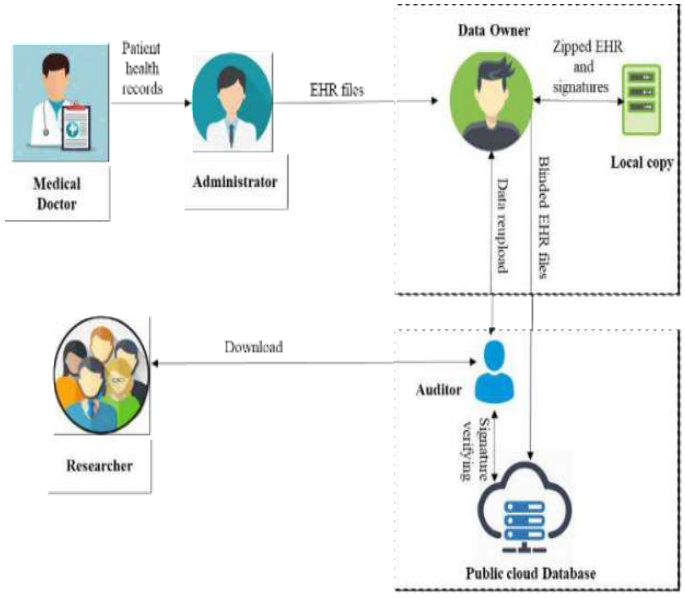
$$H[i\ ] = H[\ i\ ] + g$$

Where g represents the working buffers where $i \rightarrow 0 \leq i \leq 7$

STEP:4 Convert the hash value to hex strings with leading zeroes. Convert hex bytes to string of characters

IV. PROPOSED SYSTEM

The Scheme‘s main algorithm is the Auditing using Hashing signature which is implemented and works between the public cloud and local data



Public Cloud- Public cloud is an on-demand computing services provided by third-party organisation over the public internet. Anyone the place where the Patient's EHR files are stored by encrypting the sensitive data. It provides ease of access to files for the users. They can access anywhere at anytime.

Local Data-This is situated at the Administrator side where all the EHR files of the patient are stored in the local disk. The Data present here are much more safer without any corruption.

EHR Files- Electronic Health Record Files consists of details of the patients and their history of disease which tells diseases from which they have been affected. The most sensitive information includes Patients details like Name, Age, Address, Phone number and etc. Remaining Part of the EHR files consists of Patient’s Blood group, X-ray Scans details, diseases which affected the patient, Symptoms which occurred during the spread of disease, Name and Dosage of medicine given to patient at the advancement of disease.

Hashing Signature- this is our proposed system which uses signature verification to prevent data corruption and to enable data integrity of the EHR files stored in public cloud. Data Owner before uploading the EHR files to the public cloud, the files is hashed using SHA-2 algorithm which uses 256 bits for Hashing. Hashed 256 bits value is stored in the local disk in a table directory.When the sensitive data in the EHR files are encrypted and stored in the same table directory.When the Auditor detects any upload or modification, then hash value of the file is calculated. It is compared

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IJARCCE

ISSN (Online) 2278-1021
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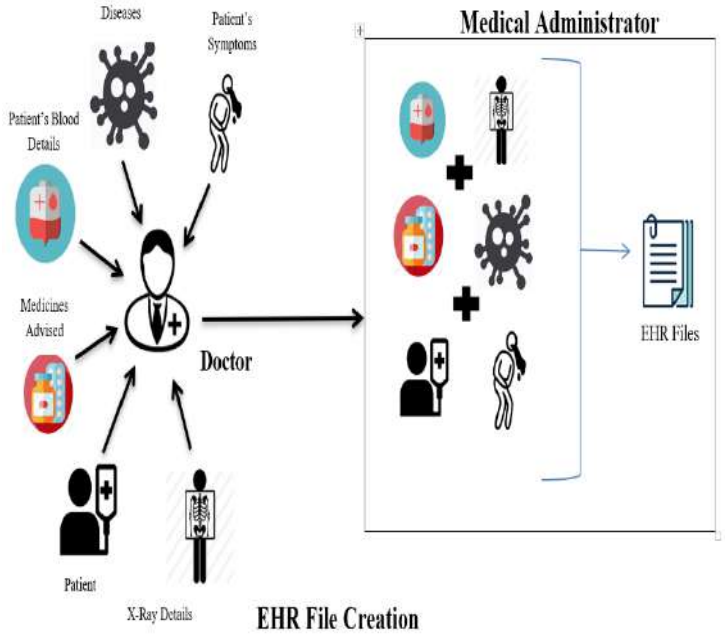
International Journal of Advanced Research in Computer and Communication Engineering

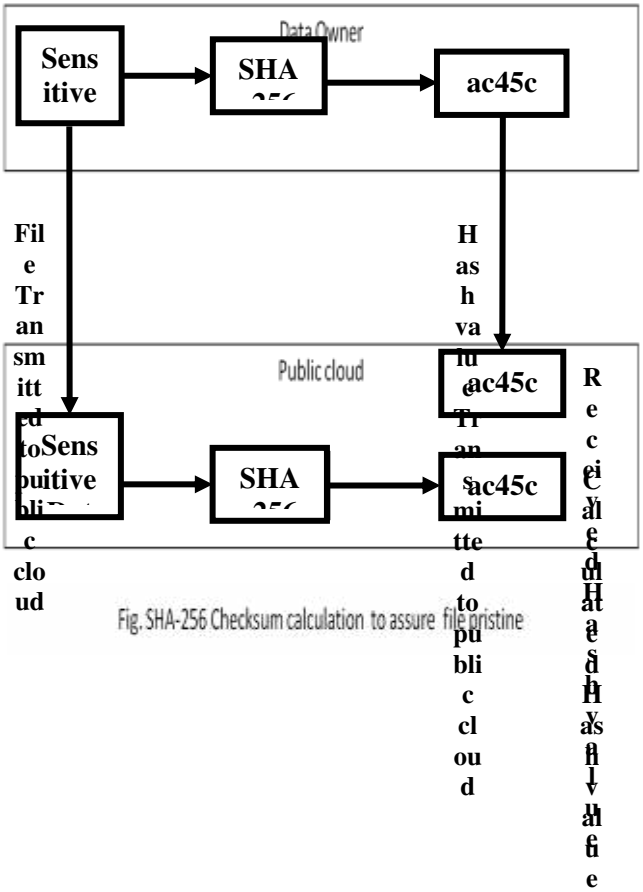
Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10319

with the data owner's local disk for its match. If matched, then the file is marked as the original file.If not,local copy of the file is again uploaded to the public cloud.



- Auditor – here auditor is an automated entity



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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10319

V. EXPERIMENTAL EVALUATION

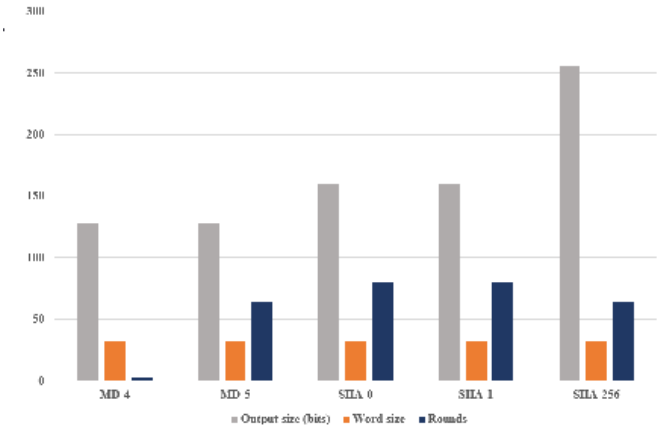

Fig. 2. Parameters comparison

VI. FUTURE ENHANCEMENT

The length extension attack can degrade the security mechanism of SHA-256 which makes it easy for finding the data in the file with the bit length and the hashed value of the output. So, in near future we would like to introduce the SHA-3 Security Mechanism which counter measures the Length Extension Attack.

CONCLUSION

In this paper, we proposed an identity-based data integrity auditing scheme for secure cloud storage, which supports data sharing with sensitive information hiding. In our scheme, the file stored in the cloud can be shared and used by others on the condition that the sensitive information of the file is protected. Besides, the remote data integrity auditing is still able to be efficiently executed. The security proof and the experimental analysis demonstrate that the proposed scheme achieves desirable security and efficiency.

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10321

PLANT LEAF DISEASE DETECTION SYSTEM USING CONVOLUTIONAL NEUTRAL NETWORKS

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Abstract: Crop cultivation plays an essential role in the agricultural field. Presently, the loss of food is mainly due to infected crops, which reflexively reduces the production rate. In the field of agricultural information, the automatic identification and diagnosis of diseases in plants is highly desired. To identify the plant leaf diseases at an untimely phase is not yet explored. To improve the identification accuracy of detection Convolutional Neural Network is used. The main challenge is to reduce the usage of pesticides in the agricultural field and to increase the quality and quantity of the production rate. Our paper is used to explore leaf disease prediction at an untimely action. The main aim of this paper is to develop an appropriate and effective method for detection of the disease and its symptoms. A colour-based segmentation model is defined to segment the infected region and place it to its relevant classes. Experimental analyses were done on samples images in terms of time complexity and the area of the infected region. Plant diseases can be detected by image processing technique. Disease detection involves steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification. Our project is used to detect the plant diseases. The detection is done without accessing the internet. It shows the accuracy of detection in percentage. This method will improve the accuracy of disease detection, and also effectively improve the model training and recognition efficiency.

Keywords: Leaf disease detection, Image processing, Image segmentation, machine learning, feature extraction.

I.INTRODUCTION

India is eminent for Agriculture that means most of the people are engaged in the agriculture industry. The agriculture industry acts as a significant role in the economic sectors. Most of the plants are infected by variant fungal and bacterial diseases. Due to the exponential inclination of population, the climatic conditions also cause plant disease.
The major challenges of sustainable development are to reduce the usage of pesticides, cost to save the environment and to increase the quality.
Precise, accurate and early diagnosis may reduce theusage of pesticides.

Data mining is termed as extracting the relevant information from a large pool of resources. Health monitoring and disease detection on plants is very critical for sustainable agriculture. The advent of data mining technologies has been adopted in the prediction of plant diseases. There are factors that affect the plants and are classified into two category:

(1) Diseases: The biotic factors that are either caused by the fungi, bacteria or algae.
(2) Disorder: The abiotic factors caused by the temperature, rainfall, nutrient deficiency, moisture.

Smartphones in particular offer very novel approaches to help identify diseases because of their computing power, high-resolution displays, and extensive built-in sets of accessories, such as advanced HD cameras. The combined factors of widespread smartphone penetration, HD cameras, and high-performance processors in mobile devices lead to a situation where disease diagnosis based on automated image recognition, if technically feasible, can be made available at an unprecedented scale. The conventional means of disease management involve farmers and the plant pathologists. The diagnosis and use of the pesticide are more often done in the fields. This process is time-consuming, challenging. With the Advancement of Computer Vision (CV), Machine Learning (ML), and Artificial Intelligence (AI) technologies, progress has been achieved in developing automated models empowering, accurate and timely identification of the plant leaves disease. Deep neural networks have recently been successfully applied in many diverse domains as examples of end-to-end learning. Neural networks provide a mapping between an input—such as an image of a diseased plant—to an output—such as a crop-disease pair. Nowadays, technology is widely used for plant disease prediction. The management of perennial leaves requires a close monitoring system especially for the diseases that affect production and post-harvest life. Deep Learning (DL) is a special class of ML algorithms which have multiple layers for transforming the raw data into information.

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10321

II. RELATED WORK

The work in [1] have presented the number of studies for the Multilayer Convolution Neural Network for the Classification of Mango Leaves Infected by Anthracnose Disease.Therefore this work proposes a deep learning model named as MCNN for the classification of leaves infected by the Anthracnose disease presented by Uday Pratap Singh, Siddarth Singh Chouhan, Sukirty Jain, Sanjeev Jain.

In [2] has present various studies of Image based Plant Disease Detection in Pomegranate Plant for Bacterial Blight presented by Sharath D.M, Akhilesh, S. Arun Kumar, Rohan M.G, Prathap C. In [3] has present Identification of maize leaf diseases using improved deep convolutional neural networks presented by X. Zhang, Y. Qiao, F. Meng, C. Fan, M. Zhang. In [4] has present Dense semantic labeling of subdecimeter resolution images with convolutional neural networks presented by M. Volpi, D. Tuia.In[5] has present Cloud-based system for supervised classification of plant diseases using convolutional neural networks presented by L. Jain, M. A. H. Vardhan, M. L. Nishanth, S. S. Shylaja.

III. METHODOLOGY

Preprocessing and Training the model (CNN): The database is Preprocessed such as Image reshaping, resizing and conversion to an array form. Similar processing Is also done on the test image. A database consisting of about 32000 different plant species is obtained, out of which any image can be used as a test image for the software. The train database is used to train the model (CNN) so that it can identify the test image and the disease it has CNN has different layers that are Dense, Dropout, Activation, Flatten, Convolution2D, MaxPooling2D. After the model is trained successfully, the software can identify the disease if the plant species is contained in the database. After successful training and preprocessing, comparison of the test image and trained model takes place to predict the disease.

1.DATASET

Initial step for any image processing-based project is acquiring a proper database which is valid. A database repository has been used, plant Village dataset repository having leaves of multiple plants. Data available here is not labeled. So the first task is to clean and label the database. The dataset is collected from Plant Village which has a collection of 54305 images. These images categorized among two classes namely multiple plants leave images with the disease, and without the disease. Based on the category these images are labeled to their respective classes. The database is accessed from crowd AI which is a plant disease classification challenge. After selection of images, we should have deep knowledge about the different leaves and the disease they have. After detail study, labeling is done by segregating the images and with different diseases.

2.IMAGE ACQUISITION

First step in image acquisition is to capture the leaves using a mobile phone or digital camera. These stored images of the leaves from the database are loaded by specifying the path. Figure 2 shows the images of the samples of plant leaves**.**

a b c

3.IMAGE PRE-PROCESSING

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10321

At first, the training and testing images were preprocessed for contrast enhancement and resizing them to a 224×224 pixels and 32×32 dots per inch. Pre-processing improves the quality of the image by removing unsought distortions. Clipping the images based on the region of interest (ROI), image smoothing and contrast enhancement are done here. Figure 3 shows the images after performing image enhancement.

Enhanced Images after Pre-processing

4.IMAGE SEGMENTATION

After the original images are preprocessed, additional versions are created by rotating the images 90°, 180°, and 270°; by mirroring each rotated image; by cutting the center of the image by the same size. Image segmentation is the method of dividing an image into different sub images. Here we use K-mean segmentation technique which uses hue estimation method for dividing and clustering the image. Since the green color of the leaves is normal, we do not consider them. We select the cluster image showing the infected area for feature extraction. Figure 4, below shows the segmented images of the leaves.

Segmented Images of the Infected Leaves

5. K-MEANS CLUSTERING

K-means clustering algorithm, the data vectors are grouped into clusters based on the closeness of the pixels by the Euclidean distance measurement. Centroids of the clusters are initialized randomly and their dimensions are equal to data vectors.

Sample No.	Disease Classified	Affected Area (Percentage)
1	Anthracnose	49.88
2	Anthracnose	53.12
3	Anthracnose	66.37
4	Cercospora Leaf Spot	30.56
5	Cercospora Leaf Spot	43.25
6	Cercospora Leaf Spot	21.89
7	Bacterial Blight	30.51
8	Bacterial Blight	15.68
9	Bacterial Blight	88.76

Classification of Disease and Affected Area

GENERAL EXPLANATION

1. The input test image is acquired and preprocessed in the next stage and then it is converted into array form for comparison.
2. The selected database is properly segregated and preprocessed and then renamed into proper folders.
3. The model is properly trained using CNN and then classification takes place.
4. The comparison of the test image and the trained model take place followed by the display of the result.

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10321

5. If there is a defect or disease in the plant the software displays the disease along with the remedy.

FLOW CHART

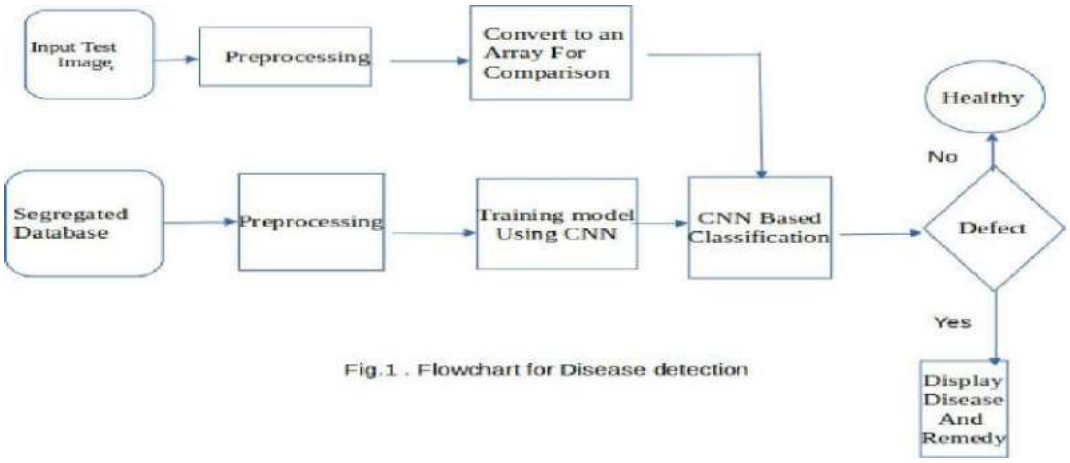

Fig.1 . Flowchart for Disease detection

TRAINING AND TESTING

Initially, the entire dataset is divided into two parts, the training and the testing dataset. This is done by randomly splitting the dataset into training sets comprising about 75% of the images and the testing set constitutes about 25% of the images. This distribution is used in the neural network applications. For the training of the CNN 40728 images are used and remaining 13577 images are used for testing the performance of the model. Training this CNN is the practice of running training examples (images) through the model from the input to the output simultaneously making a prediction and figuring out the results or errors. If the prediction is wrong then this is back propagated in reverse order. The proposed model does not include the object segmentation process.

The proposed system is based on a classification model that is then trained for the detection and classification of plant leaves. This model includes three cases
(i) to find and classify the given image (ii) the image is a non-diseased plant leaf and (iii) the image is a diseased plant leaf. The training images were taken from each of the class labels C_0, C_1, C_2, respectively maintaining the ratio of 75% images. All the other remaining 25% images were untouched during the complete process. Each image from the normalized training dataset is given as an input to the Convolution Neural network model to extract the features. This model is trained to predict the class label for every training image. The results of proposed model focus mainly on:

1. Primary task is to classify the given images. Then, the secondary task is to identify the given leaf is a non-diseased leaf, and third is to identify and classify that the leaf is a diseased leaf or not.
2. Measuring the accuracy for both the training process and the testing process of the proposed model.

