Diabetics Management using IoT and Blockchain Technology

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Abstract: Diabetes is a widely prevalent medical condition affecting patients across geographies, ethnicities, and age groups. Though a lot of medication procedures have been in practice and have been proposed in the literature till now, each patient requires an optimized treatment of diabetic conditions based on his/her physical features and body chemistry. To achieve this, it is imperative to gather data on thousands of patients about their physical conditions and their body chemistry. This is now possible to obtain due to developments in Internet of Things that enable detection of multiple heath parameters (e.g. heartbeat rate, body temperature, pulse rate etc.) using technologies relying upon Internet of Things which allow gathering of info remotely and storing them in the cloud. However, the most important inhibiting because that prevents this gathering of data is distrust of the patients that their vital physical information falls into the hands of inimical elements with mal intentions. In this regard, blockchain technology might be utilized for increasing privacy of the info that has been shared by the patients for getting into the hands of nefarious actors. Hence, we aim to investigate currently proposed fog-computing network architectures that enable blockchain-based information sharing in healthcare organizations. The abstract should summarize the contents of the paper in short terms, i.e. 15–250 words.

Keywords: Latest Blockchain Technology, Internet of Things (IoT), Diabetes Management Technique, Home Healthcare System, Transferring File Security, Privacy Management.

1 Introduction

The world is suffering from the most common disease which is diabetes, and its care is highly important which needs necessitates regular self-care and management. Recently, modern technologies names as IoT for example wearables and medical sensors can be utilized for gathering measures and track health data for diabetic self-management [1][2][3]. IoT has a lot of potential in the healthcare sector, thanks to the rapid development of smart medical devices. The current approach relies on cloud servers for centralized communication. This architecture, on the other hand, raises security and privacy concerns [4]. A large quantity of data pertaining to diabetes and general health is often generated by individuals who have illness [5]. Due to complexity of patient medical information exchange across institutions, treating physician may not always have access to data they need. Medical studies and medication efficiency could both benefit from taking this challenge on [6].

Adhering to medical professionals' recommendations as well as alleviating symptoms may help prevent diabetes. Information obtained from many doctors to reduce diabetes symptoms can be stored in a Blockchain-based decentralized database. Patients who

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utilize blockchain get ownership of their medical records. [7]. Internet of Things is being used to create an environment in which a patient's vital parameters are communicated over a gateway to secure cloud-based platforms, wherein they are stored, collected, and evaluated. It also aids in the storage of data for thousands of patients with real-time analysis, encouraging an evidence-based care system [8]. It is proposed to create IoT CGM-based systemwhose gathered blood sugar sample values may be retrieved remotely, allowing for remote monitoring and warning of patients, particularly those who are dependent [9]. Research brought up topics such as managing electronic medical records, illness prediction, patient tracking, medication traceability, and combating infectious diseases, with a focus on COVID-19. [10]. Need for IoT increases their degree of participation in many types of modern healthcare equipment. However, various interconnected items have emerged recently to drastically increase attention to data security, resulting in the IoT revolution, which has raised a slew of concerns and issues regarding IoT in healthcare. Sensor devices will increase the risk of privacy and personal data security because their widespread use now permits data storing, with connection strengths make secure storage impossible [11].

Blockchain-based medical dataset exchange network in this study uses an off-chain storage option since it is more realistic. The blockchain network will not be able to hold critical medical [12]. Due to its unique qualities such as decentralization, transparency, immutability, data provenance, and cryptography, blockchain proved to be a promising technology [13]. IoT enabled by AI and the cloud improves operational efficiency and risk management. By strengthening existing products while expanding scalability, this combination develops new products and services. In the current technological landscape, data analytics in the cloud is much desired for cost reduction [14]. This model's architecture makes use of a web-centric [15]. The diabetic monitoring framework is critical for ensuring patient safety, particularly while utilizing IoT [16]. Because diabetes patients experience long-term and systematic suffering, it is vital to develop appropriate diabetes diagnosis and treatment procedures. Based on our thorough analysis, this paper divides those techniques into Diabetes 1.0 and Diabetes 2.0, both of which have networking and intelligence flaws [17] [18]. All patients want to live longer and healthier lives.

