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Improving IOT-Edge Fusion-based Healthcare Efficiency: An Innovative Method for Smart Health Monitoring and Diagnostics

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ABSTRACT: An emphasis on data security, privacy, and effective medical diagnosis, this article offers a novel framework that will change healthcare systems by utilizing cutting-edge technologies. Our method combines edge computing, artificial intelligence (AI), and distributed ledger technology (DLT) to build a stable and resilient medical ecosystem. Our suggested approach ensures both privacy and integrity by securely managing patient health data through the use of edge nodes and identity-based cryptosystems based on elliptic curve encryption. These edge nodes, which are made for short-range, low-power communication, are essential to the gathering and monitoring of in-vivo data about the human body. Our framework's DLT paradigm uses peer-to-peer networks to facilitate smooth information sharing and do away with the need for centralized servers. We place a strong emphasis on public edge DLTs, like Ethereum, to guarantee data ownership and accessibility for all parties involved. To further improve overall system efficiency, our system incorporates a hybrid machine learning model for early threat identification and prediction. Our results show that this method can classify data with an astounding 99.7% accuracy. To sum up, this framework's interdisciplinary approach promises real-time data processing, improved security, and privacy preservation by bridging the gaps between healthcare, edge computing, and DLT. This invention has the potential to revolutionize healthcare technologies in the wake of the Internet of Things' growth.

KEYWORDS: Cloud computing, edge computing, IoT, ML, wireless sensor network.

I. INTRODUCTION

A networked system known as the "Internet of Things" (IoT) enables previously isolated computer components to interact and communicate with one another. This makes it feasible for data to be collected and sent efficiently with the least amount of human intervention. Although research on the Internet of Things, or IoT for short, is still in its infancy, it has the potential to have a significant impact on the advancement of other technological fields. The consequences of the advancements in technology that made life possible. Barbara Masini was the associate editor who oversaw the manuscript's evaluation and gave her approval for publishing. Wearable technology and implanted medical devices (IMD) are two examples of Internet of Things applications that can help provide the best possible treatment in an IoT-based healthcare setting. This is feasible since IoT solutions have the potential to enhance patient outcomes. Several studies have shown that there are several areas for improvement with remote patient monitoring that should be explored. Thanks to the technological breakthroughs in healthcare today, patients who are not in immediate danger can nevertheless benefit from remote monitoring technology. This approach will eliminate the need to transfer elderly patients from their homes to clinics or hospitals in order to receive care. IoMT has shown successful in a number of areas, including rehabilitation, diabetic complications management, and AAL treatment techniques [1]. It is now possible to use a newly created technology to decide the best course of treatment for individuals who have sustained physical injury. The algorithm compares the patient's symptoms to those in the database and then recommends a course of treatment and medication. If a treatment plan is approved by at least 89% of the treating physicians, the method is deemed successful. It has been established that employing IoMT technology to treat persons with Parkinson's disease is effective. Numerous studies have examined the connections between obesity and diabetes as well as other illnesses. Given the specifics of this instance, two separate glucose readings are required. The dangers of depending only on self-measured blood sugar levels are made abundantly evident in each of these instances. The patient's condition and the

medical staff's involvement will determine who specifically receives the warning that the system will send. IoMT may also be helpful in the prevention of cardiovascular disease and in the early detection of illness.

II. LITERATURE SURVEY

Processing at the "edge," or the network's peripheral, is growing in popularity. The distributed architecture and enhanced efficiency of cloud computing can benefit traditional programs. Cloud computing is currently unable to address some issues with edge networks, such as inadequate resources, bad transmission, and a dearth of practical functionality. Modern devices together with one another produce an unstable environment. Sur eddy et al. present a novel approach to improving collaborative systems .Furthermore, nodes on the network's edge can maximize their cooperation with one another. We assess data gathered from real seniors and their wearable sensors to demonstrate the efficacy of the suggested architecture. Deep learning exhibits enormous promise when used to process the vast volume of unprocessed sensor data generated by Internet of Things devices. Deep learning is most useful at the edge of a network because of its decentralized architecture. There are stringent requirements for edge computing. A more adaptable framework for IoT edge computing would be beneficial.