The accuracy of the proposed method was computed to be 88%. Images taken in real condition majorly suffers from various problem

1. Variation in Temperature
2. Light density on leaf
3. Presence of multiple objects
4. Overlapping of other leaves

Handling these issues can improve the performance of the model. Figure 4 shows validation of trained datasets.

```
EPOCHS=5 #@param {type:"integer"}
history = model.fit_generator(
      train_generator,
      steps_per_epoch=train_generator.samples//train_generator.batch_size,
      epochs=EPOCHS,
      validation_data=validation_generator,

validation_steps=validation_generator.samples//validation_generator.batch_size)
```

for i in
range(total_iter,total_iter+FLAGS.training_steps

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10321

```
): print("\nRunning trainng step: " + str(i)) image_batch, label_batch = ds.get_next_batch(images,
'training', BATCH_SIZE, i, IMAGE_SIZE) feed_dict_train = {label_placeholder: label_batch,
image_placeholder:image
_batch} start = int(round(time.time() * 1000)) session.run(optimizer, feed_dict=feed_dict_train) end =
int(round(time.time() * 1000)) print("\n\tRuntime: "+str(end - start)+"ms") saver.save(session,
FLAGS.output_dir+"model")

image_batch, label_batch = ds.get_next_batch(images, 'validation', BATCH_SIZE, i, IMAGE_SIZE)
feed_dict_validate = {label_placeholder: label_batch,
image_placeholder:image_batch}

loss = session.run(cost, feed_dict=feed_dict_validate) print("\tLoss: " + str(loss))

image_batch, label_batch = ds.get_next_batch(images, 'testing', BATCH_SIZE, i, IMAGE_SIZE)
feed_dict_test = {image_placeholder: image_batch, label_placeholder:
np.zeros(num_classes)} training_accuracy = session.run(accuracy,
feed_dict=feed_dict_train) validation_accuracy = session.run(accuracy,
feed_dict=feed_dict_validate)
print("\tTraining accuracy: {0:>6.1%} Validation accuracy:
{1:>6.1%}".format(training_accuracy, validation_accuracy))
```

IV. CONCLUSION

The proposed system was developed taking in mind the benefits of the farmers and agricultural sector. Computer vision with machine learning methodologies has performed in solving a number of plant leaves disease problems including pattern recognition, classification, object extraction etc. In this project, we propose an innovative model for the classification of plant leaves infected from the disease. The developed system can detect disease in plants and also provide the remedy that can be taken against the disease. By proper knowledge of the disease, the remedy can be taken for improving the health of the plant.

V. FUTURE WORK

The proposed system is based on python and gives an accuracy of around 88%. The presented model is also computationally efficient and simple. The accuracy and the speed can be increased by use of Goggles GPU for processing. The system can be installed on Drones so that aerial surveillance of crop fields can be done. Improvised models of this system can be done by building a Web/Internet of Things (IoT) enabled real-time disease monitoring system.

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10323

DETECTING FAKE ONLINE REVIEWS USING SUPERVISIED LEARNING

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Abstract: Online reviews have great impact on today's business and commerce. Decision making for purchase of online products mostly depends on reviews given by the users. Hence, opportunistic individuals or groups try to manipulate product reviews for their own interests. This paper introduces supervised text mining models to detect fake online reviews as well as compares the efficiency of both techniques on dataset containing hotel reviews.

Keywords: Supervised learning, random forest algorithm

INTRODUCTION:

Technologies are changing rapidly. Old technologies are continuously being replaced by new and sophisticated ones.These new technologies are enabling people to have their work done efficiently. Such an evolution of technology is online marketplace. We can shop and make reservation using online websites. Almost, every one of us checks out reviews before purchasing some products or services. Hence, online reviews have become a great source of reputation for the companies. Also, they have large impact on advertisement and promotion of products and services. With the spread of online marketplace, fake online reviews are becoming great matter of concern. People can make false reviews for promotion of their own products that harms the actual users.Also, competitive companies can try to damage each others reputation by providing fake negative reviews.Researchers have been studying about many approaches for detection of these fake online reviews. Some approaches are review content based and some are based on behaviour of the user who is posting reviews. Content based study focuses on what is written on the review that is the text of the review where user behavior based method focuses on country, ip-address, number of posts of the reviewer etc. Most of the proposed approaches are supervised classification models.

Few researchers also have worked with semi-supervised models. Semi-supervised methods are being introduced for lack of reliable labelling of the reviews.

In this paper, we make some classification approaches for detecting fake online reviews, supervised learning. For supervised learning, we use Expectation-maximization algorithm. Random forest classifier used as classifiers in our research work to improve the performance of classification. We have mainly focused on the content of the review based approaches. As feature we use to detecting the hotel reviews is fake or not using machine learning algorithm.

In the following section II, we discuss about the related works. Section III describes our proposed approaches and experiment setup. Results and findings of our research are discussed in Section IV.

RELATED WORK:

Many approaches and techniques have been proposed in the field of fake review detection.The following methods have been able to detect fake online review with higher accuracy.

Sun et al. [1] divided these approaches into two categories.

a) Content Based Method: Content based methods focus on what is the content of the review. That is the text of the review or what is told in it. Heydari et al. [2] have attempted to detect spam review by analyzing the linguistic features of the review. Ott et al. [3] used three techniques to perform classification. These three techniques are- genre identificationdetection of psycholinguistic deception and text categorization [1]–[3].

1) Genre Identification: The parts-of-speech (POS) distribution of the review are explored by Ott et al. [3].They used frequency count of POS tags as the features representing the review for classification.

2) Detection of Psycholinguistic Deception: The psycholinguistic method approaches to assign psycholinguistic meanings to the important features of a review.Linguistic Inquiry and Word Count (LIWC) software was used by Pennebaker et al. [4] to build their features for the reviews.

3) Text Categorization: Ott et al. experimented n-gram that is now popularly used as an important feature in review detection.

Other linguistic features are also explored. Such as, Feng etal. [5] took lexicalized and unlexicalized syntactic features by constructing sentence parse trees for fake review detection. They shown experimenally that the deep syntactic features improve the accuracy of prediction. Li et al. [6] explored a variety of generic deceptive signals which contribute to the

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10323

fake review detection. They also concluded that combined general features such as LIWC or POS with bag of words will be more robust than bag of words alone. Metadata about reviews such as reviews length, date, time and rating are also used as features by some researchers.

b) Behaviour Feature Based Methods: Behaviour feature based study focuses on the reviewer that includes characteristics of the person who is giving the review. Lim et al. [7] addressed the problem of review spammer detection, or finding users who are the source of spam reviews. People who post intentional fake reviews have significantly different behaviour than the normal user. They have identified the following deceptive rating and review behaviours.

_ Giving unfair rating too often: Professional spammers generally posts more fake reviews than the real ones.Suppose a product has average rating of 9.0 out of 10.But a reviewer has given 4.0 rating. Analyzing the other reviews of the reviewer if we find out that he often gives this type of unfair ratings than we can detect him as a spammer.

_ Giving good rating to own country's product: Sometimes people post fake reviews to promote products of own region. This type of spamming is mostly seen in case of movie reviews. Suppose, in an international movie website an Indian movie have the rating of 9.0 out of 10.0,where most of the reviewers are Indian. This kinds of spamming can be detected using address of the reviewers.

_ Giving review on a vast variety of product: Each

person has specific interests of his own. A person generally is not interested in all types of products. Suppose a person who loves gaming may not be interested in classic literature. But if we find some people giving reviews in various types of products which exceeds the general behaviour then we can intuit that their reviews are intentional fake reviews.

Deceptive online review detection is generally considered as a classification problem and one popular approach is to use supervised text classification techniques. These techniques are robust if the training is performed using large datasets of labelled instances from both classes, deceptive opinions (positive instances) and truthful opinions (negative examples).Some researchers also used semi-supervised classification techniques.

For supervised classification process ground truth is determined by – helpfulness vote, rating based behaviours, using seed words, human observation etc. Sun et al. [1] proposed a method that offers classification results through a bagging model which bags three classifiers including product word composition classifier (PWCC), TRIGRAMSSVM classifier, and BIGRAMSSVM classifier. They introduced a product word composition classifier to predict the polarity of the review. The model was used to map the words of a review into the continuous representation while concurrently integrating the product-review relations. To build the document model, they took the product word composition vectors as input and used Convolutional Neural Network CNN to build the representation model. After bagging the result with TRIGRAMSSVM classification, and BIGRAMSSVM classification they got F-Score value 0:77.However supervised method has some challenges to overcome.The following problems occur in case of supervised techniques.

_ Assuring of the quality of the reviews is difficult.

_ Labelled data points to train the classifier is difficult to obtain.

_ Human are poor in labelling reviews as fake or genuine.

Hence Jitendra et al. [8] proposed semi-supervised method where labelled and unlabelled data both are trained together. They proposed to use semi-supervised method in the following situations.

1) When reliable data is not available.

2) Dynamic nature of online review.

3) Designing heuristic rules are difficult.

They proposed several semi-supervised learning techniqueswhich includes Co-training, Expectation maximization, Label Propagation and Spreading and Positive Unlabelled Learning [8]. They used several classifiers which includes k-Nearest neighbor, Random Forest, Logistic Regression and Stochastic Gradient Descent. Using semi-supervised techniques they achieved highest accurace of 84%.

PROPOSED WORK:

In this paper, we make some classification approaches for detecting fake online reviews, using supervised learning. For supervised learning, Random forests classifier and used as classifiers in our research work to improve the performance of classification. We have mainly focused on the content of the review based approaches. It will give accurate results. By this method we get if the labelled reviews is fake or genuine.

PROPOSED METHODOLOGY:

1. Random Forest Algorithm

Random forest is a type of supervised machine learning algorithm based on ensemble learning. Ensemble learning is a type of learning where you join different types of algorithms or same algorithm multiple times to form a more powerful prediction model. The random forest algorithm combines multiple algorithm of the same type i.e. multiple decision trees, resulting in a forest of trees,hence the name "Random Forest". The random forest algorithm can be used for both

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10323

regression and classification tasks.

The following are the basic steps involved in performing the random forest algorithm:
1. Pick N random records from the dataset.
2. Build a decision tree based on these N records.
3. Choose the number of trees you want in your algorithm and repeat steps 1 and 2.
4. In case of a regression problem, for a new record, each tree in the forest predicts a value for Y (output). The final value can be calculated by taking the average of all the values predicted by all the trees in forest. Or, in case of a classification problem, each tree in the forest predicts the category to which the new record belongs. Finally, the new record is assigned to the category that wins the majority vote.

2. Methodology:

Collect the dataset:
The dataset of 800 positive reviews and 800 deceptive reviews are collected in the form of text files.Reviews of 20 Chicago hotels are collected for process.Extracting features from dataset using text mining methods

Training and Testing of dataset:

Which are the basic machine learning steps to be achieved. After collecting the dataset 80% of data is taken for process and 20% of data is taken for testing. Both of the steps should be performed after the feature extraction (Abov features).Specific supervised algorithms are used for training process.Here have used randomforest algorithm.In training process algorithm needs two inputs Features and labels of each data.After specifying the parameters of random forest Training process is performed. Testing process is mainly used for of checking the accuracy and precision of the training process.Which also uses the random forest algorithm. We check the 20% of the review with the trained model using predict function in the algorithm. If specific accuracy is not achieved,we have to retune the randomforest.

Create the model:

For prediction process we have to save the model in specific format. We have used Pickle format (.pkl) for saving the model.

To fit the model we have used sklearn of Python programming language provides the needful libraries for the classifiers. We have different classification techniques in machine learning like random forest, Decision Tree and Random Forest classifiers. We have applied different predictions methods to reach the more accurate model.

Random Forest algorithm is an Ensemble model which creates decision trees on data samples and then gets the prediction from each of them and finally selects the best solution by means of voting .algorithm creates decision trees on data samples and then gets the prediction from each tree and finally selects the best solution from that. This produces the highest accuracy.
Random Forest can also use for classification as well as Regression analysis. Random forest is popularly used for text categorization to predict the text with word frequencies as the features. It is typically uses bag-of-words feature from NLP to identify the fake in text categorization. SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces. For SVM classifier we have gamma parameter keeping constant for perfect fit model.

RESULTS AND PERFOMANCE:

ANALYSIS

A. Experimental Environment

We have applied our experiments on a machine with Processor: Intel core i3 – 2330M and CPU- 2GHz, RAM: 4GB,S system with 64 bit OS, We have used Windows as an operating system. We have used Python as programming language with sklearn, numpy and pandas packages. Spyder 4.1.1 used as IDE.

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IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 3, March 2021

DOI 10.17148/IJARCCE.2021.10323

B. Results

We have used random forest classifier, Decision Tree and Random Forest classifiers to classify the reviews dataset. We have divided the dataset of 1600 rows with 3 columnswith column names reviews, polarity and spamity for each classification process.

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IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9506

College Networking Using Php and MySQL for Social Connection Between College Students and Faculties

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Abstract: Networking is a word that is used a lot nowadays: networking this, networking that. It's almost used so much that the meaning is lost. The gist seems to be: it is something you should be doing and doing a lot. Networking is actually pretty simple, and yes, we agree that you should be doing it! You're familiar with social networks, right? You gain followers on Instagram and add friends on Snapchat. Networking, in the professional sense, is similar in that you're establishing connections with people typically in your field. These connections could be working professionals, experts, thought leaders, or even professors. The purpose of networking is to form relationships with those who'll help get you to where you want to go, and the earlier you start building up your network, the better. That's why it's important to start networking in college — before you're even ready to enter the workforce.

I. INTRODUCTION

College networking is designed only for students of the college. This project is similar to many popular social networking platforms where the students will be provided with the opportunity to share information. It will also help them to tackle the problems they are facing in the college by highlighting the issue on this platform. One should have to make an account on this platform to get access to all of its features. Students will also be able to get updates related to the college. The creation of an account of anyone other than the college students is restricted. Students can connect by sending friend requests. After this, they can share the information which consists of educational materials and many more. Students are also able to upload their profile pictures on which they can receive likes and comments from the students to whom they connected with. There are also features of forming groups, sharing videos, etc. Students are also able to send messages to each other which is the major feature of any social networking platform.

II. RELATED WORK

Structure of the project

Many things are to be considered in the making of this project. Some of the things which are to be looked at are DFD diagrams, database, system design, etc. The system design is the skeleton of the actual project which includes components like student profile and admin control. The student profile includes the details of the profile, information on uploading files, etc. Students from any part of the world can connect with the help of this platform. They just have to log on to their account after the account getting approved by the admin.

Privileges

The privileges provided on this platform varies from the students to the admin. The students can update their profiles by adding various educational details. They can upload files and can share it with their friends on this platform or to a certain group. The privileges of the admin are the highest. Admins are not only provided with the feature which is available to the students but also with the privilege to modify the database of this project. Admins have the right to ban any member if in case that member violates the policies of this platform.

Community

The students can contact the community of this platform in case of any problem. These problems include all the bugs related to this platform or in case of any difficulty found by the students. They are also able to report other accounts in case of any inappropriate action performed by such accounts. This platform will help the students to connect with their friends and can share meaningful information.

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IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9506

III. METHODOLOGY

When the requirements document for the software to be developed is available, the design activity begins. The main aim of design process is to produce a model or representation of the system, which can be used later to bind the system. The produced model is called design of the system. A system design is a top down approach to minimize complexity and make a problem manageable by subdivided it into smaller segments. The most changing phase of the system development of life cycle is system design. It refers to the technical specification that will be applied in implementing the candidate system. The design phase is a translation from user oriented document to document oriented to programmers. The potential objects are thoroughly analysed. Class hierarchies are to check whether the system is behaving the way it has to. There after the classes are individually tested and subsequently they are integrated from the overall system. This level focuses on deciding which modules are needed for system the specifications for those modules and how these modules are that interconnected.

Logical Design:
A logical data flow diagram shows the flow of data through a transaction processing system without regard to the time period when the data flows or the processing procedures occur.

Physical Design:
The physical design maps out the details of physical systems, plans the system implementations, device a test and implementation plan and specifies any new hardware and software.

Objective of the system:
The main purpose of creating Campus Networking Site is for meeting worldwide college students and sharing knowledge, education related information's, etc. It contains standard social network content, like profiles, pictures, email and groups, and video sharing, articles, etc. Student can create a profile, browse locations worldwide, share and collect knowledge, education related tutorials, etc.

1. Applicable document:

Profile detail: It holds student profile information.

Education detail: It has education articles, tutorials, videos, photos and any other information.

Upload detail: It holds uploaded images, videos, tutorials and any other information's.

2. Functional decompositions:

- Student profile.
- Education profile.
- Education articles.
- Images, videos, etc.
- Quiz, question-answers etc.

3. Functional components and design assumptions.

The Campus network can help you maintain existing relationships with people and share pictures and messages, and establish new ones by reaching out to people you've never met before, an also using this site user can share Knowledge's, education related books, question/answer, and any other information.

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IJIREEICE

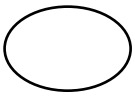
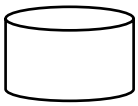
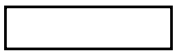
ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9506

Some of the symbols used in data flow diagram

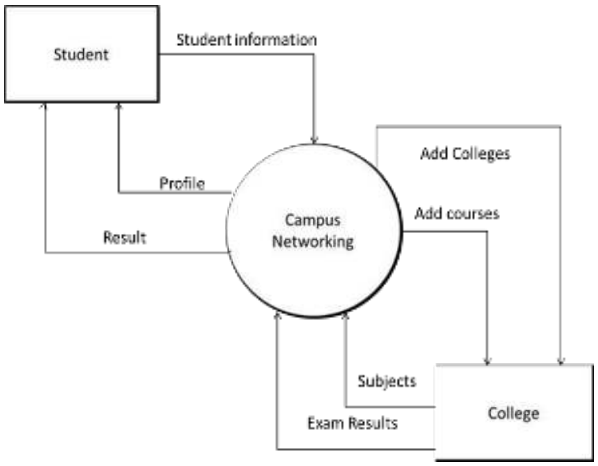
	The process shows a transformation or manipulation of dataflow with in a system. A process transforms in coming data flow into outgoing data flow.
	A database is a holding place for information within the system it is represented by an open ended narrow rectangle.
	External entities are outside the system but they either supply input data into the system or use the system output. External entities are represented by rectangle.
	a dataflow shows flow of information form source to destination a data flow represented

4.Description of the program

The customer switch diagram for online campus networking is shown in the figure below. The input and output of this section is shown in the diagram, however no of details about the function of the online campus networking system is given here. Using this as a starting point, a logical DFD of the system is developed.

4.1Context flow diagram:

The environment in which the software used is depicted in this picture. The CFD shows the external entity action on the software is shown here in CFD as a single process.



4.2 Top level DFD:

Top level DFD shows the functional component in the software package. each component shown in the top level DFD is described in the subsections.

