

Detection of Alzheimer's Disease Using Deep Learning, Blockchain, and IoT Cognitive Data

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Abstract--Telemedicine has the potential to be a good resource for early disease diagnosis, provided that it is utilised in the correct manner. The Internet of Things (IoT) is a concept that has developed in recent years as people have become more aware that they are continuously being watched. As a result of the increased prevalence of neurodegenerative disorders like Alzheimer's disease (AD), biomarkers for these conditions are in high demand for early-stage resource prognosis. Because of the precarious nature of the situation, it is absolutely necessary for these structures to offer remarkable qualities such as accessibility and precision. Deep learning strategies could be useful in fitness applications in situations in which there are a large number of data points to be analysed. Excellent data for a decentralized Internet of Things device that is based on block chain technology. By utilizing a connection to the internet that is of a high speed, it is feasible to obtain a prompt answer from these structures. It is not possible to run deep learning algorithms on smart gateway devices since they do not have sufficient computational capacity. In this study, we investigate the potential for increasing the speed of data flow in the healthcare industry while simultaneously improving data quality through the incorporation of blockchain-based deep neural networks into the control system. Experiments are being conducted to evaluate the speed and accuracy of real-time fitness tracking for the purpose of classifying groups. We are able to determine if diseases of the brain are benign or malignant by employing a model that utilises deep learning. For the purpose of determining the relative severity of each condition, the research examines the symptoms of several different mental diseases and compares them to those of Alzheimer's disease, moderate cognitive impairment, and normal cognition. The research calls for a number of different procedures. The majority of the data is used to train the classifiers, while the remainder of the data is utilised in conjunction with an ensemble model and meta classifier to classify individuals into the appropriate categories. The OASIS-three database is a long-term study that incorporates neuroimaging, cognitive, clinical, and biomarker measurements. This study focuses on healthy ageing as well as Alzheimer's disease. When comparing the outcomes of the

simulation to those acquired from the real world, the OASIS-three database (AD), in addition to the ADNI UDS dataset, is employed as a comparison tool. The findings show that answers to questions about this issue can be arrived at quickly and categorized utilizing an in-depth methodology (98%accuracy).

Keywords-- Deep Learning, classification, Disease prediction, Alzheimer Disease and Datasets.

I. INTRODUCTION

The use of massive data sets and machine learning are having an impact on a variety of industries in today's world. Businesses such as Netflix and Amazon may gain insight about the types of material their customers want the most, as well as their requirements in terms of purchasing and receiving medical treatment. Personal profiles that are produced from this information can be used for a broad variety of purposes, such as conducting research into various activities, marketing, and predicting future trends in healthcare. Some people believe that artificial intelligence (AI) will revolutionize the healthcare sector and completely transform the game. As observed in medical image processing and electronic medical records, artificial intelligence (AI) algorithms have already showed greater performance in specific jobs compared to humans [1]. (EMRs). In addition to this, they have the ability to recognise the signs and symptoms of disease and correlate biomarkers[26].

As a result of an increase in the number of people who require medical attention, a problem has arisen in many countries: there is a lack of doctors and other medical personnel. [2] When it comes to enhanced service and outcomes, suppliers have to appease a wider variety of stakeholders than just healthcare providers. There are a lot of other businesses that have the same objective. It is now

possible to provide healthcare on demand, whenever and wherever it is required thanks to developments in technology in a variety of domains, including wireless communications, cellphones, health monitoring software, online health information databases, and other areas. These programs have the ability to assist individuals and communities with low incomes, while at the same time lowering the hospital's overall costs and reducing the risk of the spread of infectious diseases within the facility. Despite the fact that less developed countries are still in the process of constructing their health care infrastructure, telehealth technology could be used to solve the demands that are now being faced [3]. Despite the fact that the idea is fairly self-explanatory, patients still need independent validation in order to have the peace of mind that the medications they are being prescribed are both safe and effective[27].