The proposed approach uses a customizable edge computing architecture and several agents to push deep learning to the edge. Given the current state of edge node processing power, researchers additionally develop a novel offloading approach to enhance the performance of deep learning applications at the edge. An idea for sophisticated IoT systems that can adapt to changing conditions and user needs is the FEC architecture. Some of the emerging ICTs that are converting healthcare into digital health include wearables, the Internet of Things, and edge computing. As consumer tools for tracking fitness and health, high-tech fitness trackers worn on the wrist are growing in popularity. Despite all of the advancements, the healthcare system is not taking full advantage of these tools to gather long-term behavioural trends. Securely collected user data could be used to create a comprehensive and preventative healthcare system. The authors of this paper [3] describe an Edge-assisted data analytics system driven by Federated Learning that retrains local machine learning models using user-generated data. This approach could employ pre-trained models to produce distinctive customer insights without sacrificing. When it comes to managing limited resources like power and battery life, edge computing outperforms cloud computing in IoT-based industrial applications. This is because the latter causes a lengthier delay and the former has a larger processing cost. In the meanwhile, a lot of discussion has focused on how AI may improve resource management in the commercial and industrial domains. Industrial IoT devices can reach farther and analyse more data with the aid of coordinated edge AI. Portable electronics that are power-hungry, have short battery lives, and have zero tolerance for delays are a major threat to accepted standards of equitable distribution. In large-scale industrial datasets, it has been demonstrated that power-saving and battery-extending strategies such as predictive transmission power control (PTPC) and the industry standard Baseline are inadequate for sustaining a dynamic wireless channel.

III.SYSTEM ARCHITECTURE

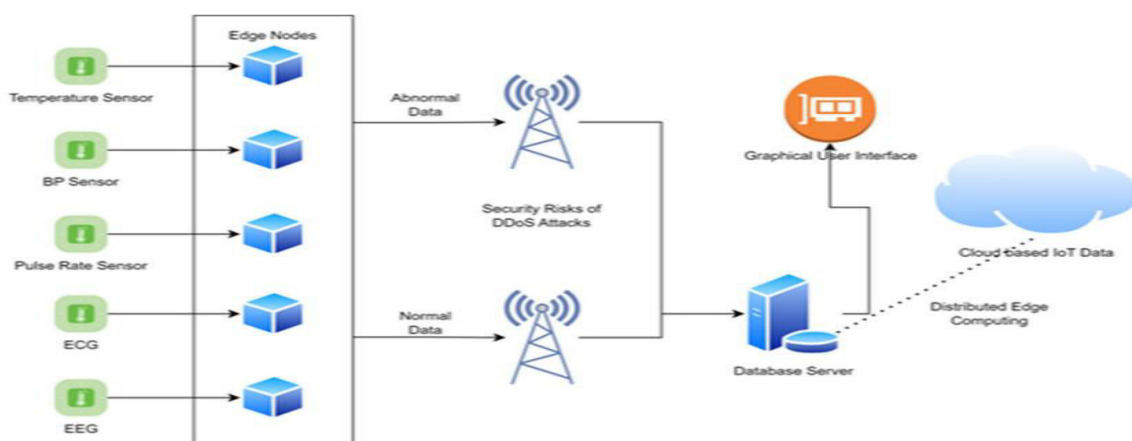


Figure1: System architecture.