As a result, the notion of Big Data in the health industry could be combined to build successful solutions for this goal [19]. As a result, a simple approach to forecasting diabetics is required so that essential precautions can be taken ahead of time. We created a web-based diabetes prediction programme with this goal in mind, which allows users to diagnose the probability of the condition by entering correct data [20][21][22]. In recent years, IoT has been proposed as a viable option for e-health solutions.

2 Related works and Literature Review

This part summarizes few most recent works in electronics health and glucose management for diabetic type I and type II patients.

Azbeg et al. (2018) offered a platform architecture built upon IoT and Blockchain to make capture patient data and securely exchange it in near real-time, without compromising privacy of any patients [1].

Denning et al. (1984) designed the homomorphism structure of public key systems had proven to be the source of this vulnerability. A technique for thwarting the attack has been presented [2].

Alshorman et al. (2020) Internet of Things, develop practical ways to improve healthcare living facilities (IoMT) [3].

Fetjah et al. (2021) proposed the structure of a new healthcare system to remotely monitor health of patients. Architecture employs blockchain technology to assure security and anonymity. The three layers that make up the architecture. A trend based on a diabetic management system has been provided to validate the proposed approach. The design has been used to monitor diabetes patients remotely. [4].

Fagherazzi et al. (2019) looked at how diabetes digitalization affects all aspects of diabetes care, as well as supplements [5].

The goal behind this blockchain-based platform, according to Cichosz et al. (2019), is to leverage signature blockchain contracts for data control, data allocation, and data encryption to protect the privacy care data [6].

Bhardwaj et al. (2020) healthcare system. Mudra is a dynamic amorphous database with a motivation system that follows a variety of enduring lives [7].

Azbeg et al. (2021) classified a latest use case in the healthcare industry. The report also investigates the barriers to Blockchain adoption in healthcare IoT-enabled technology, as well as current solutions. [10].

Singh et al. (2021) looked at a variety of review studies to investigate safety and privacy of diabetics, the theoretical progress of IoT, and the underlying need for its usage in illness diagnosis. The framework allocated to Medical Internet of Things addresses risks and advantages of protection and privacy (M-IoT). This study is mostly concerned with diabetic illness [11].

Liu et al. (2021) discovered that the intervention group's change range was 6.04 per cent, while the control group's change range was only 3.26 per cent [12].

Hiwale et al. (2021) investigated the literature upon creating of privacy-preserving machine learning models for collective learning upon blockchain technology [13].

Rajeswari et al. (2022). Designing several AI approaches in Cloud datasets for IoT data analytics was emphasis of this project. Comparing current data with previous data to analyze, predict, and make decisions [14].

Mall et al. (2017) Software architecture is so simple that even someone with no prior knowledge of the platform can create a variety of apps. This can be accomplished by employing a multi-layer strategy based on the principles of autonomous service delivery and object virtualization [15].

Mathavan et al. (2021) proposed the framework can essentially assess diabetes patients and save data such as BS, IT, and surface place is just for assessing patients; it can also use artificial intelligence to organize data [16].

Chen et al. (2018) proposed platform for exchanging 5G-Smart Diabetes systems followed by offered tailored data analysis technique for 5G-Smart Diabetes. [17].

Chatrati et al. (2020) presented an alert to the patient's healthcare practitioner if any abnormalities are discovered. Hypertension and diabetes status are predicted using a combination of IoT and blockchain -algorithms [18].

Rghioui et al. (2019) High blood sugar and large glucose variations are avoided using the proposed approach. [19].

