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Blockchain-based Secure Healthcare for Cardio Disease Prediction

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Abstract: ***Heart disease is the commonest explanation for death globally. According to a recent study by the Indian Council of Medical Research (ICMR), about 25% of deaths between the ages of 25-69 years cause due to of different heart-related problems. Cardiovascular diseases are the highest increased diseases. The shortage of specialists and high wrongly diagnosed cases have necessitated the necessity to develop a quick and efficient detection system. So weshould always even have jumped on techniques and methods used for alertness and care to avoid the overtime of the people due to the guts attack. By applying machine learningtechniques the prediction of the disease is often done. Blockchain technology has the potential to avoid fraud and data leakage. It can make better coordination between patient and hospital. The proposed system increases data security and removes the cost, time, and resources required to manage the patient's data and results.***
Keywords Blockchain Healthcare Machine LearningArrhythmia

I. INTRODUCTION

Heart disease is a leading cause of death worldwide for the past 15 years. Heart disease Diagnosis is based on an ECG test. The ECG tool plays an important role indiagnosing and treatment of several diseases associated with cardiac. A normal heartbeat is 60 beats/minute. If the heartbeats are fast or slow than the normal ones or they may be fluctuating, then there are chances of getting heart abnormalities. Early diagnosis of heart-related problems can potentially reduce the death rate and help patients maintain a far better quality of life. By analysing the electrical signal of the heartbeat, it is possible to detect some of its abnormalities. As the ECG signals are time-series data, with large enough data sets, and advanced ML techniques we can get astonishing results in predicting cardiac arrhythmia.

By measuring the electrical pulse, we can find any deep change in the ECG signal which is one of the main attributes in measuring heart disease. Diagnosing heartdefects based on the relationship betweenECG and clinical readings can lead to high- performance heart diagnostics. Early detection of heart conditions is important because it can ease the treatment and alsosave people's lives.

Cardiovascular diseases are the highest increased diseases. The shortage of specialists and high wrongly diagnosed cases have necessitated the necessity to develop a quick and efficient detectionsystem. So, we should always even have jumped on techniques and methods used for alertness and care to avoid the overtime of the people due to the guts attack. By applying machine learning technique the prediction of the disease is often done.

Blockchain technology has the potential to avoid fraud and data leakage. It can make better coordination between patient and hospital. The proposed system increases datasecurity and removes the cost, time, and resources required to manage the patient’s data and results.

A. Blockchain

Blockchain is a decentralized nodenetwork that stores the information. It is an excellent technology forsafeguarding confidential data within thesystem. This technology helps to exchange critical data and keeps it secure and confidential. it's an ideal tool to carry all the related documents in one location and securely. Blockchain also accelerates searches for applicants that fulfill specific trial criteria employing a single patient database. The Blockchain is described as a decentralized peer-to-peer (P2P) network ofpersonal computers called nodes, which maintains, stores, and records historical or transaction data. Blocks, nodes, and miners are the three main ideas in Blockchain. ***[1]***

Blockchain doesn't save any of its data at a single location. Instead, a network of computers copies and spreads the Blockchain. Every computer on thenet updates its Blockchain to reflects a new block to the Blockchain. A Blockchain hash's value depends on a cryptographic hash that connects newly added in formation block records with each data block. The Fig.1 shows the fundamental working steps ofBlockchain. ***[25]***

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There are various forms of Block chain technologies like public, private, hybrid.Each Blockchain network has different advantages and drawbacks that essentiallyinfluence its optimal applications.

[28]The public Blockchain is thatthe first variety of Blockchain technology,and it's where Bitcoin and othercryptocurrencies were conceived and helped promote distributed ledger technology (DLT). It eliminates the drawbacks of centralisation, like an absence of securityand transparency.

A private Blockchain may be a Blockchain network that operates in an exceedingly restricted context, like a closednetwork, or is controlledby one entity. during a private Blockchain, the network's inventor knows who the participants are from the beginning.