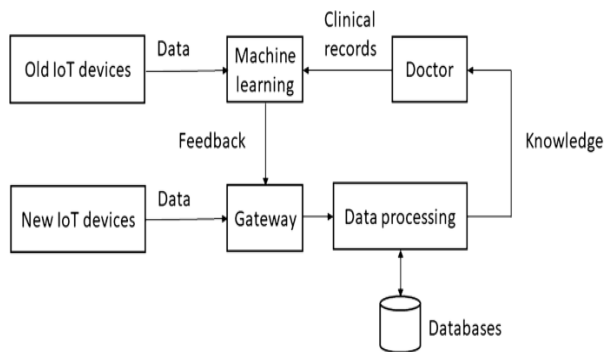


Fig. 1. Conventional block diagram of disease prediction [5]

It is becoming increasingly clear that a tool that is driven by AI [5-10] has the potential to play an important part in the development of the next generation of healthcare technology. A significant number of people hold the opinion that artificial intelligence (AI) has the potential to improve specific aspects of production and distribution[28]. A growing number of people are coming to the realisation that artificial intelligence (AI) has the potential to drastically cut down on the expenses of medical treatment, which is contributing to the rise in popularity of this field.

Alzheimer's disease (AD) is a neurodegenerative ailment that progresses over time and eventually affects both the brain and the spinal cord. This is one definition of the disease[29]. This most common form of dementia is characterised by the death of vegetative cells as well as the inability to think of new sentence combinations. According to a study that was conducted not too long ago, there are currently 40 million people in the world who are afflicted with Alzheimer's disease. Mild cognitive impairment, also known as MCI, has been considered for a very long time to be a stage that bridges the gap between normal ageing and the development of Alzheimer's disease (AD).

Alzheimer's disease and moderate cognitive impairment (MCI), also known as mild cognitive impairment, are of interest to scientists because they both involve a steady deterioration in mental capacity that does not significantly interfere with daily life. If medicine focused less on healing

disease and more on preventing illness, it could be possible to drastically cut costs associated with providing care for people who are suffering from dementia and other forms of cognitive impairment. It's possible that technology driven by AI will make it easier for individuals to keep tabs on their own health. The utilization of this technology might make it possible to do continuous monitoring and coaching, as well as early diagnosis, treatment, and further checks.

This study investigates how the implementation of blockchain-based deep neural networks into a healthcare control machine may facilitate the acceleration of the distribution of healthcare information while also ensuring its high level of quality. Experiments are being conducted to evaluate the speed and accuracy of real-time fitness tracking for the purpose of classifying groups. The following is a list of the most significant contributions made by this work:

- (i) Researchers look at the use of blockchain-primarily based totally deep neural networks in a healthcare control machine to enhance the velocity and shipping of healthcare information.
- (ii) Researchers create a real-time fitness tracking machine and examine the response time and accuracy.
- (iii) The authors have a take a observe loads of lessons to decide whether or not a mind situation is benign or malignant, together with Alzheimer's disease, slight cognitive impairment, and everyday cognitive function.
- (iv) Researchers create a framework with a sequence of processing steps where in the bulk of the information is used to teach the classifiers and an ensemble version with a meta classifier that classifies the very last class.

The sections of the paper that will be discussed next are listed below. The work on disease prediction is summarized in section 2. Section 3 discusses the proposed number of disease prediction using blockchain-based deep neural networks. Section 4 shows how the suggested disease prediction model was validated using a block chain-based deep neural network model, and Section 5 wraps up the article.

II. LITERATURE SURVEY

Distributed artificial intelligence is utilised all across the block chain nodes in order to solve the problems of scalability, cost, and storage that are associated with electronic health records (EHRs). These methods, along with other, more prevalent types of machine learning and applied mathematical methodologies [12][30][31], combed through the data in search of desirable characteristics and intriguing patterns rather than conducting an analysis of the material that was currently available. Using deep learning (DL) techniques, previously hidden or inexplicable links in datasets may now be investigated and explored without the need for human intervention [13]. This is made possible by

deep learning (DL) methodologies. A significant number of students have developed viable solutions to address the privacy and security problems brought up by the use of transitional electronic health records (EHRs) on the blockchain[32].