Kalia et al. (2021) determined diabetes, the prediction model used and evaluated different techniques such as K-nearest neighbors (KNN). Our web application's database system is built using My SQL, allowing users to log in and use system for personal purposes. XAMPP is used to deliver the full application. The web application is launched using the Python Flask framework [20].

3 Diabetes Self-Management

The main objective of monitoring the healthcare industry is changing result of rapid evolution and technological advancement. It makes use of assortment of technologies, like IoT and Blockchain being utilized in various applications connected to daily healthcare activities control is essential for living a healthy and happiest life. It's all about maintaining blood sugar levels close to normal to avoid complications from diabetes. Diabetes care is primarily self-managed, and it necessitates higher level of self-care as of meal planning, exercise, and regular blood glucose checks, among other things. The management can now benefit from technological improvements with the help of IoT devices such as a glucometer sensor to estimate glucose content in the blood. IoT can assist patients in keeping track of their medications, taking measurements, and sharing those measurements with their medical staff. Several IoT-based e-health apps for diabetes control have been proposed in recent years, although they still face certain challenges. Fig 1 shows the first type of diabetics.

3.1 Overview of Blockchain and IoT

Blockchain technology has become more popular because Bitcoin was invented in 1980. It is referred to as a "new trust notion." It is one of the network-based technologies enabling transaction transmission and storage. Blockchain is a system including decentralization, immutability, transparency, cryptography, consensus algorithms, and smart contracts. Blockchain is classified as types A. permissionless and B. permission. Decentralization, anonymity, and security are 3 crucial aspects of Blockchain that benefit healthcare applications. Several potential difficulties in the healthcare industry must be examined when using Blockchain-based solutions. IoT allows sensors to be integrated in physical items that can collect health data like vital signs. These Internet-connected devices can share data and offer medical personnel with real-time health information. In the expanding healthcare industry, IoT has emerged as an important source of medical data.

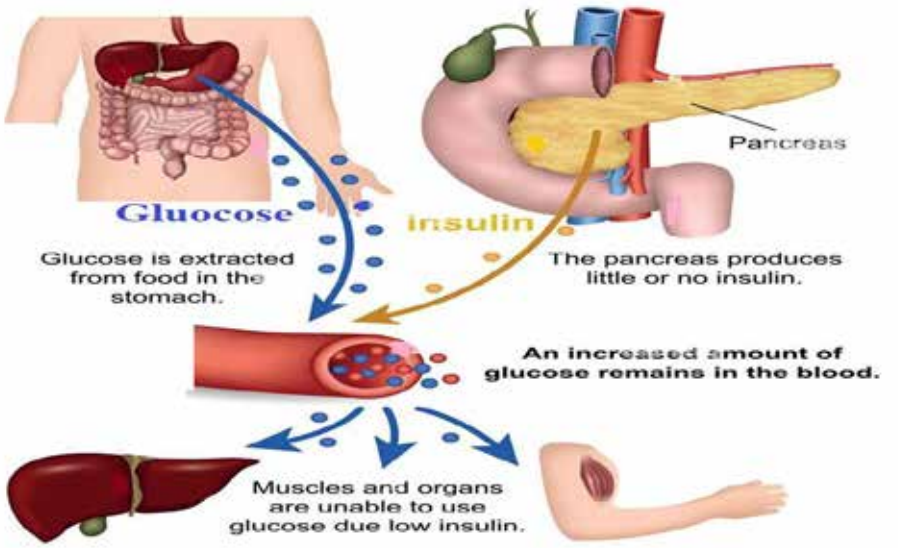

Fig. 1. Type 1 Diabetics.