A hybrid Blockchain is style of Blockchain that features private andpublic Blockchain characteristics. It's only suitable for sure organizations that aim to streamline communication amongst each other.

Based on the requirements or use case scenarios, healthcare organizations can employ any form of blockchain network as all of them have their pros and cons.

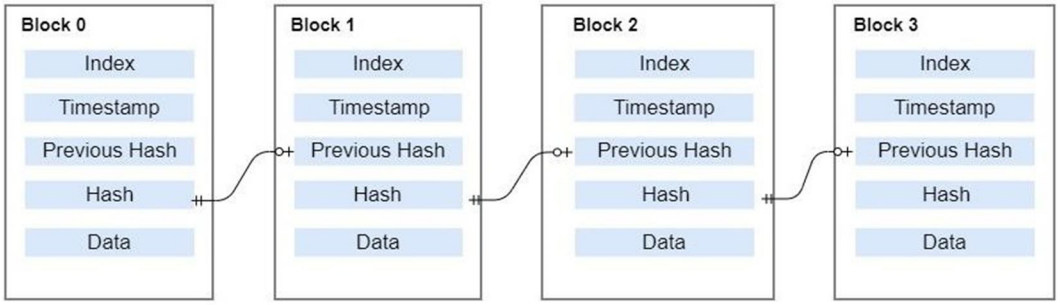

Fig. 1 Fundamental Working of Blockchain

B. Key features of Blockchain

The features listed below make Blockchain stand out and a more secure technology.***[19-23]***

1) Decentralized Network: The network is decentralized meaning it doesn't have any governing authority or one person taking care of theframework. Rather a bunch of nodes maintains the network making itdecentralized. Through decentralizedprinciples, blockchain can help to boost health data access and security of patient information, and thus can overturn the healthcare hierarchy by enabling theevent of latest systems within which patientscan manage their data. This is one among the key features of blockchaintechnology that works perfectly.

2) Transparency: Transparency is one among theforemost appealing features of blockchain technology. Enabling transparency of the health data can help to supply a completely auditable and valid ledger of transactions . the present health care data management systems are unable to supply privacy, security, and transparency at the identical time together. Blockchain notonly enforces a better level of transparency but also ensures privacy and provides authorized control over the healthcare data in a very parallel way. Greatertransparency can undoubtedly make healthcare services more efficient. Blockchain achieves transparency through encryptions and control mechanisms.

3) Immutability: Immutability is another feature of blockchain. It refers to the flexibility of a blockchain ledger to stay unaltered and un- tamper able. Blockchain achievesimmutability through cryptographic hashing.All transactions are registered on digital blocks, wherein each blockchain contains a hash, which is formed supported theprevious block's hash and also the new information entered into the new block.

4) Data provenance: Data provenance is important for healthcare to determine a specific level of trust in health data by providing complete information about its creation, access, and transfer. Storing historical health records on blockchain can enhance trustworthiness for data validation.

5) Distributed ledger and consensus Distributed ledger technology (DLT)can minimize operational inefficiencies, resulting to avoid wasting administrative costs. Through DLT, all stored health data are shared multiple times among allblockchain nodes, wherein eachinformation is definitely verifiable andaccessible for anyone within the network.

6) Anonymity and programmability Anonymity and programmability are some important features of public blockchains. Anonymity ensures that identities of senders or receivers participating in transactions remain unidentifiable. The programmability feature enables automation of latest transactions and controls through smart contracts. they enable trusted transactions and agreementsto be dispensed between anonymous parties without involving any third party or anyexternal enforcement procedure.