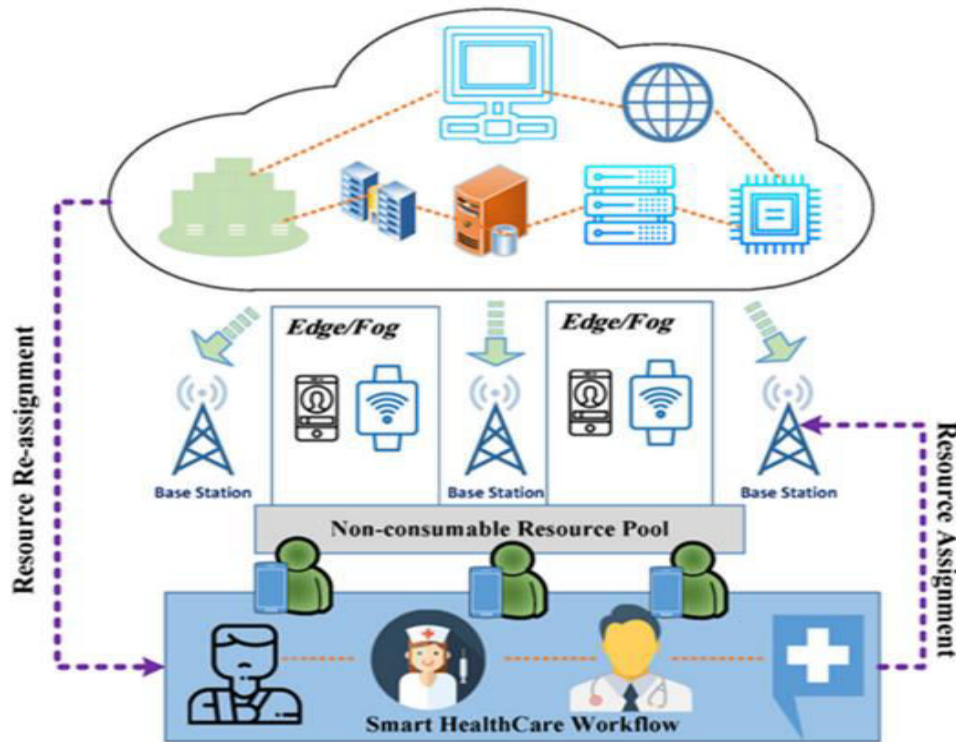


Figure2: Edge based medical healthcare system

1. Model for Protecting Privacy and Security:

ECC Encryption: Identity-based cryptosystems based on elliptic curve cryptography (ECC-IBC) are used to protect patient data confidentiality and privacy. The ECC encryption function can be expressed as follows: $E(P,k)=Q$, where P is patient data, E is the encryption function, k is the encryption key, and Q is the encrypted output.

2. Privacy-Preserving Strategy:

A model based on metrics such as Shannon's entropy or K-anonymity can be used to gauge how effective the privacy-preserving strategy is. $Privacy = f(Data)$ is how this is expressed, where Privacy Data relates to patient medical information, privacy is the degree of data privacy, and f is the function that preserves privacy.

3. Performance Evaluation Model-Distributed Ledger Transaction Throughput:

$TPS = g$ is a mathematical model that describes transaction throughput (TPS) as a function of several factors, allowing for the evaluation of the distributed ledger system's performance. $TPS = g$

4. Hybrid Machine Learning Model:

Conventional classification metrics can be used to assess the hybrid machine learning model's performance. Accuracy (ACC) is one such statistic, and its formula is $ACC = TP + FP$.

TP, where ACC stands for accuracy.

The number of true positives is known as TP.

The number of false positives is called FP.

IV. RESULTS

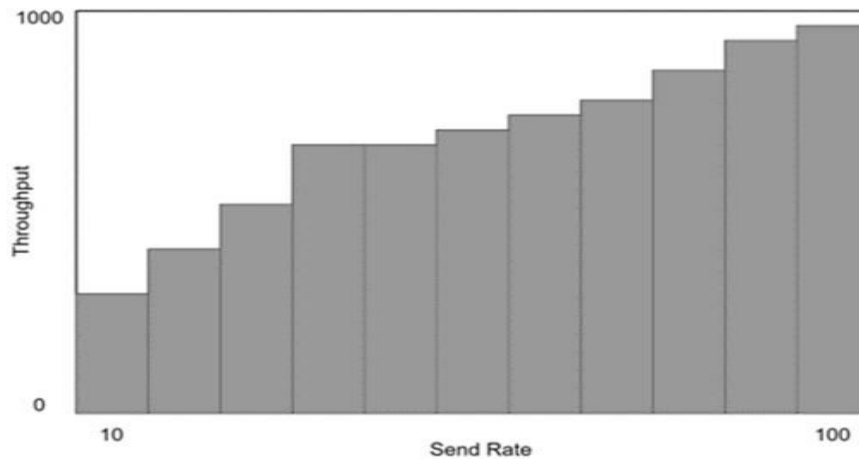


Figure 3.1: Performance of proposed system in communication.