Patients can rest easy knowing that their electronic health records (EHRs) are stored safely on a blockchain, as stated by Esposito et al. [14]. There was not sufficient information available to establish the most effective approach to organise EHRs. To begin, we constructed the EHR indices by making use of the victimisation logic expressions that had been created by Chen et al.[15]. After that point, they were incorporated into the system of distributed ledgers. The increased number of transactions that take place on the block chain will make it less scalable, which will directly lead to an increase in the price of index searches. Amin et al. [16] came up with an associate design for a single server that offers anonymity, beauty, and reduced communication costs all in one package. Gope et al. [17] devised a safe, anonymous, and somewhat delayed RFID tag structure based on the Internet of Things because no one has previously acknowledged the difficulties associated with creating and sustaining confidence with long-term clientele (IoT)[37]. Using this method, it is now possible to find out the genuine identity of the server. Zhang et al. [18] developed a blockchain with the help of the FHIRChain. This blockchain has the potential to be utilised in the tracking of the ownership of medical records as well as the determination of who has access to those information. It is irrelevant whether you speak more than one language. The usage of deciliter frameworks enables the mining of data from electronic health records (EHRs)[38]. This allows for the selection of attributes as well as the extraction of patient clinical data. Weng and his colleagues [19] verified that the block chain is measurable and transparent by employing a method to deep learning that is federated, distributed, and conducted in collaboration. However, additional research is necessary to assess whether or not transfer learning is effective when retrained models are included in the analysis.

An LSTM cell-based model was developed by Pham et al. [20] in order to show not only the passage of time but also the process of admitting patients and determining their identities. The authors of [21] created the word model word2vec by employing word embedding techniques in order to manage the enormous wordbook that contained 197,100 different medical acronyms. Cross-entropy loss in a computer programme can be used to identify whether or not a patient has been victimised by using the convolutional neural networks (CNNs) that were developed by Suo et al. [22]. CNNs can be used to determine whether or not a patient has been victimised. Transfer learning, which Alhussein and Muhammad [23] utilised, required the use of VGG-16 and coffee. Both of these substances were consumed. Word2vec is the name of the embedding method that was utilised by Jacobson and Dalianis [24]. In prior discussions, the possibility of incorporating electronic health

records (EHRs) into app versions 4.0 was brought up. The adoption of transitional EHRs on block chains is also received with considerable scepticism because of its potential security implications. Methods that protect users' privacy, authentication and authorisation systems based on lattices, and various other possibilities are also being investigated. Scalability was a problem for which they did not have any solutions at the time. In addition, projections for pre-trained models, feature parameters, and vector similarity have been constructed [22, 24].

Applications built using the 4.0 paradigm already embed security and prediction models into their code, which enables them to communicate with one another and makes it feasible for them to interact with one another[39]. Because of this research, we now have a better understanding of one of the most innovative ideas for creating and maintaining Internet of Things applications. Both of these primary objectives might be thought of as being pertinent to this research project. When a transaction has been mined successfully, the blockchain ensures that it cannot be changed and that it is processed as soon as possible. This prevents any fraudulent activity from occurring. By using DNN prediction to the data that is provided in EHR characteristics, classification can be completed quickly, and patients may be informed of the outcomes of the classification[35][36]. Automated recommendations are what make this possible. These recommendations cut down on the amount of work needed to extract characteristics and make the process of evaluating the value of a mined transaction easier to understand. There are some pointers supplied for locating the health problems and evaluating their present status. This makes it possible for people to receive the care they require in a timely manner, which may save their lives.

III. PROPOSED METHODOLOGY

This research paper suggests a blockchain network so that data can move faster from the seed node to the destination node while still being safe. Using information from IT devices as input, the sparse autoencoder is used to predict illness. Figure 1 shows how powerful blockchain and a deep mastering mechanism are used to collect and process data in order to figure out the disease. It starts by collecting data, which is then sent over the blockchain in a smart way. On cloud servers, the data is preprocessed, functions are extracted, and then the data is classified to determine the type of illness.

Figure 2 shows an auto encoder network with a hidden layer that is used to learn certain compact properties of the information in Figure 3: $x = fx_1, x_2, x_3, x_4, x_5$ g. Layer 1 shows the input layer, layer 2 shows the hid layer, and layer 3 shows the output layer's reconstruction. The goal of the coaching method is to cut down on the reconstitution layer error as much as possible. Because the data options could also be found in the hidden layer, it could be seen as an alternative way to represent data.

An autoencoder network is used to figure out the details of the task that needs to be done. The number of neurons in the hidden layer will be kept to a minimum to make it easier to mine information for things that aren't obvious because of how this architecture is set up.