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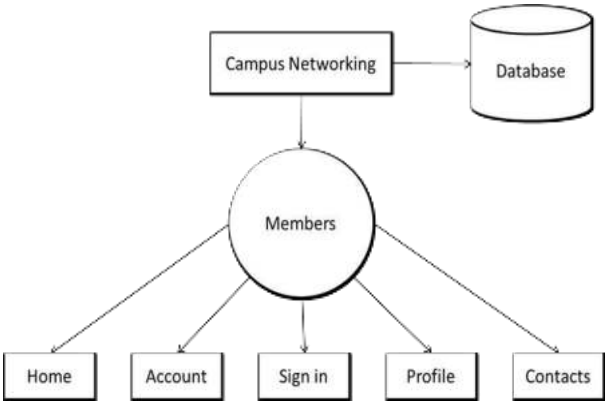
IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9506



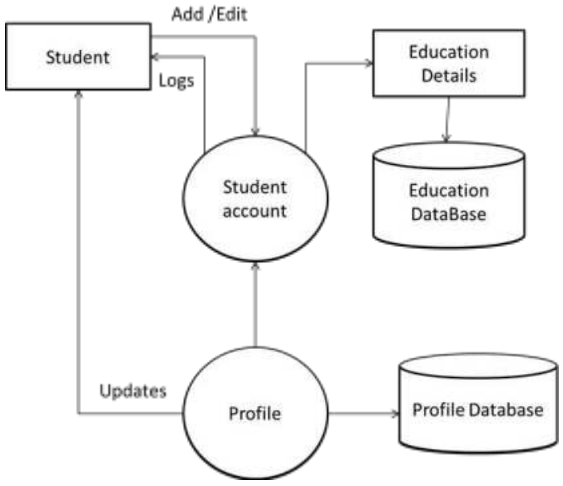
4.3 Description of the components

4.3.1 Functional component 1: Student Profile

Input- Student adds profile information and education details

Process- System checks previous student account and education details.

Output- Student can view education detail and profile details.



4.3.2 Functional component 2: Tutorials

Input- Student uploads education articles, tutorials, images, videos etc.

Process- System uploads education articles, tutorials, images, videos to database.

Output- Student can view uploaded education articles, tutorials, images, videos etc.

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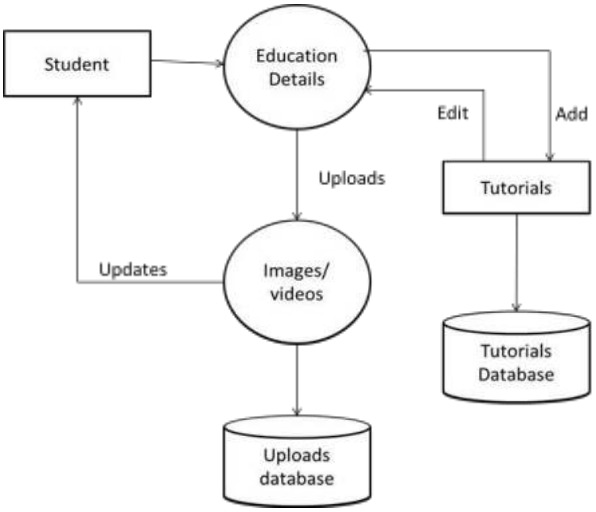
IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

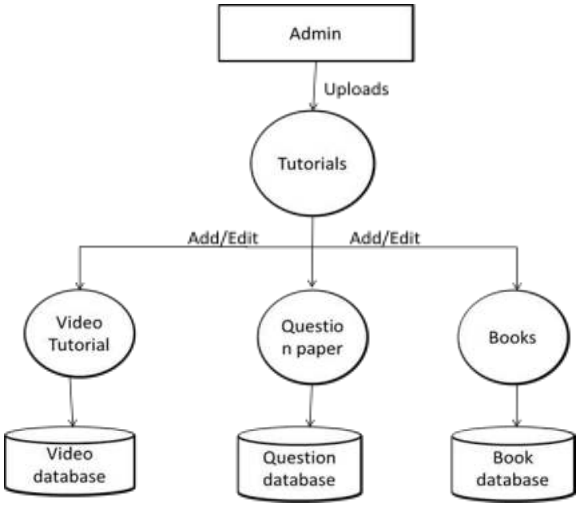
Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9506



4.3.3 Functional component 3: Admin

Input- Admin can upload and share video tutorials, question papers, books etc.
Process- System uploads education tutorials, question papers, books to database.
Output- Student can view uploaded tutorials, question papers, books etc.



IV. CONCLUSION

Now that you know the importance of networking in college, you can begin developing your path for your future post-graduation. You want to do whatever it takes to get that job you dream of and use the degree you earned. Networking is one of the most important parts of reaching this goal. It can help you build a bridge from academic success to career success. Several groups can be formed on certain topics to get updates related any information. These groups play a major role in highlighting the issues caused by an individual or a group of colleges. This makes this social networking platform an amazing one for the students as they can get connected and can share important information. With this college networking website application, you can connect with friends, find old friends, share pictures and messages, and reach out to new people registered into the application you've never met before. There may be rooms for enhancements and improvements in this project, so students are recommended to work on that to make this application a better one.

V. FUTURE SCOPE

It may seem like all college students are using technology at all times, and generally speaking, there is truth to that statement. Most college students come to campus with multiple technology devices, using their devices for reasons both academic and personal. Academically this project is going to help the students at present and for the future college

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IJIREEICE

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 9, Issue 5, May 2021

DOI 10.17148/IJIREEICE.2021.9506

students which will benefit them with the up to date information, career oriented and even personal behavioural development by meeting new students and faculties all over the world.

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8412

REAL TIME TRANSLATION OF SIGN LANGUAGE TO SPEECH AND TEXT

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Abstract: Creating a desktop application that uses a computer webcam to capture a person signing gestures for Indian Sign Language (ISL) and translate it into corresponding text and speech in real time. The translated sign language gesture will be acquired in text which is further converted into audio. In this manner we are implementing a finger spelling language translator. To enable the detection gestures, we are making use of a Convolution neural network (CNN). A CNN is highly efficient in tackling computer vision problems and is capable of detecting the desired features with high degree of accuracy upon sufficient training. This project is about converting the hand gesture of sign language to voice or text using Machine Learning Techniques and vice versa. In this we are going to capture a real time translation of indian sign language using single and double hand gestures and recognize the words and convert it into text and then to speech. If the person gives speech as input it is first converted to text and then it displays the suitable sign as output and vice versa.

Keywords: Indian Sign Language, Hand Gesture Recognition, Convolution Neural Network, K- means algorithm, Open CV.

INTRODUCTION:

According to the World Health Organization, 466 million have a disability in hearing as well as speech. 80% of deaf people are illiterate or semi-literate [which means most of them are not able to access their native language or writable knowledge], and most of them exclusively use sign language to communicate.

DEEP LEARNING:

Deep learning is an Artificial Intelligence(AI) function that imitates the working of a human brain in processing data and creating approach-patterns for use in decision making. Deep Learning is a subset of machine learning in artificial intelligence that has network efficiency of learning unsupervised from data that is mutable or unlabelled. Also known as deep neural learning or deep neural network. Deep Learning however known as deep structured learning is part of a border family of machine learning methods built of artificial neural networks with representation learning. Deep Learning on the other hand, is a type of Machine learning, inspired by the structure of a human brain.

The first advantage of deep learning all-over machine learning is the needlessness of the so-called feature extraction. The result of Feature Extraction is a representation of the given raw data that can be utilized by these classic machine learning algorithms to perform tasks. For example, the sorting of the data into several categories or classes. Feature extraction is usually quite complicated and involves detailed knowledge of the problem domain. This preprocessing layer must be matched, tested and refined over several iterations for optimal results.

EXISTING SYSTEM:

The Voice Disorder and hearing loss people usually recognize the sign language through the charts and identify the sign language. There are some applications that are used to recognize the gestures with an AI interaction video platform which identify the hand gesture recognition with different types of sign language as text.

PROPOSED SYSTEM:

The proposed system will identify the expression of the voice disorder and hearing loss people and recognize the hand gestures and give the description as text. Our method is that we will also add a feature as Audio with voice for their easy understanding. Our project is application based and it can be easily accessed with the web camera. This will also provide a learning platform via online.

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8412

MODEL CONSTRUCTION:

A convolutional neural network is a feed-forward multilayer perceptron that is used for pattern classification and is inspired by the natural visual perception mechanism of living creatures. Such networks usually consist of an input, an output and multiple hidden layers. Hidden layers typically consist of convolution, pooling, fully connected and normalization layers. Convolutional neural networks can be used for various applications, including image classification, object detection, object tracking, text detection and recognition, speech and natural language processing. The emotion recognition model is based on a deep learning approach, which uses convolution neural networks (CNNs) which is one of the most effective deep learning structures. The CNN model is being trained and the forward-pass mechanism obtains a classification prediction based on the image it took as input. This prediction is compared to the images label and a loss of the estimation is measured. The data collection interface was created by first fine-tuning a CNN model that was pre-trained on an existing dataset of face expression images that we collected from the web. The users face images from the device camera running the game interface are then analysed by the CNN model, labelled and added to our new dataset. Using this approach, it collected approximately a dataset of 20,000 images, which were used to train a fine-turned CNN model, which forms the basis for the Emotion Training Platform.

Framework:

In order to succeed real-time sign language computing performance, we mapped and implemented a framework. Gesture expressions they are presented with on the screen. By incorporating our work in real-time sign language recognition from a web camera, the platform is able to track the user's gestures in real-time and judge if the user is performing those gestures accurately. It is demonstrated that training in sign language expression mirroring is necessary to improve the recognition skills. This sort of training allows us to improve the skills of individuals with Indian sign language hand gestures recognition.

Gesture Expression Training Platform:

Gesture Train is a platform that is projected to target deficits in recognizing and marking sign expressions, and reciprocating language. When playing gestureTrain , users are involved to attempt to match the images of upper left corner OpenCV and landmark detector are utilized to track the user's gesture on the screen.

Contribution of this research:

We aim to recognize sign language expressed by voice disorder and hearing loss children from hand gestures. The angle, distance, velocity and acceleration are features calculated from head to sign points. The extracted features are given to the input of the Random Forest (RF) classifier and Support Vector Machine (SVM) classifier. Based on the gesture expressed by the deaf and dumb people and this helps them to communicate easily with normal people.

CONCLUSION:

This project aims to predict sign language recognition using machine vision with the help of deep learning. The performance of this tool is on part with that of humans for distinguishing the sign language gesture with real-time image.

FUTURE WORK:

In the future we tend to help the autistic children with the need of real information as a classroom environment to test the actual scenario. After we collect the autistic children's real data, future work can be carried out. The current research mainly identifies the emotions of the person, but the teaching process is a one-to-one interaction process. If teachers behaviours are included in the scope of recognition, it will be more realistic. Then after recognizing the emotional performance of auistic children, we can consider evaluating the score for the emotions expressed and the result will be displayed. If the score is less, it will motivate the person to practice more. In addition, we will include anxiety, surprise, and much more emotions.

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ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8412

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8411

Secure Message Transmission Using Base 64 Algorithm

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Abstract: Web security is important to keeping hackers and cyber-thieves from accessing sensitive information. Without a proactive security strategy, businesses risk the spread and escalation of malware, attacks on other websites, networks, and other IT infrastructures. Injection and authentication flaws, XSS, insecure direct object references, security misconfiguration, sensitive data exposure, a lack of function-level authorization, CSRF, insecure components, and unfiltered redirects. In this Application the users has to select either want to send something by encrypting or wants to receive by decrypting. If it want to send them it have to select source file previously designed or type some message which is to encrypt and transfer.[1] Whereas on the receiver side again the receiver has to select the file which is to be received from the sender along with decryption key to decrypt the message. Decryption key randomly generate and send to the Receiver inbox. Every receiver has a inbox login and it use graphical password. After logged in receiver can view the decrypted key for open the data.

Keywords: Secure Message Transmission; Base 64; Online web Application; Encryption.

INTRODUCTION

The security of data in today's digital age is very important , steganography and cryptography can be used to secure data in the form of text messages, documents, images, audio and video. Pictures are the most widely used objects both offline and online and also some images are confidential and should not be publicized which is maybe a picture of research or just personal consumption.The internet is simply a large collection of networked .Man has grown to depend on the internet on A continual basis and have incorporated it into their lives.Due to this dependence upon the internet, terrorists have Made the internet a potential attack platform Security, as of now, is the techniques developed to Securely guard information and information systems Store on computers. Potential threats consist of the Destruction of computer hardware, software, theft, Unauthorized use, or disclosure of data.[2] Computer and The information they contain are often considered Confidential systems because their use is typically Restricted to a limited number of users. This Confidentiality can be exposed to danger in a variety of Ways. For example, data and information can be exposed By hackers, viruses and worms. Therefore, security can be Defined as the resistivity degree to, or protection from Harm. Security is one of the basic needs of man since Creation.The case between the first two children (Cain And Abel) of the first human creature, Adam attest to This. It is also a statement of fact that security dynamics Have evolved over the years [1].

Cryptography is an art and science of hiding messages To introduce secrecy in data and information security is Known as cryptography.[1] The word ‘cryptography’ was Derived by combining two Greek words, ‘Krypto’ which Means hidden and ‘graphene’ which means writing

PROBLEM ANALYSIS

Data security is a major issue which we are facing today in this digital world of communication .as we know that today hackers are almost at every corner in search of our useful data which can be hacked by them for their different purpose. So, a system or terminology must required to make that data safe forever by any means during communication. So introduce a web application for security. It gives the security by using Cryptography. In this application we mainly show’s that how to store the file with security using Encryption algorithms. The user will login to the application by giving a valid email id of whom the file security key must be sent. After successful login the user will upload the file the file will encrypt and stored in the given path and security key sent to given mail id.[8] The user will download the decrypted file by giving security key which is received in user mail id.

A.Description of the Proposed Algorithm(Base 64) :

Java provides a class Base64 to deal with encryption. You can encrypt and decrypt your data by using provided methods. You need to import java.util.[1]Base64 in your source file to use its methods. This class provides different encoders and decoders to encrypt information at each level. Base 64 is an encoding scheme that converts binary data into text format

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8411

so that encoded textual data can be easily transported over network un-corrupted and without any data loss String BasicBase64format= Base64. Base64 is used commonly in a number of applications including email via MIME, and storing complex data in XML.

Encode simple String into Basic Base 64 format

StringBasicBase64format=Base64.getEncoder().encodeToString("actualString".getBytes());

Explanation: In above code we called Base64.Encoder using getEncoder() and then get the encoded string by passing the byte value of actualString in encodeToString() method as parameter.

Decode Basic Base 64 format to String

byte[]actualByte=Base64.getDecoder().decode(encodedString);
String actualString= new String(actualByte);
Explanation: In above code we called Base64.Decoder using getDecoder() and then decoded the string passed in decode() method as parameter then convert return value to string.

RELATED WORK

Base 64 Algorithm

The first step is to take the three bytes (24bit) of binary data and split it into four numbers of six bits. Because the ASCII standard defines the use of seven bits, Base64 only uses 6 bits (corresponding to 2^6 = 64 characters) to ensure the encoded data is printable and none of the special characters available in ASCII are used. The algorithm's name Base64 comes from the use of these 64 ASCII characters.[1] The ASCII characters used for Base64 are the numbers 0-9, the alphabets 26 lowercase and 26 uppercase characters plus two extra characters '+' and '/'.

Base64 Encoding/Decoding Table															
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Q	R	S	T	U	V	W	X	Y	Z	a	b	c	d	e	f
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
w	x	y	z	0	1	2	3	4	5	6	7	8	9	+	/
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63

In our programs, we can simply define this table as a character array. For example in 'C' we will do:

```
/* ---- Base64 Encoding/Decoding Table --- */ char b64[] =
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789+/";
```

Technically, there is a 65th character '=' in use, but more about it further down.
The ASCII conversion of 3-byte, 24-bit groups is repeated until the whole sequence of original data bytes is encoded. To ensure the encoded data can be properly printed and does not exceed any mail server's line length limit, newline characters are inserted to keep line lengths below 76 characters.
What happens when the last sequence of data bytes to encode is not exactly 3 bytes long? If the size of the original data in bytes is not a multiple of three, we might end up with only one or two remaining (8-bit) bytes. The solution is to add the missing bytes by using a byte value of '0' to create the final 3-byte group. Because these artificial trailing '0's cannot be encoded using the encoding table, we introduce a 65th character: '=' to represent '0'. Naturally, this character can only appear at the end of encoded data.

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8411

Example

Let's say we want to convert three bytes 155, 162 and 233. The corresponding 24-bit stream is 100110111010001011101001.

```
155 -> 10011011
162 -> 10100010
233 -> 11101001
```

Splitting up these bits into 4 groups of 6bit creates the following 4 decimal values: 38, 58, 11 and 41.

```
100110 -> 38
111010 -> 58
001011 -> 11
101001 -> 41
```

Converting these into ASCII characters using the Base64 encoding table translates them into the ASCII sequence "m6Lp".

```
38 -> m
58 -> 6
11 -> L
41 -> p
```

METHODOLOGY AND ARCHITECTURE

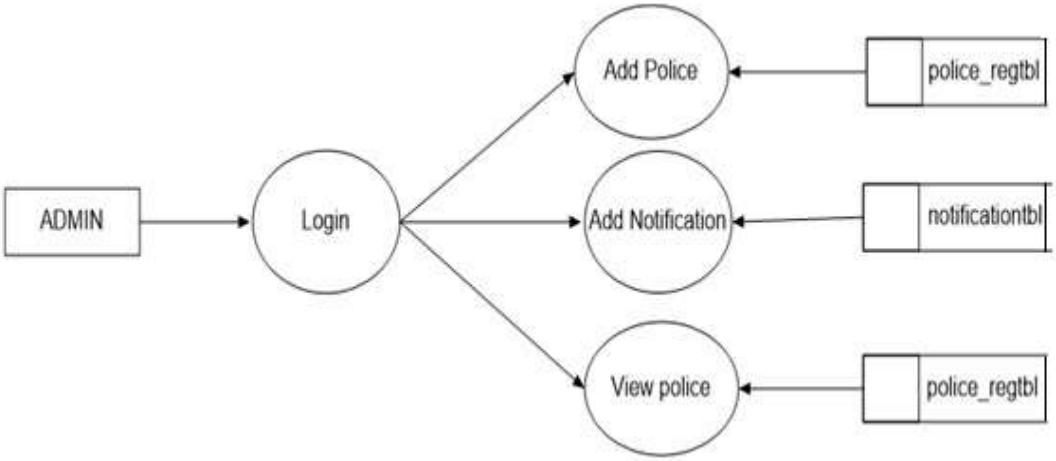
In the proposed system we are trying to automate the manual process. Here users can send and receive the records confidentially. Every receiver has a inbox login and it use graphical password. After logged in receiver can view the decrypted key for open the data.

This system contains 2 main modules based on the services provided. That are,

- Admin
- Police

Admin:

Admin can login by using username and password. Admin manage overall system. And he can add police officers and view their details .He can add all the notification. View the doctor .can view about the police details.