The above figure contains chart suggests that as the send rate rises, the system or network can handle a higher throughput, possibly indicating effective scalability or an efficient data processing mechanism. However, without additional context, it's unclear if there's a limit or an optimal point beyond which throughput may plateau or decline due to system constraints.

If this chart is part of a study on network performance or IoT healthcare applications, it could imply that the system supports high data transaction rates efficiently, which is crucial for real-time data processing in healthcare.

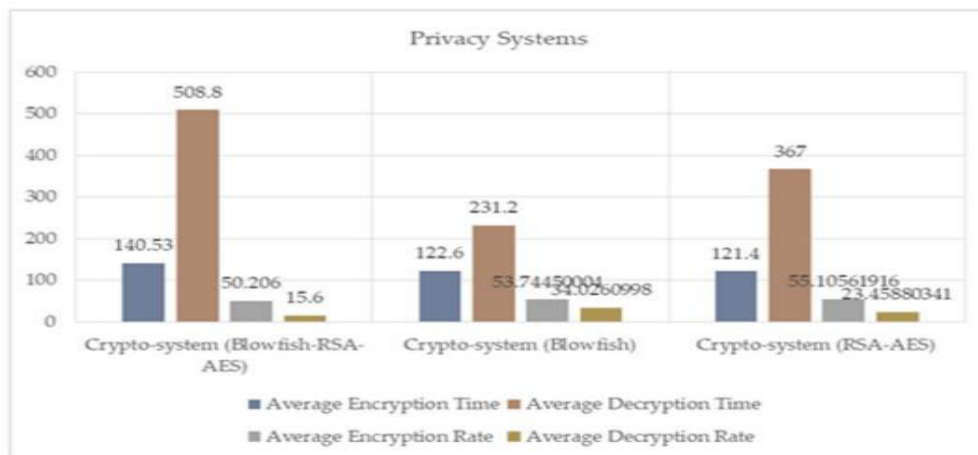


Figure 3.2: Performance analysis of privacy preserving strategy.

The above figure explains about chart suggests a trade-off between encryption/decryption speed and security levels. The Blowfish-RSA-AES combination offers high encryption and decryption times, likely due to the complexity of multiple algorithms working together, which may enhance security at the cost of speed. Blowfish alone offers a good balance with relatively high encryption and decryption rates and moderate times. RSA-AES has moderate encryption/decryption times but lower rates.

In a healthcare IoT system, choosing the cryptosystem would depend on the need for speed versus security, with Blowfish alone possibly being the best choice for faster, efficient encryption without significant latency.