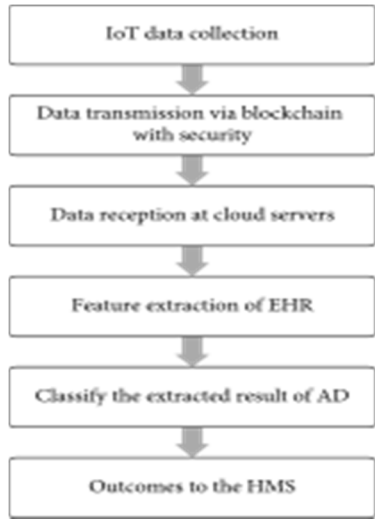


Fig. 2. Proposed work methodology

For example, a 3232 picture can be processed by 10,242 neurons. An auto-encoding network with a hidden layer of fifty neurons could be used to create a short description of the picture. In practise, principal component analysis (PCA) and methods for reducing the number of dimensions do the same things as described above. On the other hand, the layer that is buried only has a small number of different types of nerve cells. Even though there are a lot of neurons in this layer, it is still possible to see the basic features. If the activation value of each neuron in the buried layer is increased to its maximum, the number of neurons will go down. When the input neurons are used, the next step is to use the output neurons.

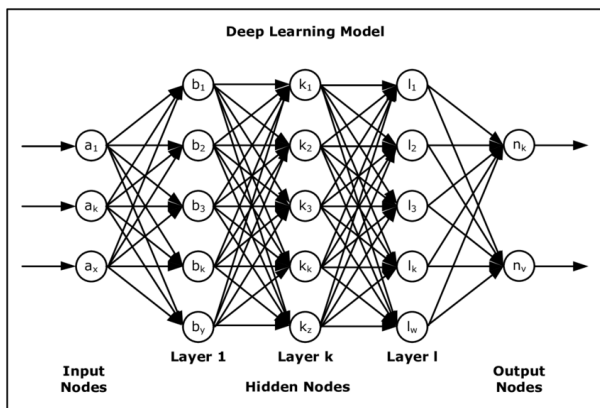


Figure 3. Deep learning algorithm processing [25]

$$\rho_j = \frac{1}{m} \sum_{i=1}^m a_j x_i, \quad (2)$$

where m is the total number of input neurons and j is the sparse parameter in the equation. When addressing the

problem with the hidden layer, the KL distance formulation is used so that the sparse parameter may be increased to its maximum.

$$KL(\rho|\rho_j) = \rho \log \frac{\rho}{\rho_j} + (1 - \rho) \log \frac{1-\rho}{1-\rho_j} \quad (1)$$

Since this is the case, each feature map is simply added to the spatiotemporal kernel. Once a network has been set up by hand, it can only do so much to learn from its own mistakes and pull out the most important information from the data it receives. Because it can't learn from other networks, it can't do as much as it could. Figure 2 is an example of a thin auto combination learning strategy, which is used to automatically learn how to combine input feature maps. This method is used to learn the input to the convolution layer. The sparsity of the network limits what the sparse autoencoder output of a neural network can be. When the sparse constraint is used on the input, the same constraints are also used on the output. Even though these two ways of doing things are different, they both lead to the same results. The sparse autoencoder neural network is useful in a wide range of business sectors and applications because it can learn from the low-level decisions stored in computer files. In order to turn on the network output layer, sparse limitations must be used on the network output side. To make the most compact representation of the input data, or to get the most compact representation of the data, we will only turn on the neurons in the output layer that have been trained to respond to certain inputs.

It is important to note that the input feature maps from the layer below are used as inputs for each of the feature maps that are made by this architecture for spatiotemporal convolution. This is important and shouldn't be forgotten. But because the borders are so small, the final feature map can only include a very small number of feature maps.

IV. RESULTS AND DISCUSSION

As a consequence of result, some background information on the DNNBC paradigm that has been proposed is presented, along with some examples of DNN-enabled smart contracts, distributed ledgers, and multi-factor authentication.

Comparative analysis of the data is often carried out using a variety of performance metrics, including packet delivery rate, throughput, latency, and energy efficiency. Additionally, it is essential to keep a close eye on how specificity and the capacity to categorise objects shift over the course of time. TensorFlow2.2 is used to create a model of the CNN, while Python3.8 is used to simulate it. In order to carry out the simulations, a high-end computer engine that has 32 threads, 16 GB of main RAM, and a GTX 1060 graphics processor was utilised. Because of this, the researchers were able to finish their work in the shortest

amount of time possible. The sophisticated computer platform that is in charge of running the simulation is powered by blockchain technology as well as an attention management system that comes with a classification module.