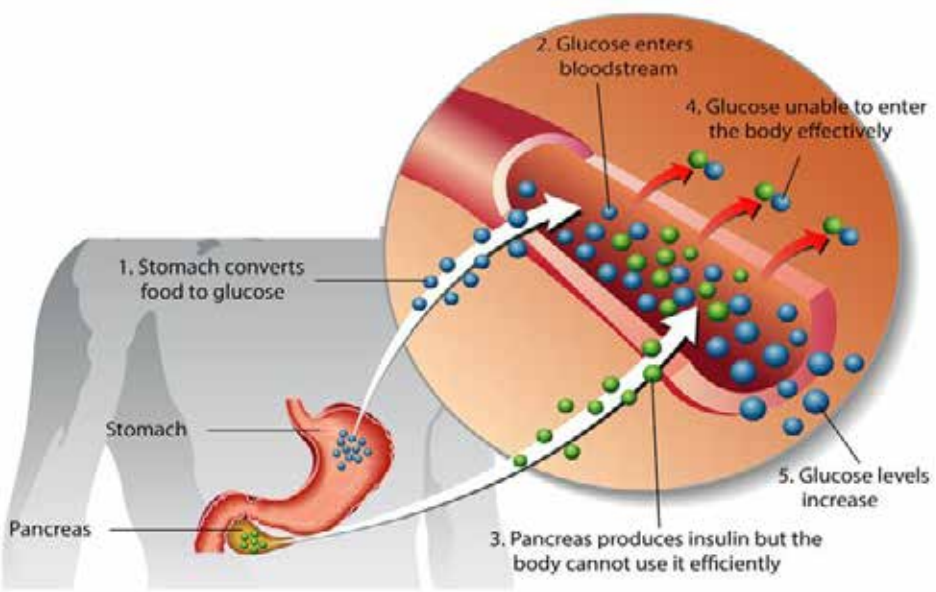

Fig. 2. Type 2 Diabetics.

Here Type 2 diabetes is depicted in figure 2 with a self-explanatory image.

4 Proposed Method

4.1 Proof of Work (PoW) Algorithm

Majority of algorithms rely on proof of work. Cryptocurrencies like Bitcoin and Ethereum employ this algorithm, albeit they are distinct from one another. Proof of Work (PoW) was first proposed by Cynthia Dwork and Moni Naor in 1993 and subsequently implemented by Satoshi Nakamoto in an article on Bitcoin in 2008. To reach a consensus, most circulating cryptocurrencies use Proof of Work. Markus Jakobsson and Ari Juels coined the phrase "proof of work" in a 1999 paper.

The idea: A solution that is challenging to discover yet simple to confirm. In a system where nodes do not trust each other, the goal of using IoT for diabetes control is to get all the nodes to agree, or trust each other. Upon completion of all transactions included inside, new block is then uploaded to the network. To avoid confusion, remember this block will be added to longest chain. The name "Proof-of-Work" is derived from the fact that network nodes known as "miners" do computational labor to solve a complex mathematical problem for the purpose to add a block to the network. The mathematical issue becomes increasingly complicated as time goes on. Below, you will find the following detailed steps: The proof of work design flow as portrayed into Fig 2.

Step1: In proposed method the patients can use their smartphones to feed their details, more ever the smart watches.
Step 2: Sample Collection by Health Organizer.
Step 3: Passing Sample /Information using IoT Gateways or Physical Handover
Step 4: Blockchain and IOT-enabled technology has been used.

Based on components presented in Fig 3, an early proof-of-concept version of the proposed system was implemented using the following. Fig 4 displays the structure of the integrated system for managing diabetes in patients