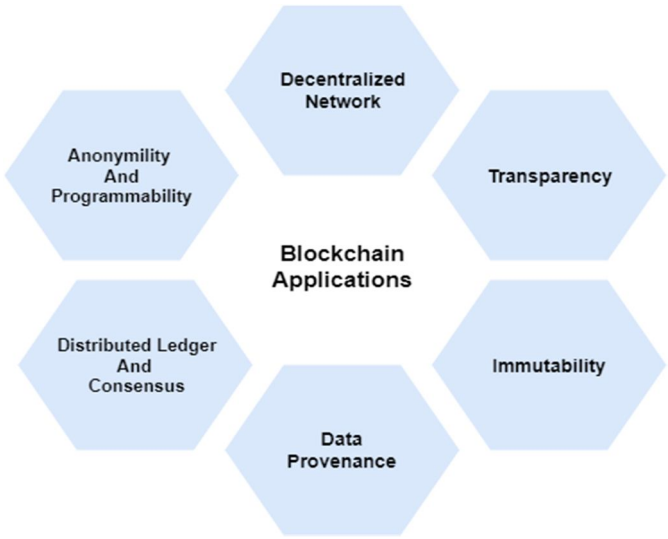

Fig. 2 Key Features of Blockchain

C. Blockchain in healthcare

Today the necessity is for quality health facilities supported by advanced and newer technologies. ***[2], [9], [14]***Blockchain plays a critical role in transforming the healthcare sector. additionally, the landscape of the health system is moving towards a patient centered approach specializing in two main aspects: accessible services and appropriate healthcare resources the least bit times. ***[15]***Health Information Exchange is yet again consuming and repetitive process that results in high health industry costs, quickly sorted out using this technology. A centralized database is employed to manage the complete healthcare system and organizations. Blockchain technology enhances security, data exchange, interoperability, integrity, and real-time updating and access when correctly implemented. Using blockchain technology, healthcare providers can have a whole picture of patients' medical record. All the stored data on blockchain are immutable, transparent,traceable, and secure.

Blockchain can help to eliminate the danger of knowledge theft or mishandling through the immutability feature supported cryptographic principles.Health data stored on blockchain alsoare secure from damage stemming from natural disasters or medical facility collapse because the identical data are stored on multiple locations, so there's no central point of failure. ***[7]***

Blockchain can assist in reducing the prices of medical companies because they will easily access complete patients' data without visiting multiple locations where such data won't to be stored. In certain medical emergency scenarios, an intensive knowledge of a patient's past medical record is mandatory before prescribing any medication for correct treatment as an example, a patient stricken by a significant reasonably disease and should require to consult a doctor just in case of some sudden emergency. In such a case, a medical professional usually requires a patient'sprior medical records to supply better and quality healthcare services.

The patient's medical history can help doctors to investigate various aspects, like a past medicine history, drug allergy information, and records of prior treatments, which might cause devise moreoptimal treatment strategies.

D. Machine Learning

[18]Machine learning is an application of AI that permits systems to find out and improve from experience without being explicitly programmed. Itfocuses on developing computer programs which will access data and useit to be told for themselves.

ML has proven valuable because it can solve problems at a speed and scale that can't be duplicated by the human mindalone. With massive amounts ofcomputational ability behind one task or multiple specific tasks, machines willbe trained to spot patterns in and relationships between input file and automate routine processes.

A vast majority of ML algorithms use supervised learning. Any new ML practitioner will begin his journey with this type of algorithms. Supervised learning, as the name suggests, teaches the machine to develop a model using the available dataset to have the desired program. In supervised learning, we divide the whole dataset into training and testing datasets. The ML models are developed using the training dataset. Testing datasets are then used for accuracy checking and adjustment of the error so that expected outputs are closer to the actual to the extent possible. Based on data received, the supervised learningtechniques are further subdivided into regression and classification. The regression algorithm in ML is used to predict a continuous output, i.e., the expected outputis a real number. Whereas, in classification, predicted output will be in discrete form. The below Fig 2 shows the flow of machine learning.