Fig. 4.(a) Comparative results of the activated different algorithms and (b) Comparative results of performance parameters both before and after the installation of deep learning algorithm in the current framework

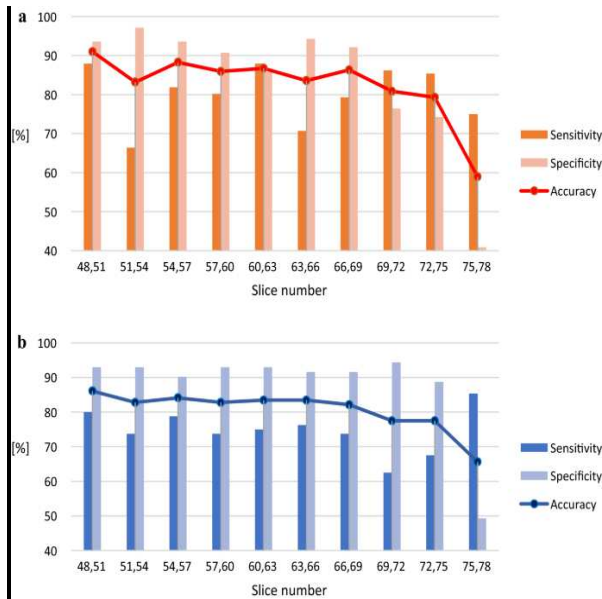


TABLE 1. COMPARATIVE RESULTS OF THE ACTIVATED DIFFERENT ALGORITHMS

Slice Numbers	48,51	51,54	54,57	57,60	60,63	63,66	66,69	69,72	72,75	75,78
Features	48,51	51,54	54,57	57,60	60,63	63,66	66,69	69,72	72,75	75,78
Accuracy.	90	83	85	84	84	84.5	86	80	79	60
Sensitivity.	85	63	82	80	87	70	80	84	84	74
Spfecity.	93	97	92	90	83	92	91	74	74	40

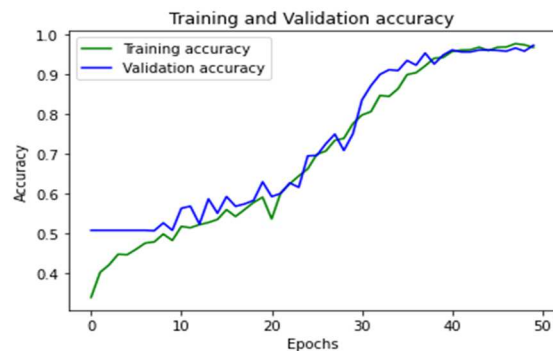
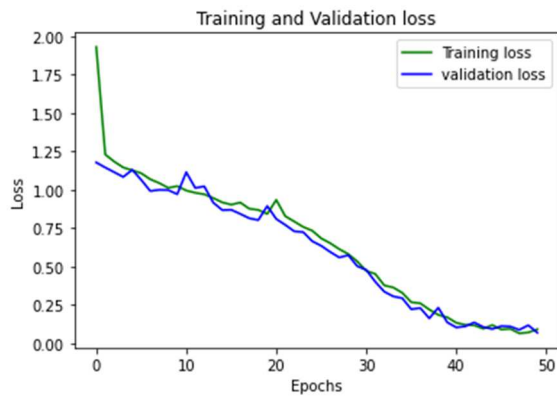


Fig. 5(a) and 5(b) Comparative results of the accuracy and validation test and loss data

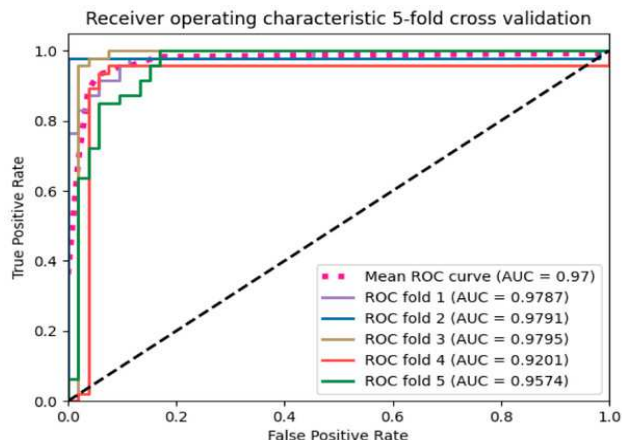


Fig. 6a ROC performance of the model while it is being trained and tested on data.