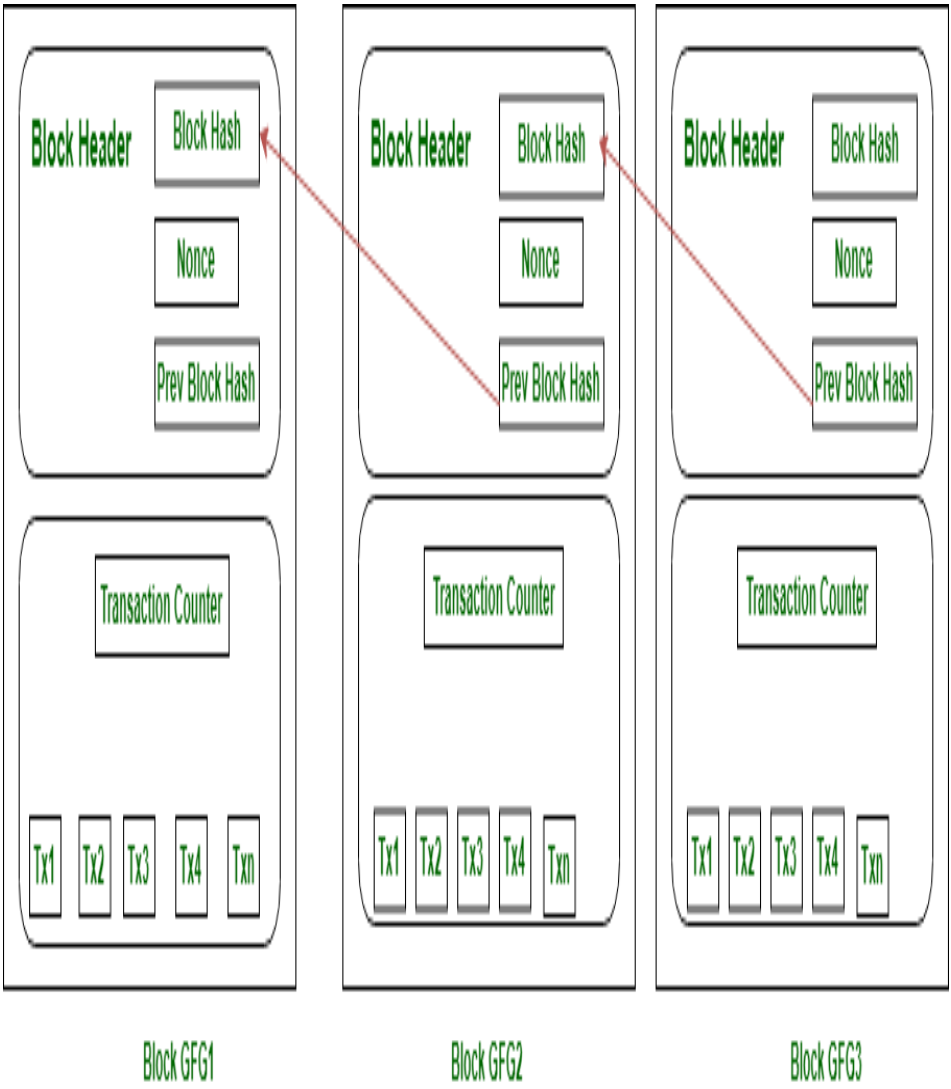

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Fig. 3. Design Flow of Proof of Work.