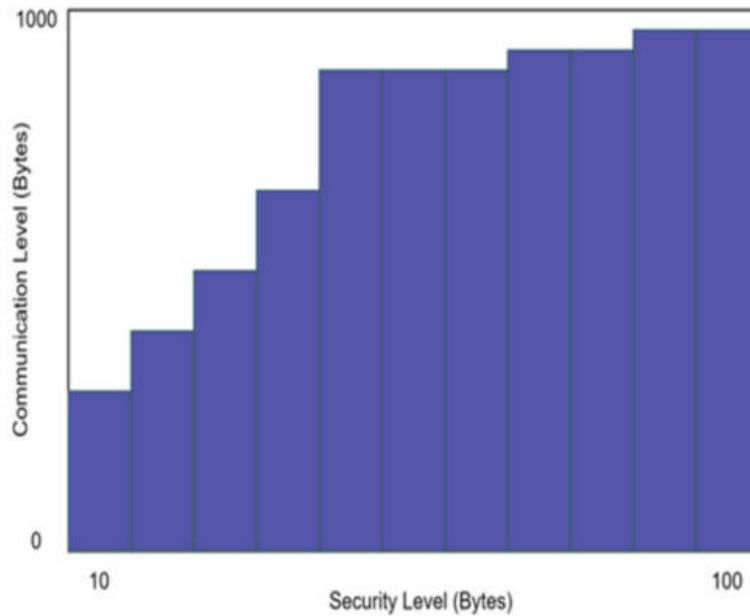


Figure3.3: Read transaction throughput

The above figure contains about the database systems, a "read transaction" generally refers to a type of transaction where only read operations are performed—meaning no data modifications or updates are made. In simpler terms, it's a transaction focused on retrieving information without altering it. This type of transaction is crucial in systems where consistent, isolated data views are needed for reporting, analytics, or general information retrieval without impacting concurrent data operations.

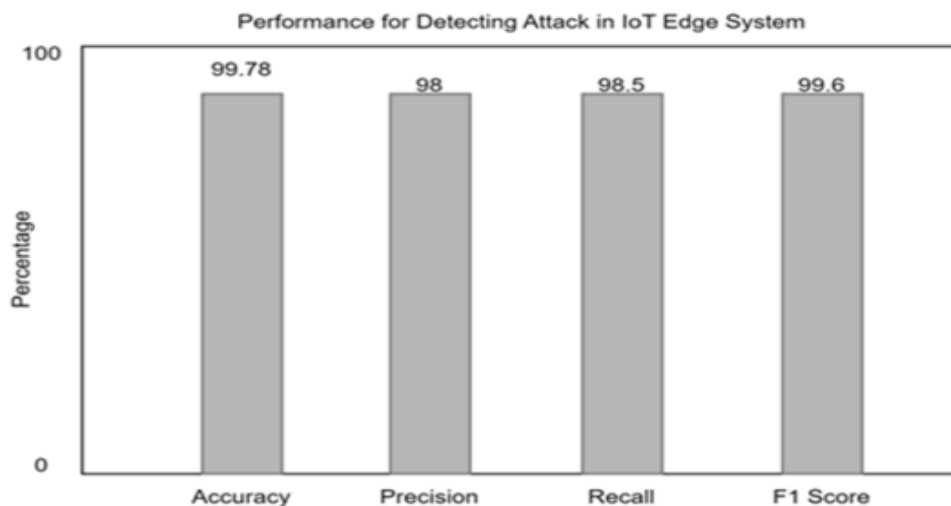


Figure3.4: Hybrid classification model performance

The above figure contains about the hybrid classification model combines multiple machine learning (ML) models or algorithms to improve overall classification accuracy, robustness, or other performance metrics. Hybrid models are often used when a single model cannot meet performance goals or when different types of data patterns need specialized handling. The performance of a hybrid model is generally evaluated on criteria such as accuracy, precision, recall, F1 score, computational efficiency, and robustness.

V. CONCLUSION

The suggested framework offers a comprehensive strategy for integrating cutting-edge technologies to transform the healthcare system. A comprehensive approach to improving patient privacy, medical data security, and system performance is provided by the integration of edge computing, distributed ledger technology, elliptic curve cryptography, and a hybrid machine learning model. Patient records are safely safeguarded by utilizing identity-based cryptosystems based on elliptic curve cryptography, guaranteeing data integrity and privacy preservation. The distributed ledger system's performance evaluation shows that it can manage large transaction volumes. The hybrid machine learning model's promising accuracy enhances the early detection and prediction capabilities, contributing to improved patient care. This multifaceted approach not only addresses the critical issues of dependability and data security but also fosters efficient and rapid information exchange among healthcare stakeholders. The integration of edge computing further enhances response times and network security. With the ever-increasing importance of data in healthcare, this framework holds the promise of significantly improving medical services, patient outcomes, and the overall healthcare ecosystem while providing a robust foundation for future research and development in the field.

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