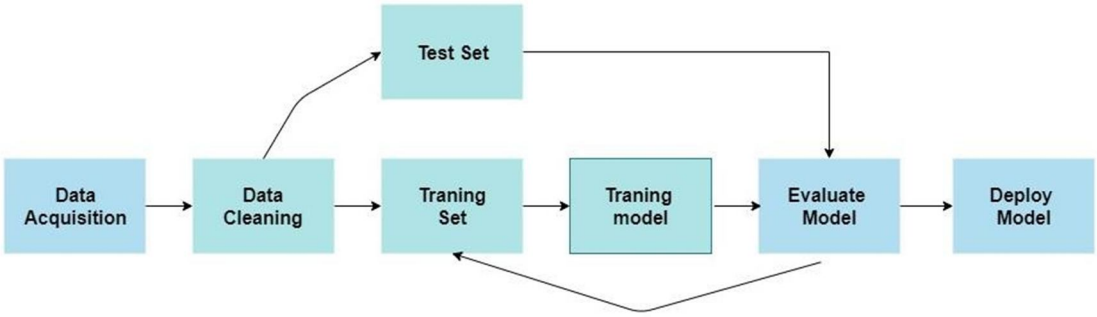

Fig. 3 Flow of Machine Learning

E. Machine Learning in Healthcare System

[3]Machine learning is already lending a hand in diverse situations in healthcare. Machine learning in health care helpsto analyze thousands of various data points, suggest outcomes, and supply timely risk scores and precise resource allocation, and has many other applications. it's the age where we have to advance more informationto clinicians, so that they can make better decisions about patient diagnoses andtreatment options, while understanding the possible outcomes and price for every-one.

The worth of machine learning in healthcareis its ability to process huge datasets beyond the scope of human capability and then reliably convert analysis of that data into clinical insights that aid physicians in planning and providing care, ultimately resulting in better outcomes, lower costs of care, and increased patient satisfaction.

ML need prior preparations before itsapplication can be implemented in healthcare so that it can differentiate the types of data, associate among similar kind of data, learn from the data, and gives out appropriate output. This data can be in the form of clinical records, diagnosis reports, screening records, demographics, images, physical examinations, medical notes, etc.

II. CHALLENGES AND LITERATURE SURVEY

Often the doctors and medical staffs faceproblems in interpreting an ECG report. Very little change in any section of the ECG graph may result in several sorts of diseases. During medical emergencies, like in ER or ICU, where time is of the essence, it mightbe more advantageous to seek out what's ailing the patient for immediate treatment. Moreover, it's very difficult for a doctor to read an ECG report with bare eyes. At times,there is a high chance to miss out on any abnormality in the ECG report as the change in the ECG wave shape is hardly noticeable. So doctors often deny concluding any disease from the ECG report of a patientwith 100% accuracy until they conduct somemore tests for the patient.

[8]*(2021)*This paper proposes efficient Blockchain-based secure health-care services for disease prediction in fog computing. Diabetes and cardio diseases are considered for prediction. Initially, the patient health information is collected from Fog Nodes and stored On a Blockchain. The novel rule-based clustering algorithm isinitially applied to cluster the Patient health records. Finally, diabetic and cardio diseasesare predicted using a feature selection-based adaptive neuro-fuzzy inference system (FS- ANFIS).

The security and privacy for accessing patient medical data and some hybrid clustering and classification model can be added to enhance the performance of the prediction results.

[4](2021)Machine learning is an important and effective tool for analysing extremelycomplex medical data. With massive amounts of medical data being generated,there is an urgent need to effectively use thisdata to benefit the medical and health care sectors worldwide. This survey paper presents a systematic literature review for theinvestigation of various machine learning techniques used for a variety of medical applications that have recently been published in highly reputable venues. Using only recent work, we can survey the current machine learning and deep learning models being used for medical data. This review of the literature reveals a clear shift in the use of artificial intelligence techniques in the medical domain, with deep learning methodstaking precedence over other methods. Usage of the Isolation Forest algorithm to detect outliers. Isolation Forest is a decision tree-based unsupervised machine learning approach. It first locatesoutliers by randomly selecting one of thefeatures and then performing an arbitrary split selection between the minimum and maximum values of the selected feature. This process of random feature subdivision produces smaller paths in the tree structure for the anomalies, distinguishing them from the normal data. This algorithm detects anomalies relatively quickly and requires less memory than other outlier detection methods; thus, it is the method we used in our study. Improving the accuracy of prediction of heart disease risk based on ensemble classification techniques.