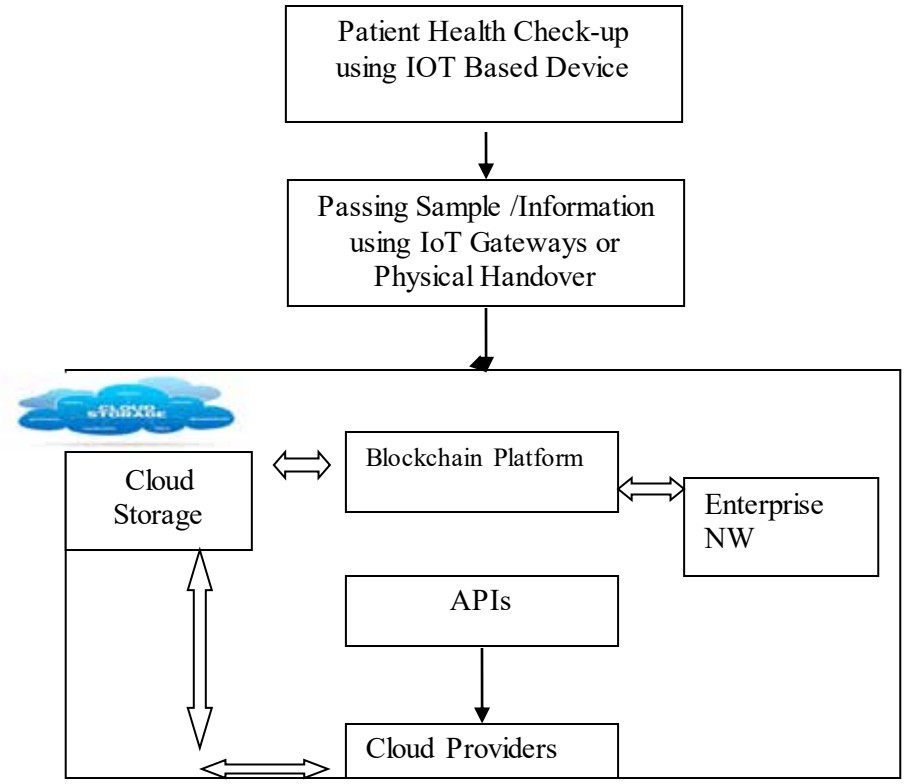

Fig. 4. Design Flow of the framework of the for-patient Diabetes disease management.

5 Result and Discussions

The findings of diabetic patient analysis pointed to a broad range of blockchain utilities as well as technical variations in the methods used to create a blockchain [3-10]; In Fig 5 discusses about blood sugar level variation. In the Fig 6 represents about hemoglobin a1c level chart. In Fig 7 represents Python code for average response in a cloud server. In Fig 8 represents Python code for average response in cloud server real data. In Fig 9 represents python code in cloud server real data for replicating and fetching.

Python Code for Average Response in Cloud server

```
x = np.array([64, 1000, 2000, 3000,4000])
y = np.array([2.5, 2.2, 2.0, 2.8,1.5])
plt.plot(x, y)
xl = [64, 1000, 2000, 3000,4000]
y1 = [4.8, 4.5, 4, 3.5,3.5]
plt.plot(xl, y1, '-.')
plt.xlabel(" Payload Size in Byte")
plt.ylabel(" Average request time per second")
```

```
plt.title('Average response time s')
plt.show()
plt.savefig('plot.png', dpi=750, bbox_inches='tight')
```

Python Code for Average Response in Cloud server whenever real data

```
x = np.array([0, 50, 100, 150,200,250,300,350,400])
y = np.array([0, 50, 100, 95,101,95,85,55,55])
plt.plot(x, y, '-.')
x1 = [0, 50, 100, 150,200,250,300,350,400]
y1 = [0, 50, 100, 150,200,250,300,200,170]
plt.plot(x1, y1, '-.')
plt.legend(["blue", "green"], loc ="lower right")
plt.xlabel(" desired rate per second")
plt.ylabel(" Real rate per second")
plt.title('Average response time of cloud nodes')
plt.show()
plt.savefig('plot_new.png', dpi=750, bbox_inches='tight')
```