TABLE 2. ROC PERFORMANCE OF THE MODEL WHILE IT IS BEING TRAINED AND TESTED ON DATA.

ROC Fold	AUC
1	0.9787
2	0.9791
3	0.9795
4	0.9201
5	0.9574

The proposed DNN-BC model is compared to the current smart contract with DNN, distributed blockchain with DNN, and multifactor authentication with DNN in terms of how long it takes for a packet to be delivered. (b). As a result of these simulations, it seems that the DNN-BC model being considered has a higher PDR rate, but causal knowledge is being recorded on blockchains from the source to the destination. As shown in Figure 4, the results of the proposed DNN-BC model are similar to those of the existing DNN-based smart contract, distributed blockchain, and multifactor authentication systems. (b). The results of the simulation show that the DNN-BC model should have a higher output rate and be able to send information from a source to a destination that is on more than one blockchain at the same time. This chart compares the suggested DNN-BC solution to other solutions that are already on the market, such as distributed blockchains, smart contracts, and DNN-based multifactor authentication. The results of simulations show that moving data from one source to another takes less time when you use the fast DNN-BC model. The paradigm that is meant to be used with DNN-BC is talked about in relation to existing DNN-based smart contracts, distributed blockchains, and multifactor

authentication systems. The results of the simulation show that when causal information is sent from a source to a destination using blockchains, using the recommended DNN-BC model makes blocks use less energy. The information is being sent from a source to a place where it will be used.

The OASIS-3 dataset, which is a longitudinal neuroimaging, cognitive, clinical, and biomarker dataset for normal ageing and AD, and the UDS dataset from ADNI can be used to test how well the model works. These two sets of data come from ADNI. Test results that compare how well the DNN-BC model groups things to how well smart contracts, distributed blockchains, and DNN-based multifactor authentication work now. The results of the simulation show that the expected DNN-BC model has improved the accuracy of classification in the attention business after typical knowledge cases have been found.

V. CONCLUSION

In this investigation, blockchain modeling-based DNN is used to make sure that the IoT node supporting the police investigation and the destination supporting the user query in this article can share information as efficiently as possible. In the scope of the study, a health care management system is used to help speed up the delivery of data. The accuracy and best response time of the health monitoring and categorization system are both affected by the user's question and how long it takes to test the data. The results of the simulations show that the suggested method answers queries correctly and gives results faster than the other methods that are currently used to transfer blockchain data. In the future, machine learning or deep learning might be a great way to improve the way a distributed ledger models blockchain. This would be done so that better results would come out of it.

REFERENCES

- [1] P. Esmailzadeh, "Use of AI-based tools for healthcare purposes: a survey study from consumers' perspectives," *BMC Medical Informatics and Decision Making*, vol. 20, no. 1, pp. 1–19, 2020.
- [2] C. Vijai and W. Wisetsri, "Rise of artificial intelligence in healthcare startups in India," *Advances In Management*, vol. 14, no. 1, pp. 48–52, 2021.
- [3] D. HariPriya; Keshav Kumar; Anurag Shrivastava; Hamza Mohammed Ridha Al-Khafaji; Vishal Moyal; Sitesh Kumar Singh; Mohammad R Khosravi, "Energy-Efficient UART Design on FPGA Using Dynamic Voltage Scaling for Green Communication in Industrial Sector," *Wireless Communications and Mobile Computing*, 2022-05-05, DOI: 10.1155/2022/4336647
- [4] M. S. Hossain, G. Muhammad, and N. Guizani, "Explainable AI and mass surveillance system-based healthcare framework to combat COVID-19 like pandemics," *IEEE Network*, vol. 34, no. 4, pp. 126–132, 2020.
- [5] J. J. Wadden, "Defining the undefinable: the black box problem in healthcare artificial intelligence," *Journal of Medical Ethics*, vol. 3, 2021.