[5](2021)Machine learning (ML) is the study of computer algorithms for experience-based automation. ML is a subsetof artificial intelligence (AI) that creates computer systems capable of performing tasks that require human intelligence.

While healthcare communication isessential for tactfully translating and disseminating information to support and educate patients and the general public, ML has been shown to be applicable in healthcare due to its ability for complex dialogue management and conversational flexibility.

[11](2020) A Linguistic Neuro-Fuzzy with Feature Extraction (LNF-FE) model is utilized for the analysis of medical data for disease classification. Initially, this model uses a linguistic fuzzification process to generate membership values that handle the uncertainty problems. These membershipvalues may not significantly contribute tothe model, but it will increase thedimensions, for which more time will be required to train the model. Thisexperimental analysis shows that our proposed model outperforms better as compared to other models for solving real- world problems. Medical disease classification using machine learning algorithms is a challenging task due to the nature of data, which can contain incomplete, uncertain, and imprecise information.

The availability of such information in the dataset affects the performance of the classification model. Similarly neuro fuzzy logic are completely dependent on human knowledge and expertise. You have to regularly update the rules of a Fuzzy Logic control system. These systems cannot recognize machine learning or neuralnetworks.

[12],[26](2020)Edge-based privacypreserving cryptosystem is identified as the upcoming amenities of cloud-based secureremote healthcare monitoring systems. Usually, the cloud-based healthcare system will directly collect the remote patient data through a sensor layer and provide the continuous monitoring and diagnosis through various prediction processes made by the decision support system. These sensing and processing of real-time patient's medical data without compromising its privacy and security become daunting issuesin the traditional healthcare services.

Edge computing improves security by reducing the quantity of data that has tobe protected in data centers, it also raises security concerns at each localized point of the edge network. In addition, some data is more vulnerable to breaches because not every edge device has the same built-in authentication and security capabilities. Edge devices may require more hardware and software for optimal performance and local storage needs, and costs can quickly escalate when they're spread across multiple local geographies.

[18](2019)A machine learning based automated seizure detection method hasbeen proposed in the IoT framework, which utilizes Hjorth parameters as well as statistical features, and DWT based feature extraction. The system was validated using ahardware-in-loop based simulationapproach. The experimental results show that the proposed approach is highly effective in understanding complex EEG dynamics, which leads to an improvedclassification accuracy as compared to existing algorithms.

The prototyping of the proposedNeuro-Detect was done using a hardware-in-the-loop based simulation approach. The simulator was configured using a hardware support package provided by vendor. Theactual board was constructed and then the proposed Neuro-Detect was run on theboard. The user's EEG data were continuously stored on the 'Neuro-Detect'channel in the IoT cloud storage. which increases costing of product.

[6]Health Fog is used for integrating ensemble deep learning in Edge computing devices and deployed it for real-lifeapplication on automatic heart disease analysis. It delivers healthcare as a fog service using IoT devices and efficiently manages the data of heart patients which comes as per user.

More intelligent ensemble models can be deployed for further improving the accuracy. Further, the proposed architecture can be made robust and generic to in- corporate other fog computing applications such as agriculture, healthcare, weather forecasting, traffic management, And the smart city.

[16](2019) The authors of this paper have provided information on both machine learning and data mining and how they can be used in the health care system. The healthcare industry is a data miningapplication area because it has vast data resources that are difficult to manage manually. Even in developed countries, heart disease has been identified as one of the leading causes of death. One of the reasons for heart disease fatality is that the risks are either not identified or are identified only at a later stage.