Police:

Police have logged on to the web application with username and password .when the admin add the police, an OTP will be sent to that police's email id .by using these OTP as a password to login . after the login, If he want to send some important files and he have to select source file previously designed and then transfer. the receiver can receive a message to his email id .after logging into the police web application, he has an inbox registration with a username and password,

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IARJSET

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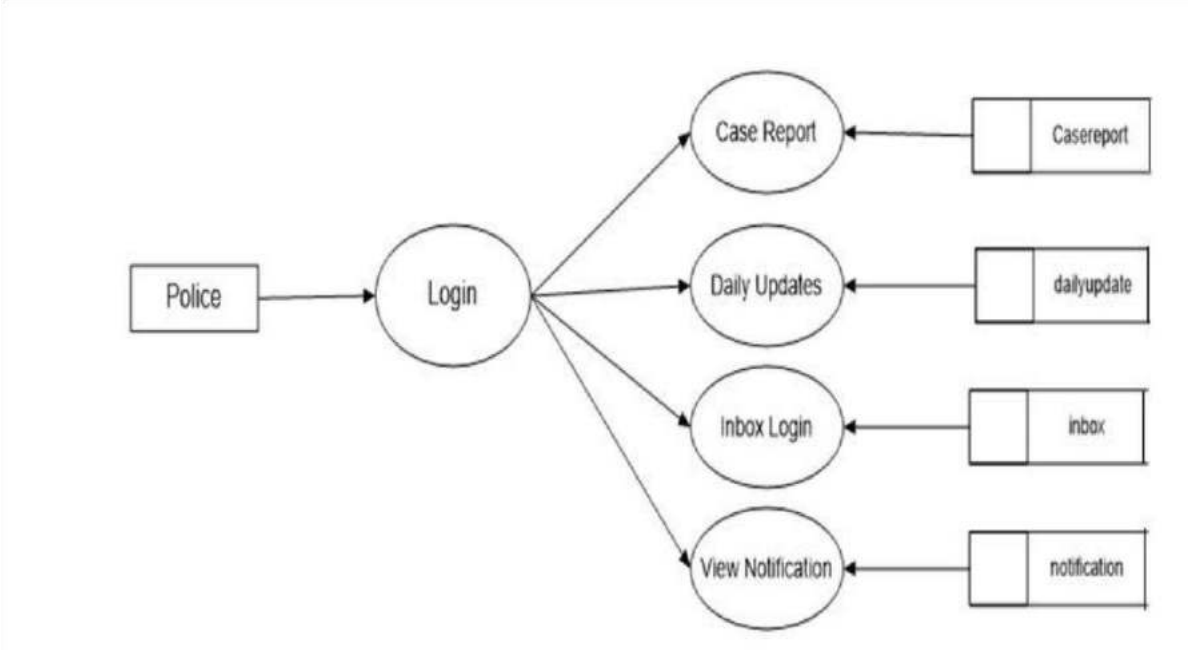
which is a color code that will be sent to his email id. that part is done by encryption .he has an inbox login to open his case report .with color code, username and encrypted. Copy paste that encrypted key and then click ok button then he can view his case report and to download.



CONCLUSION AND FUTURE WORK

This System helps the whole police departments to get the information safely. Because by using encryption algorithm it helps the department to provide an department way to encrypt and decrypt its data in a secure and controlled way **.** This will helps the police department to manage their record easily through encryption.[15]

Since this project is a web application ,in future ,We can develope the android application of this system by using high secured algorithm of cryptography. my project can do the cryptography by encrypting and decrypting data. dependent on other mailing system like gmail for information transfer.in future I can add the module so after encryption users can transfer information by the same software

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

DOI: 10.17148/IARJSET.2021.8408

JEWELLARY MANAGEMENT OF SOFTWEAR SYSTEM

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Abstract: Jewellery Shop Management is software which is concerned with the computerization of the records maintained in jewellery. In this project the details about the customer, agents and the staff are stored in separate tables. Customers' details are stored in a single table by day to day process at the time of purchase. The agent details are stored indifferent tables based on the item purchased i.e., gold, silver, diamond etc. Then staff's details can be classified into different categories according to their respective designations on the basis of which their salary is calculated. The standard rate of purchasing items such as gold, silver and diamond are stored in a separate table. Reports generation and billing can be done easily. As the market rates are volatile these rates can be changed as and when required. It is planned to design in such a way that a normal computer user even with account knowledge can use this software to maintain the resource flow. Addition, deletion and modification of the record are easy. These processes are done by entering the details and clicking on the respective place. Thus the project satisfies the entire needs of the jewelers in the process of maintaining these records and saves a lot of time.

Keywords: Data flow diagram, Databases, Jewellery, Visual basic

INDRODUCTION

ABOUT THE ORGANIZATION: Using manual process the work become slowly. As technologies are been developed and we now updating to the advanced technology want work to be done faster and to reduce the manpower involved in the work. The maintenance cost will be more and it should be maintain carefully. A person who doesn't have knowledge of it could not be able to handle the system. Thus taking this into consideration. In the Jewellery Resource Management project, the project can give any kind of information through reports and queries if required is very sophisticated to use and modify. The project is designed in such a way that it can afford any changes that occurs in future .The project can also be modified according to the needs It is feasible to have an integrated system with GUI and Relational Database for the Jewellery Resource Management. The wastage of storage space is avoided by eliminating the data redundancy, which needs careful programming. The careful programming minimizes the processing time. The user can easily handle the system. The system adopts regularity and it is flexible to operate But maintaining the same quality or upgrading the present one is not an easy task because quality is the ultimate picture of the entire business. Good quality of a product depends on many factors e.g. sound infrastructure, better management control, etc. So to obtain the optimum quality, jewelers have to upgrade.

ABOUT THE PROJECT: - Those ingredients by which the quality is affected. To upgrade those ingredients the jewellers have to depend on some types of data. So, if the decision making person of the business wants to have a grip on the total business, he/she will have to have a knowledge of the entire flow of data and information within the organization .It cannot be done without the help of a Business Related Software. Jewellery management system is developed in Asp.Net, which can keep track of all your business activity in a jewellery shop from small segments to large and very large segments. As we all know the jewellery trade can be divided into three major categories i.e.

1) Retail
2) Wholesale
3) Export

Main Features Of Jewellery Management System:

Creation of unlimited types of purity

Each purity can be divided into 50 grades depending on percentage of alloys.

- Creation of Artisan/Dealer Master

Every single information regarding the artisan/dealer can be stored here e.g. name & address of the artisan, making charge of an ornament etc.

- Creation of Customer Master

Every single information regarding the customer can be stored here e.g. name & address of the customer etc.

- Creation of Stone Master

  There are many types of stones in the business which are categorized according to:

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

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DOI: 10.17148/IARJSET.2021.8408

1) Diamond : It can be divided into many categories e.g. round, square, Marquise etc.
2) Colour Stones : Ruby, Pearl, Emerald, etc.

NET FRAMEWORK CLASS LIBRARY

The .NET Framework class library is a collection of reusable types that tightly integrate with the common language runtime. The class library is object oriented, providing types from which your own managed code can derive functionality. This not only makes the .NET Framework types easy to use, but also reduces the time associated with learning new features of the .NET Framework. In addition, third-party components can integrate seamlessly with classes in the .NET Framework.

For example, the .NET Framework collection classes implement a set of interfaces that you can use to develop your own collection classes. Your collection classes will blend seamlessly with the classes in the .NET Framework.

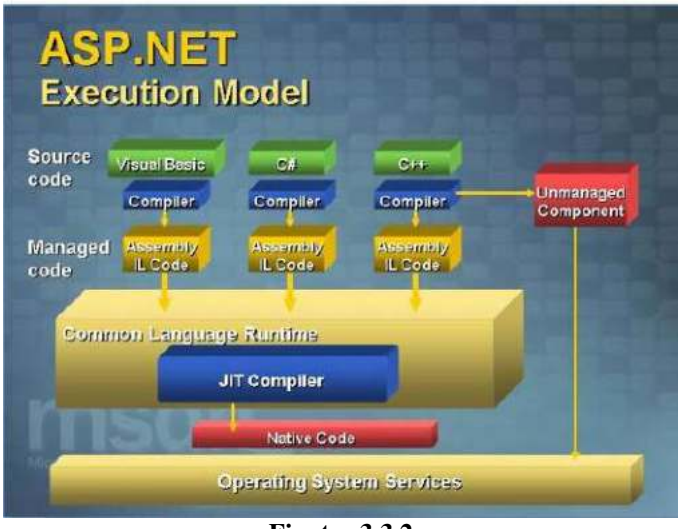
As you would expect from an object-oriented class library, the .NET Framework types enable you to accomplish a range of common programming tasks, including tasks such as string management, data collection, database connectivity, and file access. In addition to these common tasks, the class library includes types that support a variety of specialized development scenarios. For example, you can use the .NET Framework to develop the following types of applications and services:

- Console applications.
- Scripted or hosted applications.
- Windows GUI applications (Windows Forms).
- ASP.NET applications.
- XML Web services.
- Windows services.

For example, the Windows Forms classes are a comprehensive set of reusable types that vastly simplify Windows GUI development. If you write an ASP.NET Web Form application, you can use the Web Forms classes.

CLIENT APPLICATION DEVELOPMENT

Client applications are the closest to a traditional style of application in Windows-based programming. These are the types of applications that display windows or forms on the desktop, enabling a user to perform a task. Client applications include applications such as word processors and spreadsheets, as well as custom business applications such as data-entry tools, reporting tools, and so on. Client applications usually employ windows, menus, buttons, and other GUI elements, and they likely access local resources such as the file system and peripherals such as printers.



Figuter 3.3.2

The Windows Forms classes contained in the .NET Framework are designed to be used for GUI development. You can easily create command windows, buttons, menus, toolbars, and other screen elements with the flexibility necessary to accommodate shifting business needs.

For example, the .NET Framework provides simple properties to adjust visual attributes associated with forms. In some cases the underlying operating system does not support changing these attributes directly, and in these cases the .NET Framework automatically recreates the forms. This is one of many ways in which the .NET Framework integrates the developer interface, making coding simpler and more consistent.

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IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 4, April 2021

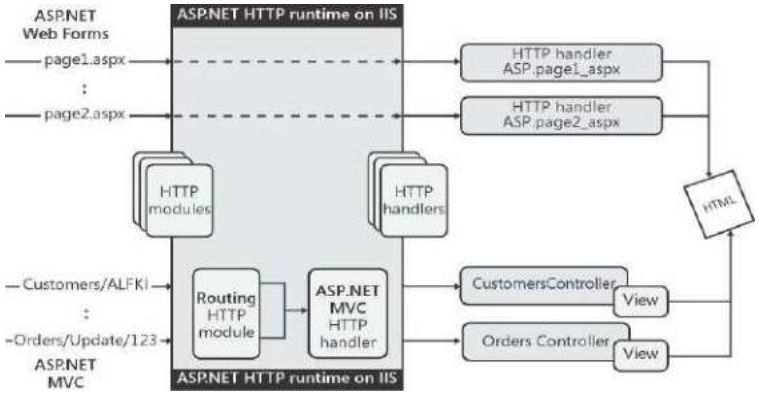
DOI: 10.17148/IARJSET.2021.8408

ASP.NET

Server Application Development

Server-side applications in the managed world are implemented through runtime hosts. Unmanaged applications host the common language runtime, which allows your custom managed code to control the behavior of the server. This model provides you with all the features of the common language runtime and class library while gaining the performance and scalability of the host server.

The following illustration shows a basic network schema with managed code running in different server environments. Servers such as IIS and SQL Server can perform standard operations while your application logic executes through the managed code.



Figuter 3.3.3

SERVER-SIDE MANAGED CODE

ASP.NET is the hosting environment that enables developers to use the .NET Framework to target Web-based applications. However, ASP.NET is more than just a runtime host; it is a complete architecture for developing Web sites and Internet-distributed objects using managed code. Both Web Forms and XML Web services use IIS and ASP.NET as the publishing mechanism for applications, and both have a collection of supporting classes in the .NET Framework.

XML Web services, an important evolution in Web-based technology, are distributed, server-side application components similar to common Web sites. However, unlike Web-based applications, XML Web services components have no UI and are not targeted for browsers such as Internet Explorer and Netscape Navigator. Instead, XML Web services consist of reusable software components designed to be consumed by other applications, such as traditional client applications, Web-based applications, or even other XML Web services. As a result, XML Web services technology is rapidly moving application development and deployment into the highly distributed environment of the Internet.

If you have used earlier versions of ASP technology, you will immediately notice the improvements that ASP.NET and Web Forms offers. For example, you can develop Web Forms pages in any language that supports the .NET Framework. In addition, your code no longer needs to share the same file with your HTTP text (although it can continue to do so if you prefer). Web Forms pages execute in native machine language because, like any other managed application, they take full advantage of the runtime. In contrast, unmanaged ASP pages are always scripted and interpreted. ASP.NET pages are faster, more functional, and easier to develop than unmanaged ASP pages because they interact with the runtime like any managed application.

ACTIVE SERVER PAGES.NET

ASP.NET is a programming framework built on the common language runtime that can be used on a server to build powerful Web applications. ASP.NET offers several important advantages over previous Web development models:

- Enhanced Performance. ASP.NET is compiled common language runtime code running on the server. Unlike its interpreted predecessors, ASP.NET can take advantage of early binding, just-in-time compilation, native optimization, and caching services right out of the box. This amounts to dramatically better performance before you ever write a line of code.
- World-Class Tool Support. The ASP.NET framework is complemented by a rich toolbox and designer in the Visual Studio integrated development environment. WYSIWYG editing, drag-and-drop server controls, and automatic deployment are just a few of the features this powerful tool provides.

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IARJSET

ISSN (Online) 2393-8021
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DOI: 10.17148/IARJSET.2021.8408

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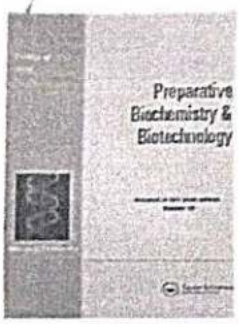

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Selection of suitable adsorbent for the removal of Cr(VI) by using objective based multiple attribute decision making method

Saroj Sundar Baral , Kavitha Mohanasundaram & Surendran Ganesan

To cite this article: Saroj Sundar Baral , Kavitha Mohanasundaram & Surendran Ganesan (2020): Selection of suitable adsorbent for the removal of Cr(VI) by using objective based multiple attribute decision making method, Preparative Biochemistry & Biotechnology, DOI: 10.1080/10826068.2020.1789993

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Selection of suitable adsorbent for the removal of Cr(VI) by using objective based multiple attribute decision making method

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[a]BITS Pilani, K K Birla Goa Campus, Goa, India; [b]JCT College of Engineering College, Coimbatore, India; [c]KPR Institute of Engineering and Technology, Coimbatore, India

ABSTRACT

The objective of the current manuscript is to develop a systematic and simplified expert system for the selection of suitable adsorbent to treat Cr(VI). Selection of adsorbent among the large options available by considering all possible factors and their interaction is required in an easy, organized and rational way. In this study, fuzzy logic is used for the choosing an appropriate adsorbent for the Cr(VI) removal. Multiple attribute decision making (MADM) is utilized to work out the relative weighting values for the chosen sorbent. The preference index is calculated by using the subjective and objective weights. The normalized value associated with each parameter has given on the basis of effect of each parameter on the removal of Cr(VI) and uptake capacity of each material. The associated MADM method results and the barriers of the approach is mentioned to lay the basis for in addition enhancement.

KEYWORDS

Cr(VI); fuzzy number; MADM; preference index

Introduction

In the last few decades, adsorption has emerged as popular process in the context of its application to wastewater treatment. The industrial accomplishment of the adsorption technique in wastewater management has given rise to in significant lookup that has led to the find out a huge variety of adsorbent materials. There are wide varieties of absorbent materials available in the market for removal of chromium from aqueous solution which necessitate that there is a most efficient material for the process.[1–3] Most of the adsorbents are micro/mesoporous materials like activated carbon, adsorbent from agricultural product, industrial waste, domestic waste, etc. They are used either in its original form or by modifying using techniques such as ion exchange. During the development of sorption process, numerous sorbents will be available which may be appropriate for Cr(VI) removal from aqueous solution.[4–6] Initially, the suitability can be assessed by comparing the isotherms, kinetics or/and the uptake rates of Cr(VI) from simulated solution.[7–9] However, a superficial visual examination may be confusing and may not enumerate the importance of the efficiency of the adsorbent for the water treatment. Furthermore, a large number of choices can make it confusing and difficult to select and therefore a systematic technique is required to select the correct sorbent. There are a large number of criteria available which has to be considered for the selection of a suitable adsorbent.

A detailed literature survey indicates that the scientific paper related to the selection of adsorbent is rather scanty. In present manuscript, an attempt is made to critically review the important attributes of adsorbent for the removal of Cr(VI). Furthermore, attribute-based multiattribute decision making method is used to asses and decide the best adsorbent for the Cr(VI) adsorption. A three-stage method that consists of elimination search is suggested to assess the large adsorbents.

Extensive literature review suggests that naturally available, low cost bio-adsorbents have very high adsorption capacity.[10,11] However, the tannin and lignin presents in the biomaterials may leach-out and create environmental pollution and hence required suitable pre-treatment which may not be economical and environmental friendly.[12] Furthermore, economy of an adsorption process reliant on the number of sorption–desorption cycle of each adsorbent. The amine and electron donor groups present in the biomaterials lead indirect reduction and increase the chemi-sorption. When pH of the aqueous section is decreased, a huge amounts of H_2 ions coordinate with the amino, hydroxyl, CN without difficulty and react with the $Cr_2O_7^{2-}$ which is irreversible.[13] Therefore, regeneration of the adsorbents is not possible and hence the adsorbents may not be economical and also can create disposal problem.[14,15] The adsorption capacity of some of the adsorbent is high but at lower pH and other adsorbents has very low adsorption capacity. From the above discussion, it is evident that, some of the attributes in the adsorption may conflict in nature i.e., for positive attributes, large values are desired and for different attributes smaller values are favored. Then trade-off among the parameters is needed, due to the fact properties of attributes is altering for different cases. Therefore, a

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professional system which will dispose of the human inaccuracy and is successful of coping with this kind of challenges is required. MADM is a well-known method, when there are contradictory standards to evaluate a scheme amongst the handy choices.[16] MADM is a device usually used to conciliate a couple of contrast criteria, considering the choices of a decision maker. In MADM technique, the parameters records are assessed to reach at best options.

While choosing a sorbent, a number of influences should be taken into account out of which few are outline bellow:

- Sorbent should capture the Cr(VI) – adsorb into the particle and not only on the outside surface of adsorbent.
- All Cr(VI) in the water should absorb by the sorbent.
- The absorbent should be cheaper.
- The absorbent should be environmental friendly.
- It should have high adsorption capacity.
- It should be safe to handle and should not a threat to the worker and atmosphere.