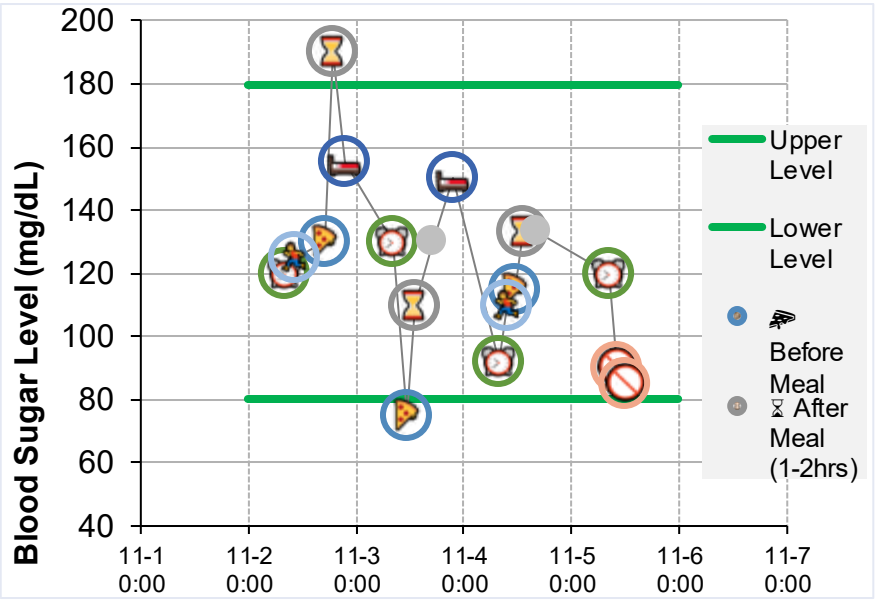

Fig. 5. Blood Sugar Level Variation.

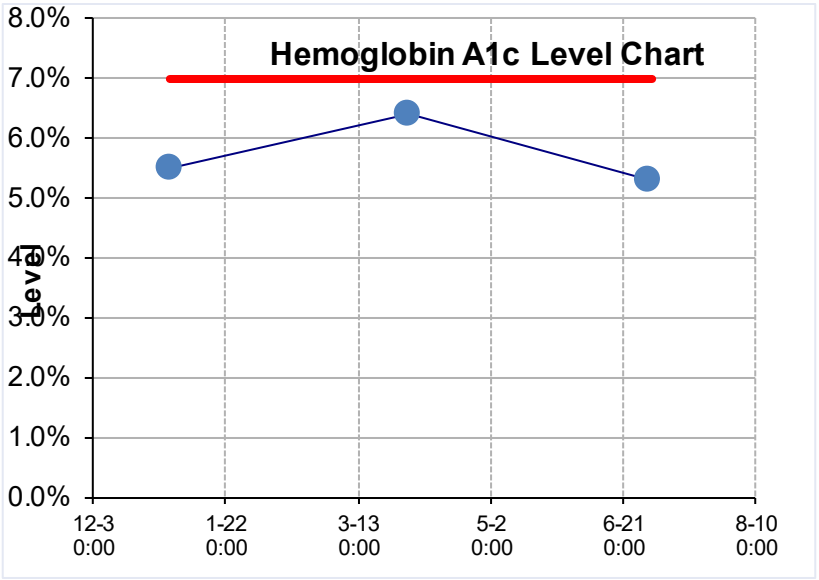

Fig. 6. Hemoglobin A1c Level Chart.

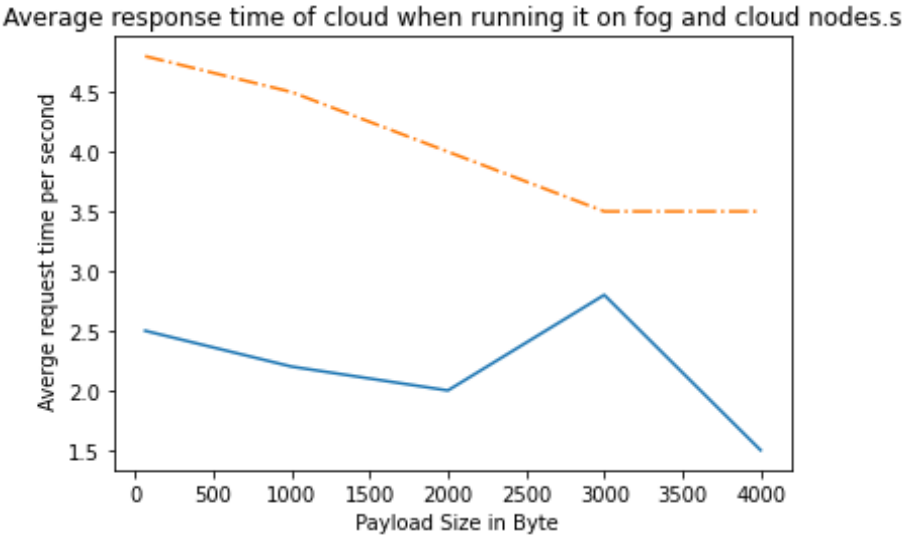

Fig. 7. Python code for average response in a cloud server.