- [6] A. Adadi and M. Berrada, "Explainable AI for healthcare: from black box to interpretable models," in *Embedded Systems and Artificial Intelligence*, pp. 327–337, Springer, Singapore, 2020.
- [7] S. Kumar, R. D. Raut, and B. E. Narkhede, "A proposed collaborative framework by using artificial intelligence-internet of things (AI-IoT) in COVID-19 pandemic situation for healthcare workers," *International Journal of Healthcare Management*, vol. 13, no. 4, pp. 337–345, 2020.
- [8] Anurag Shrivastava; D. HariPriya; Yogini Dilip Borole; Archana Nanoty; Charanjeet Singh; Divyansh Chauhan, High performance FPGA based secured hardware model for IoT devices, *International Journal of System Assurance Engineering and Management*, 2022-03, DOI: 10.1007/s13198-021-01605-x
- [9] Suresh Kumar; S. Jerald Nirmal Kumar; Subhash Chandra Gupta; Anurag Shrivastava; Keshav Kumar; Rituraj Jain; Punit Gupta, IoT Communication for Grid-Tie Matrix Converter with Power Factor Control Using the Adaptive Fuzzy Sliding (AFS) Method, *Scientific Programming*, 2022-03-29, DOI: 10.1155/2022/5649363
- [10] H. Greenspan, R. S. J. Estépar, W. J. Niessen, E. Siegel, and M. Nielsen, "Position paper on COVID-19 imaging and AI: from the clinical needs and technological challenges to initial AI solutions at the lab and national level towards a new era for AI in healthcare," *Medical Image Analysis*, vol. 66, p. 101800, 2020.
- [11] K. Salah, M. H. U. Rehman, N. Nizamuddin, and A. AlFuqaha, "Blockchain for AI: review and open research challenges," *IEEE Access*, vol. 7, pp. 10127–10149, 2019.
- [12] K. P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT press, 2012.
- [13] P. Domingos, "A few useful things to know about machine learning," *Communications of the ACM*, vol. 55, no. 10, pp. 78–87, 2012.
- [14] C. Esposito, A. De Santis, G. Tortora, H. Chang, and K. K. R. Choo, "Blockchain: a panacea for healthcare cloud-based data security and privacy?," *IEEE Cloud Computing*, vol. 5, no. 1, pp. 31–37, 2018.
- [15] L. Chen, W. K. Lee, C. C. Chang, K. K. R. Choo, and N. Zhang, "Blockchain based searchable encryption for electronic health record sharing," *Future Generation Computer Systems*, vol. 95, pp. 420–429, 2019.
- [16] R. Amin, S. H. Islam, G. P. Biswas, M. K. Khan, and N. Kumar, "An efficient and practical smart card based anonymity preserving user authentication scheme for TMIS using elliptic curve cryptography," *Journal of Medical Systems*, vol. 39, no. 11, pp. 1–18, 2015.
- [17] P. Gope, R. Amin, S. H. Islam, N. Kumar, and V. K. Bhalla, "Lightweight and privacy-preserving RFID authentication scheme for distributed IoT infrastructure with secure localization services for smart city environment," *Future Generation Computer Systems*, vol. 83, pp. 629–637, 2018.
- [18] P. Zhang, J. White, D. C. Schmidt, G. Lenz, and S. T. Rosenbloom, "FHIRChain: applying blockchain to securely and scalably share clinical data," *Computational and Structural Biotechnology Journal*, vol. 16, pp. 267–278, 2018.
- [19] Srivastava, A., Singh, A., Joseph, S.G.Borole, Y.D., Singh, H.K., WSN-IoT Clustering for Secure Data Transmission in E-Health Sector using Green Computing Strategy, 2021 9th International Conference on Cyber and IT Service Management, CITSM 2021, 2021
- [20] Shrivastava, A.; Ranga, J.; Narayana, V.N.S.L.; Chiranjivi; Borole, Y.D., Green Energy Powered Charging Infrastructure for Hybrid EVs, 2021 9th International Conference on Cyber and IT Service Management, CITSM 2021, DOI: 10.1109/CITSM52892.2021.9589027.
- [21] Y. Liu, T. Ge, K. S. Mathews, H. Ji, and D. L. McGuinness, "Exploiting task-oriented resources to learn word embeddings for clinical abbreviation expansion," 2018, <http://arxiv.org/abs/1804.04225>.
- [22] Q. Suo, F. Ma, Y. Yuan et al., "Deep patient similarity learning for personalized healthcare," *IEEE Transactions on Nanobioscience*, vol. 17, no. 3, pp. 219–227, 2018.
- [23] M. Alhussein and G. Muhammad, "Voice pathology detection using deep learning on mobile healthcare framework," *IEEE Access*, vol. 6, pp. 41034–41041, 2018.