All the factors above must be used in conjunction with other important properties to select an appropriate adsorbent.[17]

The design engineers have to consider numerous factors, like pH, Cr(VI) concentration, dosage, temperature, duration and stirring speed, etc.[18] while choosing the best suitable adsorbent for adsorption process, which makes the process little bit complex.[19–21] For the selection, proper material, where several available choices and with many influencing norms, a more appropriate mathematical methodology is needed. For the above said situation, MCDM or MADM methodologies are useful for choosing the particular adsorbent on a numerous set of parameters. This approach (MADM) has been used in many different areas like plant layout selection,[22] assessment of electroplating method,[23] selection of supplier[24] and selection in mechatronic systems.[25] This approach initially implemented by Zhang[26] which integrating both subjective and also objective information and also explained with the illustrative example by the author. Most recently, a multiattribute decision approach is used for the selection of anti-COVID 19 Mask.[27]

In the current manuscript, a MADM technique is used for the sorbent selection, considering quantitative attributes is applied in evaluating and optimizing the selection adsorbent for the Cr(VI) removal. A fuzzy conversion scale was utilized to change the qualitative attributes like pH, cost, and concentration to a judgment rank value. The projected method gives an idea for the selection of adsorbent based importance of the objective weight of attributes. In order to explain the methodology a demonstrative example is given. The step by step procedure of this method has been explained which is used friendly and easily understandable.

Multiple attributes decision-making methodology

MCDM method was very effective and systematic for the selection, on the basis of preference selection index (PSI).[28,29] This method MCDM technique based on Technique for Order of Preference by Similarity to Ideal Solutions (TOPSIS).[30,31] Yang et al.[32] proposed novel decision algorithm based on q-ROF to explore the multiple heterogeneous relationships among membership functions and criteria. TOPSIS method can be used to explore the suitable adsorption parameter and their inter relation between the parameter by fitting a polynomial equation to this experimental data in a multiple regression analysis. This method has been applied in Mechanical engineering in many areas like advanced manufacturing system (AMS) like in Robot industries, Flexible manufacturing scheme, quick prototyping method, appropriate machine for flexible manufacturing cell, and Non-conventional machining methods.[33,34] Recently, Yang et al.[35] use q-rung orthopair fuzzy expert system to develop a model which helps the consumer to take appropriate decision on a particular product.

In order to solve the difficulties of choosing among a fixed number of parameters, the simple and systematic steps were proposed by Rao[36] has been applied. Different adsorbent such as Marine Strains Yeast,[37] *Aspergillus niger*,[38] *Hydrilla verticillate* seed,[39] *Salvinia cucutta*,[40] Fungal biomaterial *Coriolus versicolor*,[41] and Pomegranate husk[42] from material database and along with that our research work with Pig iron sludge have been selected for the selection of better choice of adsorbent for adsorption as per MADM method. The six properties such as pH, adsorbent dose in g/L, adsorbate concentration in ppm, speed in RPM, temperature in °C, and duration in min are taken in this manuscript. This has been illustrated in Figure 1. The methodology is represented in form of flow chart which is shown in Figure 2.

Decision making table

Find the relevant measured parameters for the chosen adsorbent and choose the adsorbent which easily identifiable parameters satisfying the requirements. All parameters are divided into two types, one is beneficial where the greater values are most preferred one and non-beneficial where lesser values are most preferred. The accepted limiting values either in terms of qualitative or quantitative have been assigned to each parameter for the considered problem. Here we more concerned about the removal of Cr(VI). After choosing the alternative adsorbent parameter and find the values related to the parameters (Z_{ij}), a decision table, analogues one which is shown in Table 1 containing the values of all parameters of the adsorbent.

Actual decision table for different kind of adsorbent that we have selected has been shown in Table 2. To change the factors in decision table to measurable and unit less quantity, it is important to normalize their values. These values are linked to each parameters (Z_{ij}) might be in dissimilar units like Concentration in mg/L, pH, speed in RPM, Cost, etc. The normalized value of each element in decision table is obtained by the following expression r_{ij} as

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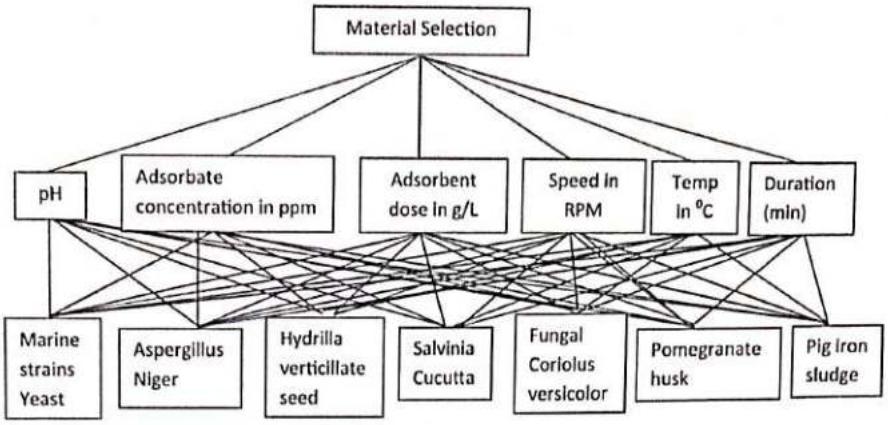

Figure 1. Materials and their properties selection.

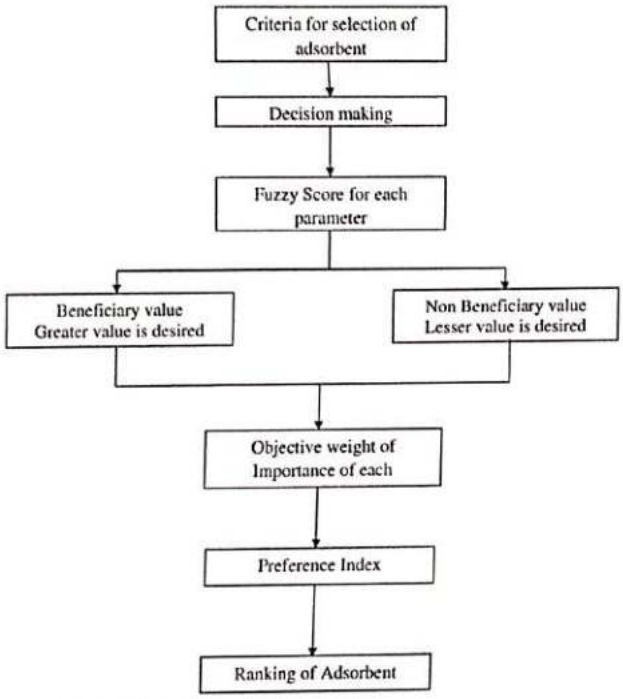

Figure 2. Proposed research model/framework.

Table 1. Decision table.

	Attributes						
Alternative	B_1	B_2	B_3	B_4	–	–	B_m
A_1	Z_{11}	Z_{12}	Z_{13}	Z_{14}	–	–	Z_{1m}
A_2	Z_{21}	Z_{22}	Z_{23}	Z_{24}	–	–	Z_{2m}
A_3	Z_{31}	Z_{32}	Z_{33}	Z_{34}	–	–	Z_{3m}
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
A_n	Z_{n1}	Z_{n2}	Z_{n3}	Z_{n4}	–	–	Z_{nm}

$$r_{ij} = \frac{Z_{ij}}{\sum_{i=1}^{n} Z_{ij}} \tag{1}$$

where r_{ij} is the normalized value of Z_{ij} and $\sum_{i=1}^{n} Z_{ij}$ is the total value of jth parameter for n different adsorbents or in general different alternatives.

Equation (1) will deal the quantitative measurement of different attributes, but for qualitative measurement of attributes there must be a method to converts this into quantitative value as in our illustrative example like pH. We have used Crisp score assigned for each fuzzy number conversion scale to change qualitative parameter in to equal quantitative value. This approach was introduced by Chen and Hwang.[43] To better understand the system, an 11-point scale is recommended. Table 3 signifies the selected parameter in a qualitative scale can be converted to quantitative by using fuzzy number.

Based on the value of fuzzy numbers associated with each attribute, we have obtained the Tables 4 and 5 which are indicating the crisp score value for each parameter of different adsorbent. After obtaining the fuzzy conversion table, our aim is to calculate the normalized data table to find the objective weight of attributes. These values have been shown in Table 6.

Objective weight of importance of attributes

The importance of objective weight of each parameter is found by using statistical variance. The following equation is used to estimate the importance of weightage of each parameter.

$$V_J = \left(\frac{1}{n}\right) \sum_{i=1}^{n} (r_{ij} - (r_{ijmean}))^2 \tag{2}$$

where V_j is the statistical variance of the data matching to the jth parameter, $(r_{ij})_{mean}$ is the mean value of r_{ij}. V_J measures the distribution of each data points nearby their mean value. The objective weight of the jth attribute Q_j^0 can be calculated by the statistical variance of each parameter divided by the total statistical variances of all the number of parameter. The given below equation has been used to calculate the importance of each attribute in objective weights. This is shown in Table 7.

$$Q_j^0 = \frac{V_J}{\sum_{i=1}^{m} V_J} \tag{3}$$

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Table 2. Different adsorbent used to remove the Cr(VI) and its parameters.

S. No	Name of the adsorbent	pH range	Adsorbate concentration in ppm	Adsorbent dose in g/L	Speed in RPM	Temp in °C	Duration in min
1	Marine Strains Yeast	1	200	9.3	130	35	120
2	Biosorption *Aspergillus niger*	2	100	0.8	180	50	2880
3	*Hydrilla verticillate* seed weed	3	100	0.8	600	27	360
4	*Salvinia cucutta* weed	1.7	500	0.8	600	30	600
5	Fungal bioremedal white rot	2	50	5	160	25	180
6	Husk of pomegranate	1	75	3	200	25	180
7	Pig iron sludge	3	10	4	170	30	360

Table 3. Fuzzy scores for qualitative measure.

Qualitative measurement of selection attribute	Fuzzy number	Assigned score in crisp value (3 decimal point)
Exceptionally low (EXL)	F1	0.046
Extremely low (EL)	F2	0.136
Very low (VL)	F3	0.227
Low (L)	F4	0.318
Below average (BA)	F5	0.409
Average (A)	F6	0.5
Above average(AA)	F7	0.591
High (H)	F8	0.682
Very high (VH)	F9	0.773
Extremely high (EH)	F10	0.864
Exceptionally high (EXH)	F11	0.955

Preference index determination

Each alternative is judged with related to its weights associated to every parameter. The Preference Index (PI) is weighted sum of the overall performance score of an alternative. The PI gives rank of particular adsorbent with compared to all other adsorbent. The PI is calculated by adding all the values of X_i^0 for different alternative. X_i^0 is the multiplication result of objective weight of importance (Q_j^0) and r_{ij}^{**} for different parameters. The following equations are used to estimate the preference index.

$$X_i^0 = Q_j^0 * \ r_{ij}^{**} \tag{4}$$

$$P_i^0 = \sum_{j=1}^{m} X_I^0 \tag{5}$$

where $r_{ij}^{**} = [r_{ij}^{b} = (r_{ij}^{b})_{\max}]$ for beneficial parameter.$[(-r_{ij}^{nb})_{\min} = (r_{ij}^{nb})]$ for non-beneficial parameter.r_{ij}^{b} is the normalized value of beneficial parameter and r_{ij}^{nb} indicated normalized value of non-beneficial parameter, respectively. $(r_{ij}^{b})_{\max}$ signifies the maximum value of jth beneficial parameter and $(r_{ij}^{nb})_{\min}$ signifies the minimum value of jth non-beneficial parameter. The calculation of preference index for each adsorbent is shown in Table 8. All the adsorbent alternatives have been arranged with respect to decreasing order of P_i^0 to get the favorite alternatives. After calculating the P_i^0, the adsorbent with largest P_i^0 value is the most suitable for considered decision-making system. This calculation has been shown in Table 9.

Conclusion

This paper presents a selection of suitable adsorbent which is the major task during the initial stage of adsorption, to remove the hexavalent chromium from industrial wastewater. As the selection of particular sorbent is very complex in nature due to the adsorption depends upon on many factors. So, there is a requirement of easy, organized and rational methods to direct the assessor by taking all possible factors and its interaction for taking correct decision. In the manuscript, fuzzy logic method is used for selection of suitable adsorbent for the Cr(VI) removal. MADM is utilized to find out the weighting values for the chosen adsorbent. Selection of an optimum sorbent for treating Cr(VI) can be done based on their preference index shown in the

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Table 4. Properties of different adsorbent and its attributes.

S. no	Name of the adsorbent	pH range	Adsorbate con. (ppm)	adsorbent dose in g/L	Speed (RPM)	Temp (°C)	Duration (min)
1	Marine Strains Yeast	EXL	VH	VH	L	L	L
2	Biosorption *Aspergillus niger*	VL	BA	EL	A	H	EH
3	*Hydrilla verticillate* Seed weed	EXH	BA	EL	H	L	A
4	*Salvinia cucutta* weed	A	EXH	EL	H	L	AA
5	Fungal bioremedal white rot	VL	VL	AA	BA	VL	BA
6	Husk of pomegranate	EXL	L	A	A	VL	BA
7	Pig iron sludge	EXH	EXL	A	A	L	A

Table 5. Quantitative value using fuzzy conversion scale.

S. no	Name of the adsorbent	pH range	Adsorbate con. (ppm)	adsorbent dose (g/L)	Speed (RPM)	Temp (°C)	Duration (min)
1	Marine Strains Yeast	0.0455	0.7727	0.7727	0.3182	0.3182	0.3182
2	Biosorption *Aspergillus niger*	0.2273	0.5	0.1364	0.5	0.6818	0.8636
3	*Hydrilla verticillate* seed weed	0.9545	0.5	0.1364	0.6818	0.3182	0.5
4	*Salvinia cucutta* weed	0.5	0.9545	0.1364	0.6818	0.3182	0.5909
5	Fungal bioremedal white rot	0.2273	0.2273	0.5909	0.4091	0.2273	0.4091
6	Husk of pomegranate	0.0455	0.3182	0.4091	0.5	0.2273	0.4091
7	Pig iron sludge	0.9545	0.0455	0.5	0.4091	0.3182	0.5

Table 6. Normalized data for calculating the objective weights of parameters.

S. no	Name of the Adsorbent	pH range	Adsorbate con. (ppm)	adsorbent dose (g/L)	Speed (RPM)	Temp (°C)	Duration
1	Marine Strains Yeast	0.015	0.233	0.288	0.091	0.132	0.089
2	Biosorption *Aspergillus niger*	0.077	0.151	0.051	0.143	0.283	0.240
3	*Hydrilla verticillate* seed weed	0.323	0.151	0.051	0.195	0.132	0.139
4	*Salvinia cucutta* weed	0.169	0.288	0.051	0.195	0.132	0.165
5	Fungal bioremedal white rot	0.077	0.069	0.220	0.117	0.094	0.114
6	Husk of pomegranate	0.015	0.096	0.153	0.143	0.094	0.114
7	Pig iron sludge	0.323	0.014	0.186	0.117	0.132	0.139

Table 7. Statistical variance and objective weight of importance of the attributes.

S. no	$r_{j,mean}$	0.143	0.143	0.143	0.143	0.143	0.143
1	Sum square $(r_j - r_{jmean})$	0.107	0.054	0.054	0.009	0.025	0.015
2	Statistical variance V_j	0.0153	0.0077	0.0078	0.0013	0.0035	0.0021
3	Objective weight of importance Qj	0.405	0.203	0.207	0.036	0.094	0.056

Table 8. Preference index (X_j values for preference index).

S. no	Name of the Adsorbent	X_{ph}	X_{conc}	X_{dose}	X_{speed}	X_{temp}	$X_{duration}$
1	Marine Strains Yeast	0.0193	0.1645	0.0365	0.0358	0.0672	0.0555
2	Biosorption *Aspergillus niger*	0.0964	0.1064	0.2065	0.0228	0.0314	0.0205
3	*Hydrilla verticillate* seed weed	0.4049	0.1064	0.2065	0.0167	0.0672	0.0353
4	*Salvinia cucutta* weed	0.2121	0.2032	0.2065	0.0167	0.0672	0.0299
5	Fungal bioremedal white rot	0.0964	0.0484	0.0477	0.0278	0.0940	0.0432
6	Husk of pomegranate	0.0193	0.0677	0.0689	0.0228	0.0940	0.0432
7	Pig iron sludge	0.4049	0.0097	0.0563	0.0278	0.0672	0.0353

Table 9. Ranking of alternative adsorbent for the removal of Cr(VI) process.

S. no	Name of the adsorbent	Values of objective based fuzzy logic (P_j)	Rank based on (P_j)
1	Marine Strains Yeast	0.38	5
2	Biosorption *Aspergillus niger*	0.48	4
3	*Hydrilla verticillate* seed weed	0.84	1
4	*Salvinia cucutta* weed	0.74	2
5	Fungal bioremedal *Coriolus versicolor*	0.36	6
6	Husk of pomegranate	0.32	7
7	Pig iron sludge	0.60	3

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previous section. Preference index is calculated by using the subjective and objective weights. The ultimate decision can be arrived by considering all practical consideration during the experimentation. This calculation has been done purely on the basis of literature survey on the Cr(VI) removal by varying different parameter of different adsorbent. The normalized value associated with each parameter has given on the basis of effect of each parameter on the Cr(VI) removal and uptake capacity of each material. However, the limitations of this computational approach still remain. Only limited number of adsorbent was chosen for comparison and this can be extended for very large data with numerous parameters to prove with respect to cover all the sustainability dimensions like the environment, economic and social dimensions. The associated MADM method results and the limitation of the approach is elaborated to help in the additional improvement.

Acknowledgments

The authors are thankful to the Director, BITS Pilani, K. K. Birla Goa Campus, India and also Chairman and Principal of KPR Intitute of Engineering and Technology, Coimbatore, India for permitting to publish the work.

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Bull Mater Sci (2020)43:217
https://doi.org/10.1007/s12034-020-02194-4

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Morphology, optical, thermal and antimicrobial studies of ibuprofen-based hyperbranched polyester

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MS received 20 September 2019; accepted 4 April 2020

Abstract. Herein we report the synthesis of ibuprofen-based hyperbranched polyester ranging from morphological, thermal and fluorescent behaviour. The proposed synthesis of ibuprofen-based hyperbranched polyester was achieved by a simple acid chloride approach. The formation of aromatic ester linkage in the product was confirmed using Fourier transform infrared and nuclear magnetic resonance spectroscopy. The morphology of ibuprofen-based hyperbranched polyester was investigated by using the X-ray diffraction, scanning electron microscopy and differential scanning calorimetry (DSC) analyses. The glass transition temperature (~78°C) and double melting peaks of ibuprofen-based hyperbranched polyester were observed using DSC. The liquid chromatography-mass spectrometry analysis confirmed the chemical structure and the molecular weight of the ibuprofen-based hyperbranched polyester. The presence of broad absorption peak at 301 nm in UV region indicated the fluorescent property of ibuprofen-based hyperbranched polyester. The antimicrobial tests of ibuprofen-based hyperbranched polyester were carried against Gram-negative organisms such as *Escherichia coli* MCIM 2065 and *Salmonella paratyphi* MCIM 2501, Gram-positive organisms such as *Bacillus subtilis* NCIM 2063 and *Staphylococcus aureus* NCIM 2079 and fungi such as *Aspergillus niger* MTCC 1344 and *Candida albicans* MTCC 3100. The result of agar disc diffusion method showed that the polymer had higher antimicrobial potential towards fungi than bacteria.