[10]Machine learning techniques, on the other hand, can be useful for overcoming this problem and predicting risk at an early stage. Some of the methods used to solve such prediction problems Support Vector Machines (SVM), Neural Networks, Decision Trees, Regression, and Nave Bayesclassifiers are some examples.

A comparison of classification techniques revealed that decision treeclassifiers are both simple and accurate . Thebest algorithm was discovered to be Nave Bayes, followed by neural networks and decision trees . Disease prediction is alsoaided by artificial neural networks. Existing research has used ensemble methods to improve classification accuracy in heart disease prediction. For feature extraction, a combination of genetic algorithms and neural networks based on fuzzy logic demonstrated an increase in accuracy of up to 99.97 percent. A trained recurrent fuzzy neural network based on a genetic algorithm produced an accuracy of 97.78 percent in diagnosing heart disease.

[17]Blockchain technology is redefining data modelling and governance, and it is being used in a variety of healthcare applications. This is primarily due to its adaptability and unique ability to segment, secure, and share medical data and services.

Data sources, blockchain technology, healthcare applications, and stakeholders are conceptually organised into four layers in emerging blockchain-based healthcare technologies.

The healthcare ecosystem is expectedto be reshaped by blockchain technology. Not only will the process be transparent and secure, but it will also be safe. However, the quality of healthcare will improve at a lower cost. We discussed various blockchain applications in the healthcare industry in thispaper, as well as major research initiatives and future research opportunities.

[13], [27]A mobile application is deployed to collect health data from personal wearabledevices, manual input, and medical devices, and synchronize data to the cloud for data sharing with healthcare providers and health insurance companies. To preserve the integrity of health data, within each record, aproof of integrity and validation is permanently retrievable from cloud databaseand is anchored to the blockchain network.

Enabled by mobile and wearable technology,personal health data delivers immense and increasing value for healthcare, benefiting both care providers and medical research.

The secure and convenient sharing of personal health data is crucial to the improvement of the interaction and collaboration of the healthcare industry.Faced with the potential privacy issues and vulnerabilities existing in current personalhealth data storage and sharing systems, as well as the concept of self-sovereign dataownership, we propose an innovative user- centric health data sharing solution by utilizing a decentralized and permissionedblockchain to protect privacy using channel formation scheme and enhance the identity management using the membership service supported by the blockchain.

III. SYSTEM PROPOSED

Cardiovascular disease is the leading global explanation for death. A traditional pulse is 60-100 beats per minute. However, a rate on top of 76 beats per minute when resting is also linked to a better risk of anattack. It's very difficult for a doctor to read anECG report with bare eyes. At times, there is a high chance to miss out on any abnormality within the ECG report because the change within the ECG waveform is hardly noticeable. Here we are developing a scheme that will analyse the ECG data of patients for predicting the kind of arrhythmia.

Fig. 4 Proposed System

The data entered in the form of ECG reports is then evaluated using machine learning algorithm to give us a definite solution whether the given patients data is detected by arrhythmia or not. And if the patient is being detected by the arrhythmia, then the results also display the type of arrhythmia in the output. Following, the entire data is then saved on the Blockchain in anencrypted manner for future references. This saves time and gives the highest accuracy in medical emergency scenarios.

IV. CONCLUSION

Blockchain technology wouldsignificantly enhance and eventually revolutionize how patients and physicians treat and use clinical records and improve healthcare services. Within the currenthealthcare system, the employment of BC plays an important role.

It may end up in automated processes for collecting and verifying data, correcting and aggregating information from different resources that are indisputable, defiant to manipulation and providing protected data, with condensed cybercrime chances and which also supports disseminatedinformation with system redundancy. Thispaper proposes efficient BC based secure healthcare services for disease prediction in ML. Arrhythmia are considered for prediction. The proposed work efficiently clusters and predicts the disease compared toother methods.