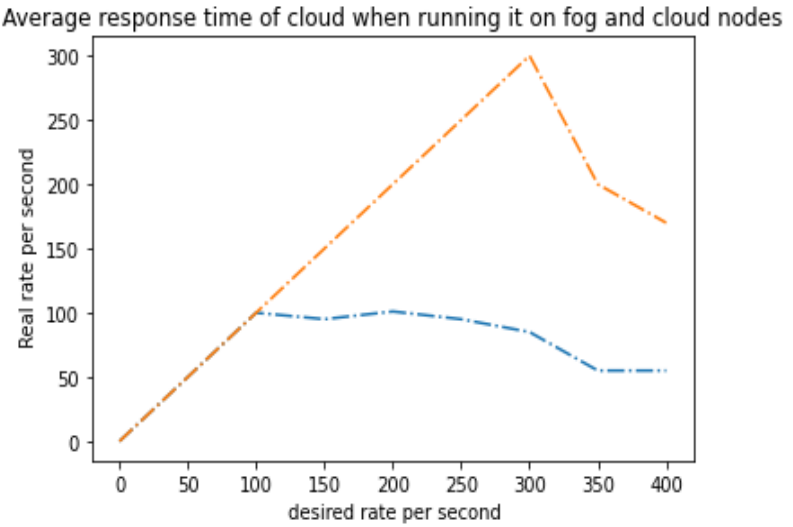

Fig. 8. Python Code for Average Response in Cloud server Real Data.

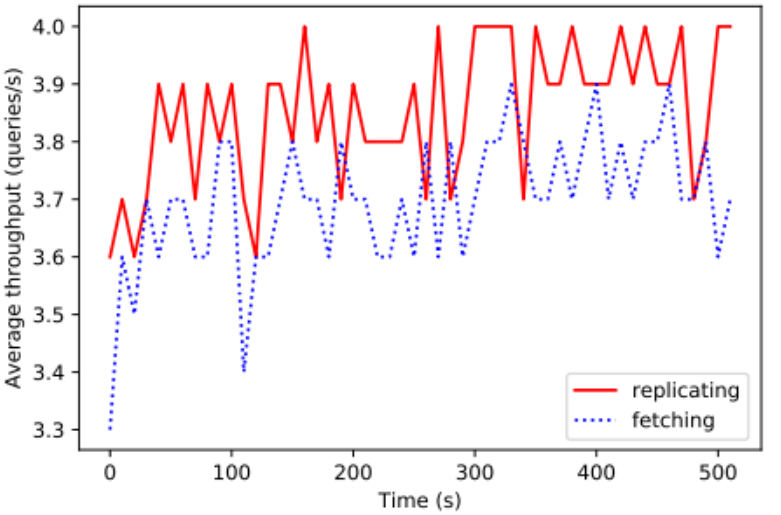

Fig. 9. Python Code in Cloud server Real Data for replicating and fetching.

6 Conclusion

It is noticed that a design of a "Proof of Work" algorithm and corresponding network architectures for running a decentralized data-storage system to set up a community that will safely share health information by associated patients and their related hospitals. The proposed algorithms can be able to efficiently handle redundancies in the system that will be able to handle multi-pronged cyber-attacks and simultaneous

multiple infrastructure failures. The healthcare industry is changing regularly because of rapid evolution and technological advancement. It makes use of a different number of technologies, including the modern IoT and Blockchain.

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