Keywords. Ibuprofen; hyperbranched polyester; morphological properties; antimicrobial activity.

1. Introduction

Hyperbranched polyesters have attracted widespread attention in recent decades [1,2]. They are extensively studied because of their excellent thermal stability, chemical resistance and mechanical properties [3,4]. They have a highly branched structure, a large number of functional groups and inner cavities, showing low viscosity, excellent solubility and high chemical reactivity, being widely used in many fields [5]. Hyperbranched polyesters can be synthesized from easily available and less expensive raw materials, and have compelled many research groups to investigate them in detail [6]. They can also be prepared by a single-step process avoiding complicated iterative reaction sequences and chromatographic purification [7–10]. The functional groups present at the periphery of the hyperbranched polyesters could be used to modify other materials, so they can be used as polymeric processing agents, toughening components, rheology modifiers, macroscopic tubes and biocompatible polymers [11–13]. The properties of hyperbranched polyesters are often affected by the nature of the backbone, the chain-end functional groups, degree of branching, chain length between branching points and the molecular weight distribution [14]. On account of high solubility and low viscosity, it is possible to prepare modified hyperbranched polyesters by using different agents [15,16]. Hyperbranched polyesters can be easily modified to tailoring their properties for a specific purpose, and it was expected that their modifications would make to obtain nonsteroidal anti-inflammatory drug (NSAID)-based polymers [17,18]. Ibuprofen, a NSAID; however, its solubility in water is poor, which affects pharmaceutical product development in nearly all therapeutic areas [19,20]. Researchers showed interest towards the antimicrobial activity of ibuprofen, both direct and indirect, which has been known for more than 23 years.

Electronic supplementary material: The online version of this article (https://doi.org/10.1007/s12034-020-02194-4) contains supplementary material, which is available to authorized users.

Surprisingly, only about few studies can be found on the subject, while some aspects of the antimicrobial activity of ibuprofen have not been explored at all, such as the mechanisms of the antibacterial action [21].

Ibuprofen is used similar to other NSAIDs because of its analgesic and antipyretic properties [22]. Therefore, it is thought that ibuprofen, as an agent to modify hyperbranched polyester, could be more advantageous in applications [23]. The modification of ibuprofen with certain substances (like silver, polyesters, etc.) has already been reported in the literature. The synthesis of new zinc(II)–ibuprofen, containing complexes with 2-aminopyridine, 2-aminomethyl pyridine, 2,2′-bipy and 2-(methylamino)pyridine and their antimicrobial activity, was evaluated [19]. The synthesis and self-assembling behaviour of well-defined amphiphilic diblock copolymer NSAID prodrugs was evaluated by direct reversible addition–fragmentation transfer polymerization of the acrylamide derivative of ibuprofen [22]. A novel poly(anhydride-ester) using a mannitol-*co*-succinate backbone with four pendant ibuprofen groups per repeat unit as a model bioactive-releasing system [24]. The antibacterial assays over Gram-positive and Gram-negative pathogenic bacterial strains of a silver(I) complex with ibuprofen (Ag–ibu) have been reported [25]. The modifications of ibuprofen with polyester and naproxen-based polyesters have also been reported [18]. In this paper, we incorporated ibuprofen into hyperbranched polyester by a simple condensation route *via* the acid chloride approach and their properties were investigated. The antimicrobial activity of ibuprofen-based hyperbranched polyester was evaluated against the Gram-negative organisms such as *Escherichia coli* and *Salmonella paratyphi*, Gram-positive organisms such as *Bacillus subtilis* and *Staphylococcus aureus* and fungi such as *Aspergillus niger* and *Candida albicans*.

2. Materials and methods

2.1 *Materials*

Hyperbranched bis-MPA polyester-16-hydroxyl generation-2 (hyperbranched polyester) was purchased from Sigma-Aldrich (India). Ibuprofen, tetrahydrofuran (THF), triethylamine, 4-(dimethylamino)pyridine (DMAP) and acyl chloride were purchased from Nice Chemicals Private Limited (India). All other solvents and above chemicals were used with further purification.

2.2 *Synthesis*

Ibuprofen-based hyperbranched polyester was synthesized by two-step reactions: (1) acylation of hyperbranched polyester and (2) terminal modification of acyl chloride-terminated hyperbranched polyester with ibuprofen.

2.2a *Preparation of acyl chloride-terminated hyperbranched polyester:* The preparation of acyl chloride-terminated hyperbranched polyester was carried out according to the reported procedure [26,27]. The details and characterization of acyl chloride-terminated hyperbranched polyester were given in supplementary data.

2.2b *Synthesis of ibuprofen-based hyperbranched polyester:* A total of 1.0 g (13.5 mmol) of acyl chloride-terminated hyperbranched polyester (I) was dissolved in 50 ml of THF to make a clear solution in a three-necked flask equipped with a magnetic stir bar, a thermometer and a condenser. To the clear solution, 0.5 g (16.3 mmol) of DMAP was also added. A total of 1.04 g (30.1 mmol) of ibuprofen, dissolved in THF, was added dropwise into the above solution mixture with constant stirring. The reaction was maintained with constant stirring at room temperature for 2–4 h. The solvent was removed by a rotary evaporator under vacuum. Finally, the solid product (II) was obtained and dried. Yield: 85%. IR (KBr, cm^{-1}): 3341.48 (–NH stretching), 2923.11 ($–CH_2$ stretching), 1719.09 (–C=O stretching), 1063.19 (–CO stretching). ^{1}H NMR (200 MHz, DMSO-d_6, δ/ppm): 7.215 (d, 48H, ArH), 3.6 (d, 16H, C=O), 1.8 (t, 16H, OCH_2CO). ^{13}C NMR (400 MHz, DMSO-d_6, δ/ppm): 174.32, 142.76, 39.42, 16.48. LC-MS: *m*/*z* 5730.70 (M^+) (supplementary figure S1).

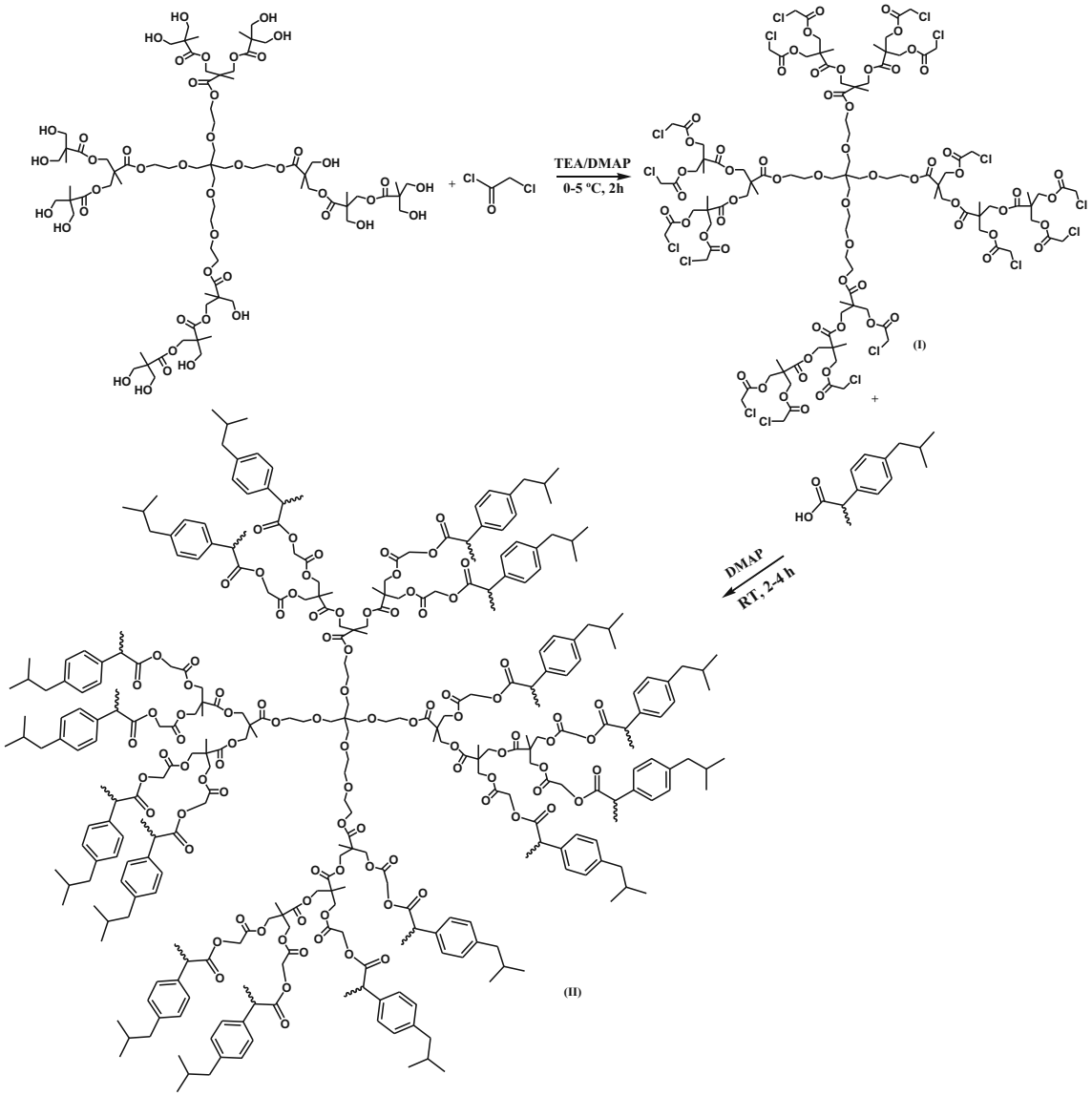
2.3 *Characterization studies*

Fourier transform infrared (FTIR) spectra were obtained using a Shimadzu IR Prestige-21 spectrometer at room temperature in the wavenumber range of 600–4000 cm^{-1}. ^{1}H nuclear magnetic resonance (NMR) spectra were recorded on a Varian 200 MHz spectrometer using DMSO-d_6 as the solvent and internal reference. ^{13}C NMR spectra were measured on JEOL GSX 400 MHz using tetramethylsilane as the internal standard. Molecular weight of the polymer was determined by the liquid chromatography-mass spectrometry (LC-MS) infusion method using LC-MSD-Trap-XCT Plus. X-ray powder diffraction (XRD 6000 Shimadzu model) coupled with Cu-Kα radiation (k = 1.54) was utilized to study the nature of the substance. Scanning electron microscopy (SEM) analysis was utilized to study the morphology and size of the substance using a JEOL JSM-6390 microscope. UV–visible spectra were recorded on a Shimadzu UV-1800 spectrophotometer. The fluorescence spectra were measured on Jasco FP-8200 spectrofluorimeter with a 10 mm quartz cuvette. Thermogravimetric analysis (TGA) (ZETZSCH-STA 409C thermal analyzer) measurements were carried out from 30 to 800°C at a heating rate of 10°C min^{-1} under nitrogen atmosphere with a gas flow rate of 90 ml min^{-1}. Differential scanning calorimetry (DSC) measurements were performed on a ZETZSCH-STA 109C thermal analyzer from 0 to 300°C at a heat range of 10°C min^{-1} under

nitrogen atmosphere. The electrochemical measurements of the polymers were carried out by the cyclic voltammetry technique, using a three-electrode cell electrochemical workstation (CHI6038D, CH Instruments, USA) with a scan rate of 10 mV s^{-1}. Glassy carbon acts as working electrode, the Ag/AgCl in KCl (3 M) solution and an auxiliary platinum wire were used as reference electrode and counter electrode, respectively. 0.1 M of tetrabutylammonium perchlorate mixed with a solution of toluene and acetonitrile (8:2 v/v) was used as the supporting electrolyte (scheme 1).

2.4 *Evaluation of antimicrobial performance*

The agar diffusion method was adopted to evaluate the antibacterial and antifungal activities of the hyperbranched polymers. The test samples were made as tablets with a thickness of 2 mm and a diameter of 9 mm, which were placed on the surface of inoculated agar plates [28]. The antimicrobial activity of the hyperbranched polymers was tested individually against the Gram-negative organisms such as *E. coli* MCIM 2065 and *S. paratyphi* MCIM 2501, Gram-positive organisms such as *B. subtilis* NCIM 2063 and *S. aureus* NCIM 2079 and fungi such as *A. niger* MTCC 1344 and *C. albicans* MTCC 3100. They were standardized with a final cell density of approximately 10^8 CFU ml^{-1} before using the cultures. Here, the following media such as Muller–Hinton agar plate (Merck) and Sabouraud dextrose agar plate (Merck) were used for bacteria and fungi, respectively. The agar plates inoculated from the standardized cultures of the test organisms were spread into the entire media uniformly as far as possible. The prepared tablets were introduced on the upper layer of the seeded agar plate. Sabouraud dextrose agar plate and



Scheme 1. Synthesis route of ibuprofen-based hyperbranched polyester by the condensation method.

Muller–Hinton agar plate were incubated at 37°C for 24 h. The antimicrobial activities of the hyperbranched polymers were compared with standard antibiotics of ciprofloxacin (10 µg per disc) and clotrimazole (10 µg per disc) for bacteria and fungi, respectively. Positive control plates were streaked with test organisms, but no tablet was used. The diameter of inhibition zone (mm) on the surface of the plates was measured on antibiotic scale and the results were reported as mean ± SD after three repeats.

2.5 *Determination of minimum inhibitory concentration by the broth dilution method*

The minimum inhibitory concentration (MIC) of ibuprofen-based hyperbranched polyester was determined by the broth dilution method. The MIC test, specifically carried out only for ibuprofen-based hyperbranched polymer, had greater antimicrobial activity against the organism. Ibuprofen-based hyperbranched polyester was diluted in the order of 1000, 500, 250, 125, 62.5 and 31.25 µg ml^{-1} in Muller–Hinton broth after which a standardized fungal suspension ($1–4 \times 10^6$ CFU ml^{-1}) to be evaluated was added and incubated at 30°C for 24 h. An MIC value is determined by finding the lowest concentration of agent that inhibited the visible growth of bacteria.

3. Results and discussion

3.1 *Characterization of ibuprofen-based hyperbranched polyester*

The synthesis of ibuprofen-based hyperbranched polyester was achieved in two steps from hyperbranched polyester, as shown in the reaction scheme. Initially the hyperbranched polyester was reacted with acyl chloride in the presence of DMAP as a catalyst in a basic medium. The formation of ester linkage between hyperbranched polyester and acyl chloride was detailed in our previous work [26,27]. In the second step, acyl chloride-terminated hyperbranched polyester was allowed to react with ibuprofen in the presence of DMAP as a catalyst. The carboxylic acid groups of ibuprofen were condensed with acyl chloride groups in acyl chloride-terminated hyperbranched polyester (I) to give ibuprofen-based hyperbranched polyester. The formation of ester linkage implies the appearance of aromatic nature in ibuprofen-based hyperbranched polyester.

The FTIR spectra of compound I (acyl chloride-terminated hyperbranched polyester) show the peaks at 1728 and 887.26 cm^{-1} which indicate the presence of the aliphatic ester and acyl chloride, respectively (figure 1). The FTIR analysis of compound II (ibuprofen-based hyperbranched polyester) confirmed the presence of carboxyl stretches of phenyl ester due to the appearance of peak at 1719 cm^{-1} (figure 1).

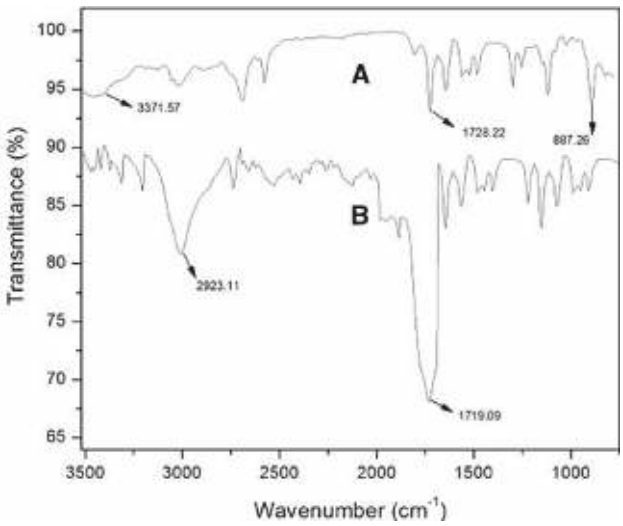


Figure 1. FTIR spectra of (**A**) acyl chloride-terminated hyperbranched polyester and (**B**) ibuprofen-based hyperbranched polyester.

The peak of ^{1}H NMR spectrum of compound I was observed at 3.02 and 1.18 ppm due to the presence of CH_2Cl and alkyl groups, respectively (figure 2A). The formation of phenyl ester and aromatic protons in final product due to the appearance of peaks at 4.2 and 7.2 ppm, respectively (figure 2B).

The appearance of the peak in ^{13}C NMR spectrum for compound I at 42 and 157 ppm confirmed the presence of acyl chloride and ester linkage, respectively (figure 3A). The ^{13}C NMR spectra for compound II showed the peak at 174 ppm which clearly confirmed the presence of ester linkage between ibuprofen and acyl chloride-terminated hyperbranched polyester and the peak at 142 ppm also showed the presence of phenyl group in the product (figure 3B). The above information suggested that the terminal modification on hyperbranched polyester with ibuprofen could be achieved by simple condensation.

3.2 *Morphological studies*

The strong aggregation of polymer enhances the surface area and makes it versatile in many applications. The patterns of the XRD profiles of ibuprofen-based hyperbranched polyester are given in figure 4. XRD patterns of ibuprofen yield typical peaks at 16, 20 and 22° and show the crystalline nature [29]. As the report has already stated, ibuprofen is a clear spherical particle [30]. The SEM image showed that particles of ibuprofen with irregularities were strongly aggregated with hyperbranched polyester layer (supplementary figure S2).