- [24] O. Jacobson and H. Dalianis, "Applying deep learning on electronic health records in Swedish to predict healthcare-associated infections," in *Proceedings of the 15th workshop on biomedical natural language processing*, pp. 191–195, 2016.
- [25] J. Amann, A. Blasimme, E. Vayena, D. Frey, and V. I. Madai, "Explainability for artificial intelligence in healthcare: a multidisciplinary perspective," *BMC Medical Informatics and Decision Making*, vol. 20, no. 1, pp. 1–9, 2020.
- [26] A. Singh, M. Chaudhary, A. Rana and G. Dubey, "Online Mining of data to generate association rule mining in large databases," 2011 International Conference on Recent Trends in Information Systems, 2011, pp. 126-131, doi: 10.1109/ReTIS.2011.6146853.
- [27] G. Dubey, A. Rana and N. K. Shukla, "User reviews data analysis using opinion mining on web," 2015 International Conference on Futuristic Trends on Computational Analysis and Knowledge Management (ABLAZE), 2015, pp. 603-612, doi: 10.1109/ABLAZE.2015.7154934.
- [28] G. Dubey, A. Rana and N. K. Shukla, "User reviews data analysis using opinion mining on web," 2015 International Conference on Futuristic Trends on Computational Analysis and Knowledge Management (ABLAZE), 2015, pp. 603-612, doi: 10.1109/ABLAZE.2015.7154934.
- [29] M. S. Raghavendra, P. Chawla and A. Rana, "A Survey of Optimization Algorithms for Fog Computing Service Placement," 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2020, pp. 259-262, doi: 10.1109/ICRITO48877.2020.9197885.
- [30] S. Gupta, A. Rana and V. Kansal, "Comparison of Heuristic techniques: A case of TSP," 2020 10th International Conference on Cloud Computing, Data Science & Engineering (Confluence), 2020, pp. 172-177, doi: 10.1109/Confluence47617.2020.9058211.
- [31] Shruti Gupta, Ajay Rana, Vineet Kansal, "Optimization in Wireless Sensor Network Using Soft Computing," *Proceedings of the Third International Conference on Computational Intelligence and Informatics*, 2020, Volume 1090, ISBN : 978-981-15-1479-1.
- [32] S. Ghosh, A. Rana and V. Kansal, "A Novel Model Based on Nonlinear Manifold Detection for Software Defect Prediction," 2018 Second International Conference on Intelligent Computing and Control Systems (ICICCS), 2018, pp. 140-145, doi: 10.1109/ICCONS.2018.8663026.
- [33] Ghosh, S., Rana, A., Kansal, V., "A statistical comparison for evaluating the effectiveness of linear and nonlinear manifold detection techniques for software defect prediction", (2019) *International Journal of Advanced Intelligence Paradigms*, 12 (3-4), pp. 370-391. Cited 9 times. <http://www.inderscience.com/ijaip>, doi: 10.1504/IJAIP.2019.098578.
- [34] B. N. Pandey, A. K. Shrivastava and A. Rana, "A Literature Survey of Optimization Techniques for Satellite Image Segmentation," 2018 International Conference on Advanced Computation and Telecommunication (ICACAT), 2018, pp. 1-5, doi: 10.1109/ICACAT.2018.8933689.
- [35] S. Chawla, G. Dubey and A. Rana, "Product opinion mining using sentiment analysis on smartphone reviews," 2017 6th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2017, pp. 377-383, doi: 10.1109/ICRITO.2017.8342455.
- [36] S. Chawla, G. Dubey and A. Rana, "Product opinion mining using sentiment analysis on smartphone reviews," 2017 6th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2017, pp. 377-383, doi: 10.1109/ICRITO.2017.8342455.
- [37] Veenita Kunwar, Neha Agarwal, Ajay Rana, "Load Balancing in Cloud—A Systematic Review", *Big Data Analytics*, 2018, Volume 654, ISBN : 978-981-10-6619-1.
- [38] A. Gupta, A. Pachauri, P. Pachauri, S. V. Singh, P. Chaturvedi and S. Sharma, "A review on conglomeration of Technologies for Smart Cities," 2021 International Conference on Technological Advancements and Innovations (ICTAI), 2021, pp. 526-530, doi: 10.1109/ICTAI53825.2021.9673458.
- [39] V. Kumar, D. Singh, S. V. Singh and T. Anand, "The Role of Converged Network in Disruptive Technology," 2020 International Conference on Intelligent Engineering and Management (ICIEM), 2020, pp. 483-486, doi: 10.1109/ICIEM48762.2020.9160337.