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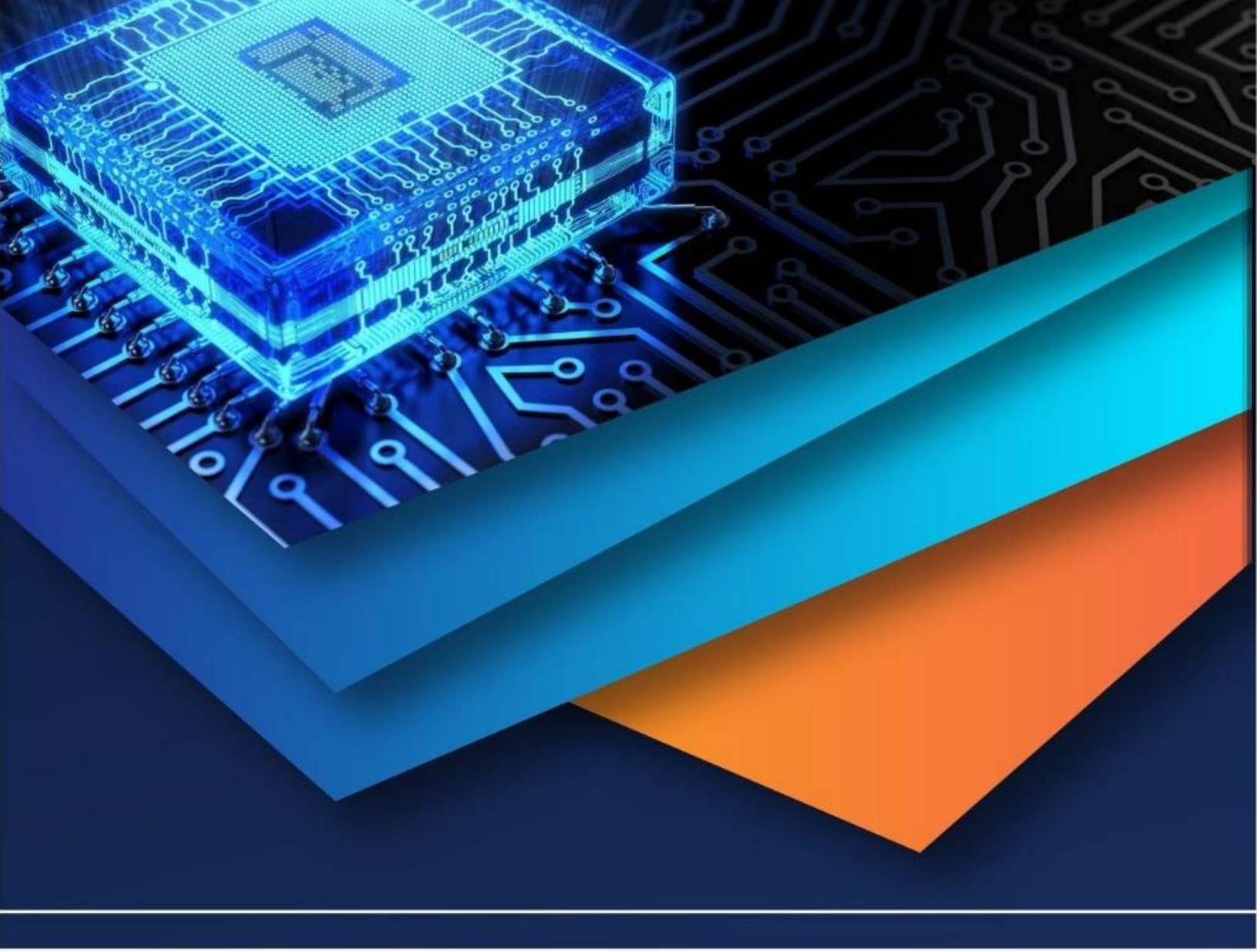

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