The results obtained from all DSC traces were similar to those of the already reported literature [31]. DSC study showed the glass transition temperature of ibuprofen-based hyperbranched polyester at 78°C and their double melting

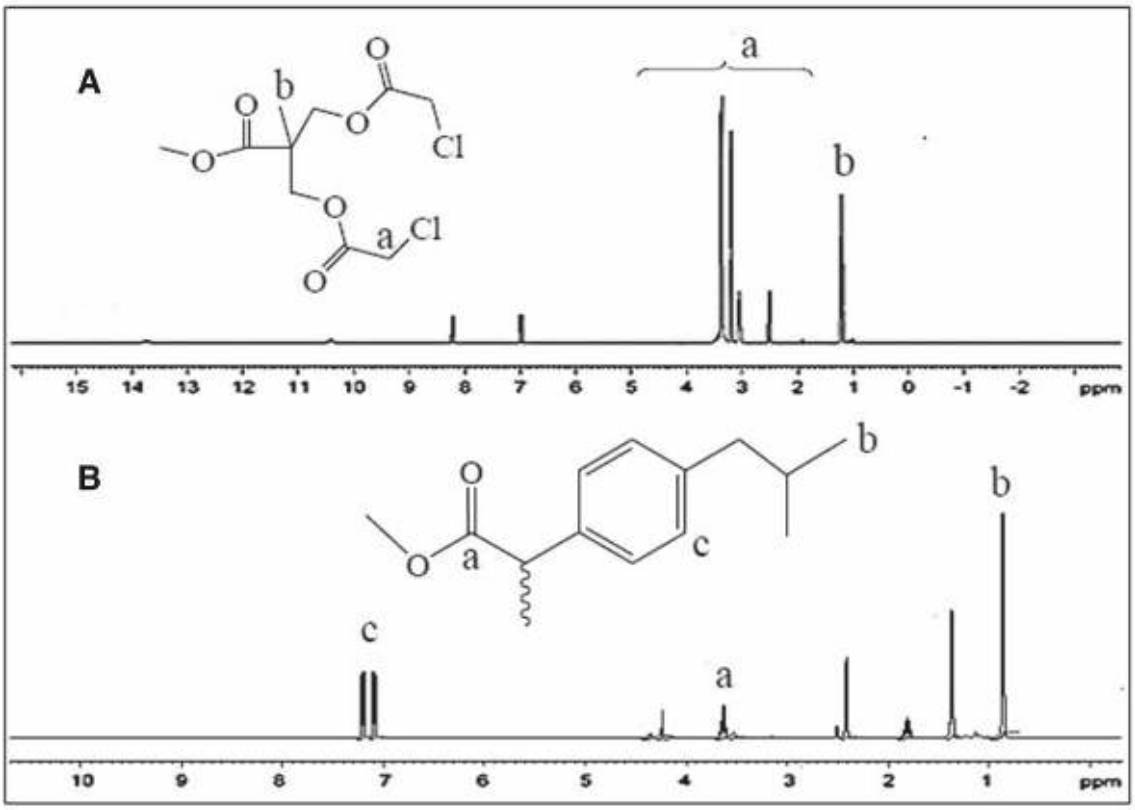


Figure 2. ^{1}H NMR spectra of (**A**) acyl chloride-terminated hyperbranched polyester and (**B**) ibuprofen-based hyperbranched polyester.

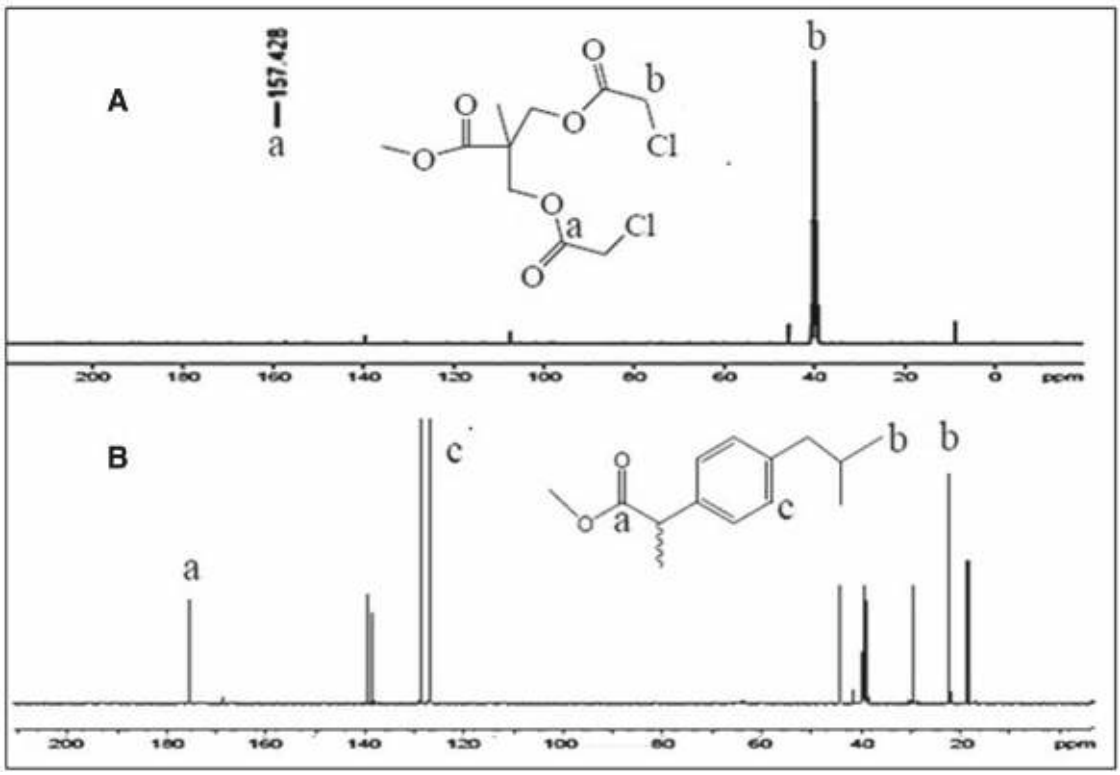


Figure 3. ^{13}C NMR spectra of (**A**) acyl chloride-terminated hyperbranched polyester and (**B**) ibuprofen-based hyperbranched polyester.

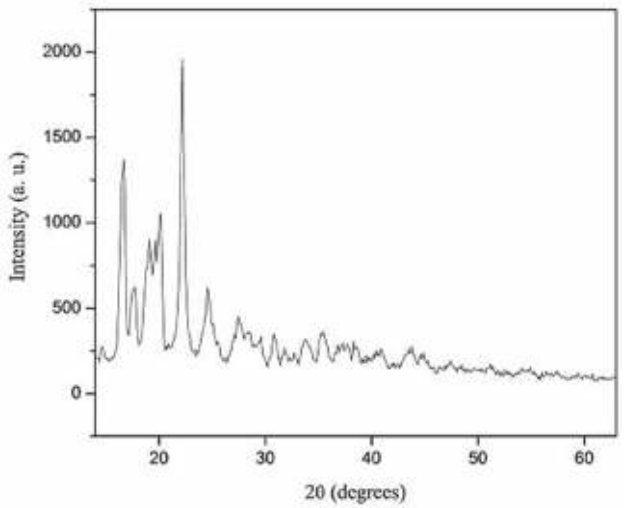


Figure 4. XRD analysis of ibuprofen-based hyperbranched polyester.

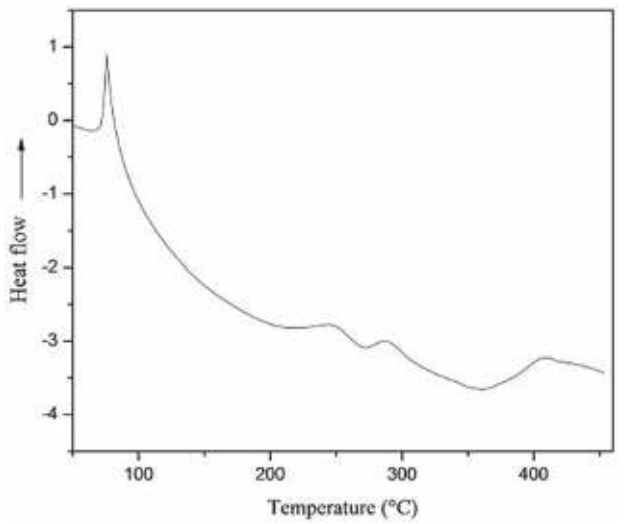


Figure 5. DSC thermogram of ibuprofen-based hyperbranched polyester.

peaks at 244.6 and 281.1°C in figure 5. These double or triple melting peaks of polyesters are usually appeared in a heating scan from DSC [31].

3.3 *Optical properties*

The absorption spectra of the acyl chloride-terminated hyperbranched polyester and ibuprofen-based hyperbranched polyester were recorded in a THF medium using UV–visible spectroscopy. In figure 6A, a broad absorption band displayed at 260 nm in the ultraviolet region for acyl chloride-terminated hyperbranched polyester was attributed to the π–π* transition of the polymer backbone [13]. The UV absorption peak of ibuprofen-based hyperbranched polyester at 301 nm in the ultraviolet region, this red shift occurred due to the association of hyperbranched polyester with ibuprofen [26,27].

The emission spectra of acyl chloride-terminated hyperbranched polyester and ibuprofen-based hyperbranched polyester were recorded (at λ = 260 and 301 nm, respectively) in the THF, as shown in figure 6B. The emission peaks for acyl chloride-terminated hyperbranched polyester were observed at 475, 510 and 565 nm, as shown in figure 6B. By comparing with acyl chloride-terminated hyperbranched polyester, very low intensity peaks were observed at 305, 525 and 570 nm for ibuprofen-based hyperbranched polyester in figure 6B. This intensity effect arises due to the terminal modification on hyperbranched polyester with ibuprofen.

3.4 *Thermal properties*

The thermal studies of ibuprofen-based hyperbranched polyester were carried out using TGA. The decomposition temperature of ibuprofen-based hyperbranched polyester was found at 328°C, as shown in figure 6C. This result showed that the polymer chains of ibuprofen-based hyperbranched polyester were thermally stable up to 328°C. Ibuprofen-based hyperbranched polyester was found to be highly soluble in polar solvents like dimethylformamide (DMF), dimethylacetamide (DMAc), DMSO and THF.

3.5 *Electrochemical properties*

The highest-occupied molecular orbital (HOMO) and lowest-unoccupied molecular orbital (LUMO) energy levels of dye properties play a vital role in the material to be used in dye-sensitized solar cells. The above properties and energy gap can be calculated by using the following equations [32]:

$$\text{HOMO} = -\text{e}(E_{\text{ox}} + 4.40)\,(\text{eV}) \quad (1)$$

$$\text{LUMO} = -\text{e}(E_{\text{red}} + 4.40)\,(\text{eV}) \quad (2)$$

$$E_{\text{g}} = \text{HOMO} - \text{LUMO}. \quad (3)$$

From this study, no characteristic peak was observed for ibuprofen-based hyperbranched polyester (supplementary figure S3).

3.6 *Antimicrobial activity*

The antimicrobial measurement of ibuprofen-based hyperbranched polyester against microorganisms was carried out based on the diameter of the inhibition zone. The diameters of the inhibition zone of ibuprofen-based hyperbranched polyester (100 µg per disc) against *E. coli*, *S. paratyphi*, *B. subtilis*, *S. aureus*, *A. niger* and *C. albicans* were 21, 14, 16, 12, 19 and 31 mm, respectively, as shown in a statistical representation in figure 7. The inhibition zone value of

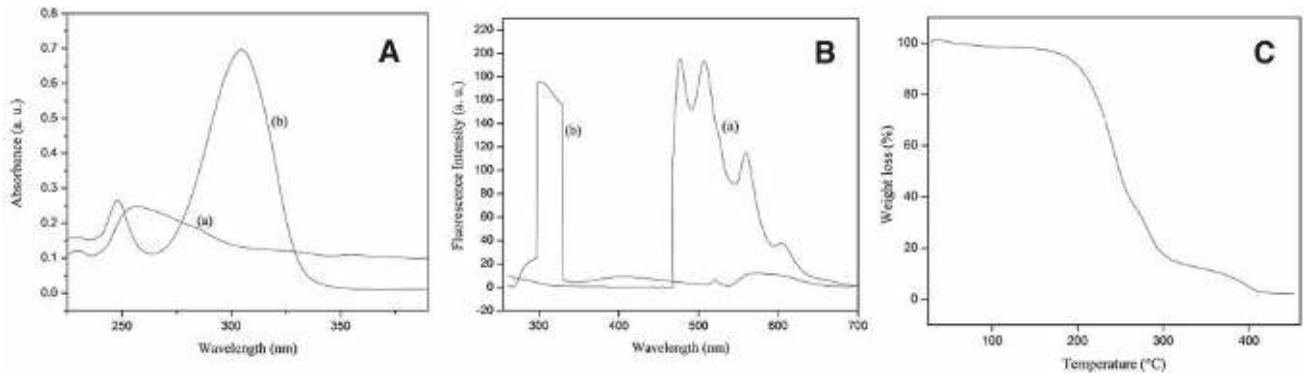


Figure 6. (**A**) UV spectra of (a) acyl chloride-terminated hyperbranched polyester and (b) ibuprofen-based hyperbranched polyester. (**B**) Fluorescence spectra of (a) acyl chloride-terminated hyperbranched polyester and (b) ibuprofen-based hyperbranched polyester. (**C**) TGA thermogram of ibuprofen-based hyperbranched polyester.

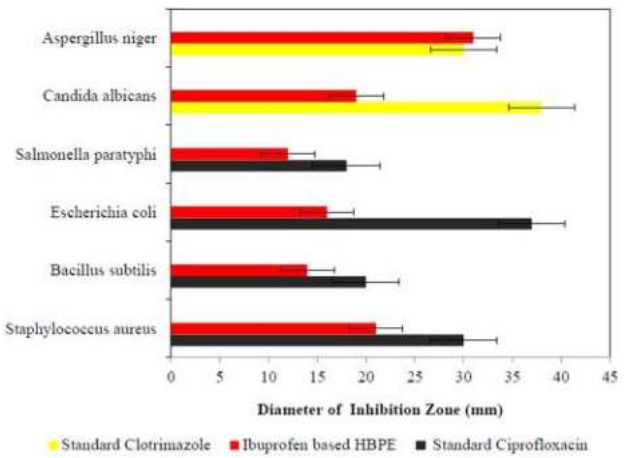


Figure 7. Statistical representation for antimicrobial activity of ibuprofen-based hyperbranched polyester.

ibuprofen-based hyperbranched polyester is correlated with the standard antibiotics, such as ciprofloxacin and clotrimazole. The result revealed that ibuprofen-based hyperbranched polyester showed a great inhibitory effect towards fungi than bacteria. In another view, ibuprofen-based hyperbranched polyester showed more inhibitory effect against Gram-negative bacteria (*E. coli* and *S. paratyphi*) than Gram-positive bacteria (*B. subtilis* and *S. aureus*). Generally, ibuprofen does not have enough potential to show against Gram-negative bacteria [33], but remarkably ibuprofen-based hyperbranched polyester showed the inhibitory effect against Gram-negative bacteria. This is because of the proper amount of ibuprofen (100 μg per disc) and the establishment of ester linkage in ibuprofen-based hyperbranched polyester [23,34]. Ibuprofen-based hyperbranched polyester showed better antimicrobial efficiency than both pure ibuprofen [21] and hyperbranched polyester, as stated in the already reported literature [35]. The improved microbial activities of ibuprofen-based hyperbranched polyester are due to a large number of alkyl chains with a low molecular weight [36]. The greater antimicrobial activity of ibuprofen-based hyperbranched polyester was shown towards fungus *A. niger*. The MIC value of the polymer was tested against *A. niger* and it was found to be 500 μg ml^{-1}.

4. Conclusions

The aromatic ibuprofen-based hyperbranched polyester was successfully synthesized from aliphatic hyperbranched polyester using the acid chloride approach. The particles of ibuprofen strongly aggregated with hyperbranched polyester were displayed in the SEM analysis. The appearance of double melting peaks and glass transition temperature (∼78°C) of ibuprofen-based hyperbranched polyester was studied from DSC thermogram. The crystalline nature of ibuprofen-based hyperbranched polyester was evident from the XRD, SEM and DSC analysis. Ibuprofen-based hyperbranched polyester holds thermal stability up to 330°C, as measured by TGA. The fluorescent behaviour of the polymer was established from UV–visible and fluorescence spectroscopy. The minor current of ibuprofen-based hyperbranched polyester was traced, but no peak potential was observed. Ibuprofen-based hyperbranched polyester was found to be highly soluble in polar solvents like DMF, DMAc, DMSO and THF. Ibuprofen-based hyperbranched polyester showed better inhibitory activity towards fungi than bacteria. Ibuprofen-based hyperbranched polyester is a promising material for pharmaceutical applications. The MIC test was carried out against *A. niger* and the value was found to be 500 μg ml^{-1}.

Acknowledgements

We gratefully acknowledge the Sri Krishna College of Technology and Bharathiar University for their constant support.

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Surface modified polymer-magnetic-algae nanocomposite for the removal of chromium- equilibrium and mechanism studies

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Received 17 May 2021, Revised 20 June 2021, Accepted 23 June 2021, Available online 2 July 2021, Version of Record 6 July 2021.

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https://doi.org/10.1016/j.envres.2021.111626

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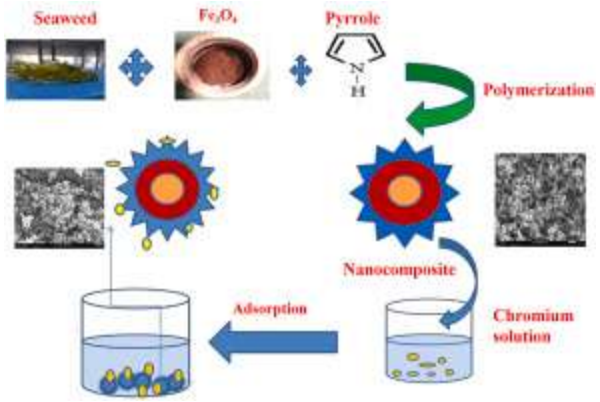
Abstract

The present work explains the sorption ability of a novel nano-composite, Polypyrrole -iron oxide-seaweed (PPy - Fe_3O_4 – SW), for Cr(VI) removal. The influence of operating parameters, namely pH, contact time, nanocomposite dosage, initial Chromium concentration and operating temperature, on the hexavalent chromium removal was studied. The novel nano-composite was analyzed using FTIR, SEM and EDS to confirm the sorption of Cr(VI) and to understand the mechanism of sorption. PPy - Fe_3O_4– SW nano-composite removed 96.36% of Cr(VI) at the optimized conditions of pH = 2, temperature = 30 °C, initial Cr(VI) concentration = 50 mg/L, nanocomposite dosage = 100 mg and contact time = 30min. PPy-Fe_3O_4-SW nanocomposite has a maximum sorption capacity of 144.93 mg/g. The kinetic studies revealed that the metal adsorption obeys pseudo second order (PSO) model and the sorption was found to be monolayer in nature as confirmed by Langmuir isotherm (R^2 > 0.9985). Electrostatic interaction and ion-exchange are identified as the fundamental mechanisms for Cr(VI) sorption on PPy-Fe_3O_4-SW composite.

Graphical abstract



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Introduction

Industrial development and expansion in production have contributed to the depletion of water resources and resulted in hazardous contamination. Water remains an important requirement both for human consumption and industrial production. Fast exploitation of underground water and increased release of toxic loads into the eco-system has contributed to searching alternatives to reuse and recycle of wastewater. Wastewater from various industries containing hazardous metals like chromium(Cr), cadmium(Cd), copper(Cu), lead(Pb), nickel(Ni) and zinc(Zn) are discharged directly into fresh water thereby contaminating the fresh water. Heavy metals are non-biodegradable contaminants which create major problem to the environment due to their tendency to resist decomposition and ability to accumulate. Among various heavy metals, Cr is an anthropogenic hazardous metal released from various industries like plating, alloying, ceramic glasses, pressure treated lumber, pigments, tannery, dyes and refractory bricks (Losi et al., 1994; Barnhart, 1997; Durai and Rajasimman, 2011). Hexavalent chromium is highly toxic compared with trivalent form and its ingestion causes epigastric pain, hemorrhage, dermatitis, ulcer and tissue necrosis (Yahya et al., 2020a). The environmental legislation of WHO require the concentration of Cr(VI) should not exceed 0.05 mgL^{-1} (Levankumar et al., 2009). Various technologies namely reverse osmosis, chemical precipitation, photocatalytic degradation, flocculation, filtration, membrane separation, ion exchange and adsorption are employed to removal Cr(VI) (Cai et al., 2014; Rajasimman et al., 2009; Jayakumar et al., 2014, 2015; Selvi et al., 2019; Malathi et al., 2021). The physical separation method is better alternative for metal removal as they are less reactive (Rajamohan et al., 2014; Theerthagiri et al., 2018). Among those various conventional technologies, adsorption is recognized as a promising and potential process in the elimination of Cr(VI) as it owns great efficacy, simplicity in operation and reduced energy requirements (Yu et al., 2019). The efficiency of adsorption process depends on the nature of adsorbent used. Huge surface area, great porosity and high pore volume are the desirable properties of adsorbent. The adsorbents which are of synthetic origin are less preferred due to their non-biodegradability. Therefore it is recommended to synthesize adsorbent from naturally available low cost biomaterials (Vijayaraghavan et al., 2005).

Heavy metal removal using biomaterials as adsorbent reduces the investment cost by 20%, operation cost by 36% and entire treatment cost by 28% when matched with several conventional technologies. Furthermore, usage of biomaterials makes the process an eco-friendly, economically feasible, rapid and reversible one with no sludge formation (Dwivedi, 2012). Agricultural wastes, industrial wastes, micro-organisms and macro-organisms are most widely used biomaterial adsorbents (Zahmatkesh et al., 2018). Recently seaweed are preferred as a promising sorbent owing to its low cost, abundance, low sensitivity to environment, high metals uptake and high retention capacity (Al-Homaidan et al., 2018). Seaweed possesses several active functionalities namely carboxyl, amine, amide, hydroxyl phosphate in the polysaccharides of cell wall (Davis et al., 2003). These functional groups promote selective uptake of metal ions through mechanisms like ion exchange, electrostatic interaction, complexation,

adsorption and micro precipitation (Murphy et al., 2009). *Ulva lactuca* is a type of aquatic green seaweed algae present in large quantities in many coastal area and helpful in bioremediation of toxic heavy metals owing to its structure, large surface area and homogeneous distribution of active binding sites (Turner et al., 2007; Sari and Tuzen, 2008).

Nowadays magnetic nanomaterial has gained interest due to its superior magnetic properties, non-toxicity and surface area which promotes high removal efficiency, ease of separation and quicker operation (Dave and Chopda, 2014). However, usage of magnetic nanoparticles in wastewater treatment tends to form agglomerates and this difficulty could be overcome by encapsulating magnetic nanoparticles on supporting materials (Ilankoon, 2014). Seaweeds are chosen as a supporting material as they possess bioactive amines, sulfates, carboxyl and hydroxyl compounds which plays a major role in adsorption process.

Conducting polymers has proved as versatile adsorbents and are reported to possess high affinity towards various contaminants due to its higher surface contact area, sufficient high energy active sites, short mass diffusion length, thermal stability, insolubility in water and ease of synthesis with low cost (Bhaumik et al., 2013). Polypyrrole (PPy) is considered as important emerging conducting polymer due to its facile synthesis, adjustable conductivity, distinct transport properties and good environmental stability (Karmakar et al., 2017; Khan and Malook, 2017). A novel nanocomposite, polypyrrole - iron oxide – *Ulva Lactuca* nanocomposite, was synthesized to have the combined advantages of algae, magnetic nano particle and conducting polymers. The synthesized composite was applied to remove Cr(VI) from aqueous solution. There was no report for the removal of Cr(VI) using polypyrrole - iron oxide – *Ulva Lactuca* nanocomposite. Hence, the intention of the current work is to explore the adsorptive efficiency of synthesized polypyrrole - iron oxide – *Ulva Lactuca* nanocomposite in removal of Cr(VI). Characterization, kinetics studies and equilibrium studies are performed to explore the performance and mechanism of sorption.

Section snippets

Chemicals used

Ferric chloride, Ferrous sulphate, Sodium Hydroxide, potassium dichromate and acetone were procured (Fisher Scientific, India). Pyrrole (C_4H_5N) (99.9% pure) was procured as analytical reagent (Sigma Aldrich, India). Pyrrole was further purified by vacuum distillation and stored at below 0^oC in dark. The chemicals employed in the experiments were of analytical grade. The

synthesized PPy - Fe_3O_4 – SW nanocomposite (Sarojini et al., 2021) was used as adsorbent in this work....

Preparation of standard stock solution

About 2.835 g of...

Characterization studies

The FTIR band of the Cr(VI) sorbed composite was given in Fig. 1 and small peaks in the category of 689.942 cm^{-1} are representative peaks of iron oxide and distinct wide band peak in the array of 3400–3250 cm^{-1} correspond to N–H enlarging peak of PPy (Bhaumik et al., 2011a,b). These outcomes point out the existence of iron oxide and PPy in the composite. Distinctive peaks of 1541 and 1341 cm^{-1} are consigned to the symmetric and anti-symmetric ring stretching modes of PPy. The characteristic...

Conclusions

In this present study, a cheap and sustainable PPy-Fe_3O_4-SW sorbent was effectively applied for Cr(VI) sorption. The categorized characterization studies established the sorption of Cr(VI) through active surface area and favorable surface functional groups. The optimum condition for efficient Cr(VI) removal were: pH-2, temperature-30 °C, nanocomposite dosage - 100 mg and contact time-30 min. The maximum uptake of Cr(VI) achieved by the nanocomposite was 144.93 mg/g. Desorption studies using...

Author contributions

G.Sarojini – Conceptualization, Methodology, Investigation, Validation, Writing – original draft. **S.Venkatesh Babu** –Writing – Review & Editing Supervision. **N. Rajamohan** – Conceptualization, Resources, Writing – Review & Editing. **P.Senthil Kumar** – Characterization, Writing – Review & Editing. **M. Rajasimman** – Characterization, Methodology, Formal analysis, Writing – Review & Editing....

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper....

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Volume 278, September 2021, 130400

Facile synthesis and characterization of polypyrrole - iron oxide – seaweed (PPy-Fe_3O_4-SW) nanocomposite and its exploration for adsorptive removal of Pb(II) from heavy metal bearing water

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Received 14 November 2020, Revised 8 March 2021, Accepted 25 March 2021, Available online 29 March 2021, Version of Record 3 April 2021.

Handling Editor: Derek Muir

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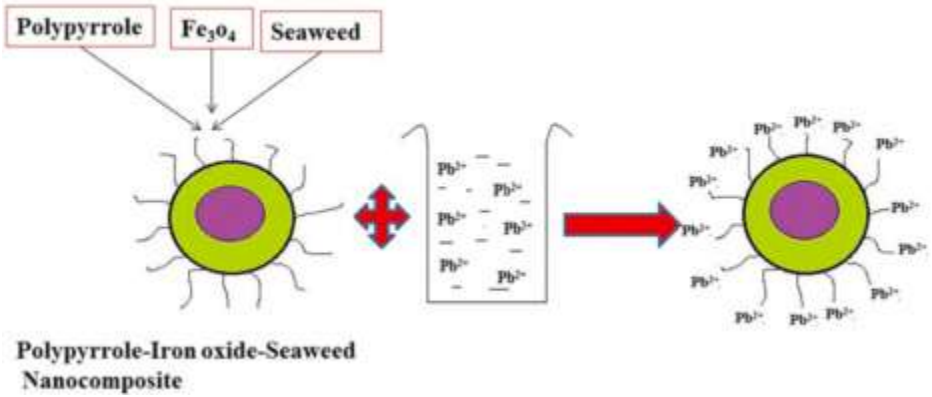
Abstract

Lead is a widely used heavy metal which is highly toxic to kidney, nervous system and reproductive system. A special featured polypyrrole based adsorbent, with admirable salinity confrontation, environmental stability and reusability, was engaged to remove lead ions from aqueous solution. The advantages of using polypyrrole based adsorbent for heavy metal removal are: ease of synthesis, biocompatibility and high metal selectivity. In this study, polypyrrole - iron oxide - seaweed nanocomposite was proposed to remove lead ions from aqueous solution. A new method was adopted for the synthesis of polypyrrole - iron oxide - seaweed nanocomposite. The nanocomposite was prepared within a short time using ultra-assisted polymerization technique. The synthesized nanocomposite adsorbent was characterized using FTIR, SEM, TEM, EDS, XRD, XPS and zeta potential analysis. The adsorption capability of polypyrrole - iron oxide - seaweed nanocomposite towards lead was explored. The influence of pH, contact time, adsorbent dosage, metal ion concentration and recyclability were investigated. The optimum condition of these parameters was found to be: pH- 5, temperature - 40 °C, initial concentration – 100 mg/L and contact time - 20 min and the results showed that the hybrid composite adsorbed 97.25% Pb (II). Different isotherms such as Langmuir, Freundlich, Temkin and D-R models were also studied for the adsorption of Pb ions. The kinetics of the adsorption process was examined by I order, II order and intra particle diffusion kinetic models. The mechanism of lead adsorption onto the nanocomposite was also explored.

Graphical abstract



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Introduction

In recent years, increased population has lead to a major development in industrial sectors which resulted in increased level of pollutants in the environment and causes serious effects on human health (Selvi et al., 2019). Among the various types of pollution, water pollution is of great concern as the deterioration of water adversely affects the human health and it must be treated carefully. The presence of heavy metals namely chromium, cadmium, nickel, cobalt and lead in excess in the water bodies originate from various chemical industries and it is a major issue today due to its toxicity. Lead, known as metabolic poison and enzyme inhibitor, is the most toxic heavy metal and can cause neuro developmental effects on children at blood levels of 10 μg/dL. Increased exposure of lead might cause defects in the central nervous system triggering the mental disorder and ultimately leads to death. The acceptable lead ion level in drinking water and the EPA action level is 10 ppb and 15 ppb respectively (Ji et al., 2019).

Various processes such as adsorption, solvent extraction, coagulation, electrochemical separation, chemical precipitation, distillation, ion-exchange, membrane processes, and advanced oxidation process are reported for the removal of lead ions (Xiao et al., 2015; Mohan et al., 2017; Carolin et al., 2017; Kwak et al., 2019; Mahar et al., 2019; Menezes et al., 2020). All the above said processes has their own merits and demerits (energy intensive, high cost and difficulties of operation). Among these methods, the sorption process has acquired significant attraction with great potential because of its simplicity, high flexibility, easy operating

potential and high efficiency (Huang et al., 2019; Lingamdinne et al., 2019). The selection of adsorbent is a very crucial parameter in adsorption process. Several adsorbents including activated carbon, zeolite, activated alumina clay, biomaterials, metal oxides and bioadsorbents has been widely used to recover lead ions. However, most of these conventional sorbents displayed low sorption capacity towards lead removal (Lee et al., 2010).

Activated carbon is the highly preferred sorbent for elimination of different kinds of pollutants present in wastewater due to its outstanding affinity of its macro, meso or microporous surface towards different pollutants and has excellent properties (Babel et al., 2003; Arwa et al., 2018). On the other side, activated carbon suffer some challenges including generation of large amount of sludge from used sorbents, more expensive to regenerate, time consuming and low sorption rate (Kobya et al., 2005; Inbaraj and Sulochana, 2004). Ideal sorbent must have short contact time to attain sorption equilibrium along with minimum sludge formation. Therefore incorporation of complexing agents is necessary to achieve better sorption characteristics. For large scale applications of sorbent, nanoscale range of sorbents is usually preferred.

Nowadays iron oxide nanoparticles are widely employed in wastewater treatment because of its high affinity towards contaminants, non-toxicity, high surface area and reactivity, availability, ease of synthesis and magnetic separation (Shubair et al., 2018; Nizamuddin et al., 2019; Liu et al., 2019). Magnetic separation which comprises mainly Fe_3O_4 has proved to be a versatile technique in wastewater treatment as it has its own advantages of effective control and ease of operation. Presence of super paramagnetic properties assist them to separate contaminants (Mohamed et al., 2018). However there are some major challenges in usage of iron oxide nanoparticles because of low adsorption capacity and ease of oxidation in acid solution (Larreza et al., 2012). Iron nanoparticles tend to agglomerate owing to its low surface energy and high intrinsic magnetic interactions (Harman and Genisoglu, 2016). In order to solve these issues, iron oxide nanoparticles can be loaded onto supporting component (Ponmani and Udayasoorian, 2013) and bonded with decorated materials like metal shell, silica shell or polymer shell (Li et al., 2011) to ensure its stability. Surface modification is employed to modify the surface of iron oxide nanoparticle and could be accomplished through coating, functionalization and stabilization. Comparatively, surface coating is much easier than other methods and herein iron oxide attracts water molecules and does not form clusters as particles gets dispersed (Ojemaye et al., 2017). Surface coating aids in transforming the closely arranged cubic geometry of magnetic nanoparticles into compact and strong which in turn increases sorption capability (Sanchez et al., 2005). Surface coated iron oxide nanoparticles are available in the literature and has been utilized in effective removal of various heavy metals (Yao et al., 2016; Xu et al., 2011; Tran 2010). It is highly recommended to coat iron oxide particles with compounds containing specific functionalities capable to interact with the pollutants which in turn not only prevents agglomeration but also facilitates in removing the desired pollutants.

In recent years, importance was given to the development of eco-friendly adsorbents from natural water resources at low cost with maximum adsorption capacity. Seaweeds (marine algae) commonly known as carbon sinks are the gorgeous renewable bioresources in the aquatic environment with around 6000 species being identified and categorized into three groups namely green (Chlorophytes), brown (Pherophytes) and red (Rhodophytes) according to their pigmentation (Azizi et al., 2014). Easy accessibility, comparatively high surface area and high binding affinity endorse it as a suitable and probable adsorbent (Sari and Tuzen, 2008). Adsorption using green algae has been reported and presence of cellulose and glycoproteins on algae surfaces favored adsorption. Presence of bioactive amines, sulfates, carboxyl and hydroxyl compounds enables it to find an imperative character in the adsorption process and to extend their application in wide areas (Donmez et al., 1999). Seaweed (SW) is very effective in removal of cationic metal ions from solution. Inspite of these advantages, seaweeds inherit very few disadvantages such as very poor conductivity, reduced surface area, less porosity and sensitive to pH which reduces their application. When seaweed alone is used as an adsorbent, a variety of metal ions present in it get released into the water, and causes an increase in the hardness and total dissolved solids. As a whole, to upgrade the adsorption capacities, seaweed surface activation or modification is essential (Bai and Abraham, 2002). In order to overcome the problems associated with raw seaweed and iron oxide nanoparticle, these two were combined and expected to perform dual function of adsorption and magnetic separation.

In addition, conducting polymers have proven advantages over traditional ones owing to its removal efficiency, capacity, more surface contact area, sufficient high energy active sites, short mass diffusion length, high speed, effective control, thermal stability, reproducibility, insolubility in water and ease of synthesis with low cost (Zare et al., 2018). Polypyrrole (PPy) has emerged as a prospective candidate due to its high electrical conductivity, safe environmental stability, facile synthesis and non-toxicity (Wu and Lin, 2006; Li et al., 2017; Chen et al., 2016). Based on the polymerization process conditions and nature of counter ions, PPy has the ability to exchange both anions and cations as it contains five membered heterocyclic ring (Chen et al., 2014). The presence of very large number of positively charged nitrogen atoms has promoted it as a most suitable adsorbent. During chemical polymerization, PPy has the tendency to form aggregates through the strong π* interaction between the polymer main chain. Therefore counter ions could be incorporated into the growing polymer chain to maintain charge neutrality. In order to overcome the problem of aggregation of PPy and to increase the sorption efficiency, resources encompassing oxygen and nitrogen groups could be bonded (Olatunji et al., 2018). PPy coated on sawdust proved to be a promising adsorbent in removal of Cr (VI) from aqueous solution (Ansari et al., 2007). Meanwhile polypyrrole coated palygorskite removed anionic contaminants from wastewater (Yao et al., 2012). However, no literature is available on iron oxide-seaweed based nanomaterials with PPy for the removal of lead. Hence, in this work, a novel PPy – Fe_3O_4 - seaweed nanocomposite was synthesized by mixing of PPy, Fe_3O_4 and seaweed composite and its ability to remove lead (II) was explored. The synthesized nanocomposite was characterized by FTIR,

SEM, TEM, XRD, XPS, and zeta potential. The parametric effects such as pH, initial lead ion concentration, nanocomposite dosage, temperature and contact period were explored. Kinetics and isotherm studies were performed to investigate the performance of sorption.

Section snippets

Materials and instrumentation

$FeCl_3 \cdot 6H_2O$, $FeSO_4 \cdot 7H_2O$, Sodium hydroxide (NaOH), Iron chloride ($FeCl_3$), Lead nitrate $Pb(NO_3)$ and acetone were procured from Fisher Scientific. Pyrrole (C_4H_5N) was procured from Sigma – Aldrich and stored at below 0 °C in dark. The Fourier transform infrared spectroscopy (FTIR - Shimadzu spectrum) was performed under the spectrum range of 4000–400 cm^{-1}. The surface organization of nano composite (prior and after adsorption) was investigated using scanning electron microscopy (SEM) (HITACHI SU...

Adsorbent characterization

Fig. 2(a) shows the infrared absorption spectra of PPy-Fe_3O_4-SW nanocomposites before adsorption process. A peak at 3138 cm^{-1} denotes hydroxyl (O–H) and amino (N–H) groups of seaweeds. Also the characteristic peak at 3138 cm^{-1} was accredited due to the stretching vibrations of hydrogen – bonded surface water molecules. The peak at 1543 cm^{-1} was considered to arise due to stretching vibration of C–C of polypyrrole. The peak at 1400 cm^{-1} corresponds to the stretching of C–H vibration. The peak at ...

Conclusion

.In the present work, a novel polypyrrole - iron oxide - seaweed (PPy-Fe_3O_4-SW) composite was produced by means of in - situ chemical oxidative polymerization technique and has been utilized as an alternate to conventional sorbents for the removal of Pb(II) ions from aqueous solution. The synthesized nano-composite was examined by FTIR, SEM, EDS, TEM, XRD and XPS instrument techniques. The morphological study showed the synthesized composite consists of spherical and aggregated

particles. The...

Author contributions

G.Sarojini – Conceptualization, Methodology, Investigation, Validation, Writing – original draft, Writing – review & editing. S.Venkatesh Babu – Resources, Writing – review & editing. M. Rajasimman – Conceptualization, Methodology, Formal analysis, Writing – review & editing Supervision...

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper....

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Chemical Engineering Journal, Volume 281, 2015, pp. 826-836

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Journal of Hazardous Materials, Volume 402, 2021, Article 123835

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Synthetic Metals, Volume 175, 2013, pp. 15-20

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