Patient Health Informatics System using Cloud computing and IoT

M. Jafar Sathick Ali, Jayakumar Kaliappan, R. Lokeshkumar

Abstract: ***With the development in technology, health care is developing both in its technicality as well as in its organization. In present day, the patient data storage is of our greatest concern, as it has to be convenient for the doctor to access at the time of emergency. The most important properties of the patient informatics are - it should be accessible by the doctors to check the medical history of the patients in order to suggest any prescription, it should be accessible to the patient medical informatics even when the patient is unconscious, should be compatible and spontaneous to any updates in the data, all this data should be stored at a centralized pool or storage, also latency and response time should be less with high performance and accuracy. With all these specifications in concern, there comes a need to develop a system which has huge storage (cloud) which accessible from any hospital, an immediate collector (storage) of sensor data which takes in the updates at sensor, actuators--things level (Edge) as well as at network level (Fog). This system therefore has high performance due to reduced latency and response time with an authorized access and security to the patient informatics.***

Index Terms*: *Cloud Storage, Patient data, Fingerprint sensor, Edge, Fog.

I. INTRODUCTION

During medical emergencies, a doctor can't delay the treatment due to insufficient information of that particular patient. In order to overcome this issue, there is a need to develop a remote cloud database which contains the medical records of the individuals, with which any doctor can access their information and start the treatment. The previous work on this topic included usage of Bluetooth technology, real-time monitoring system, wearable devices, and RFID tags. But as we know that a patient won't be in reach of all these always, especially at the time of emergencies that is where this fingerprint module will make this project very reliable. Keeping in mind the severity at the time of emergency, in case of an immediate treatment the doctor needs to know his patient's health condition. The doctor should be able to access the medical record of the patient on the fingertips. The patient may become unconscious at times it is convenient for the doctor to access his/her medical history just by scanning the patient's fingerprint

I. LITERATURE SURVEY

Understanding the situation of emergency, the implementation is made with the more handy service which facilitates the patients at the time of emergency. In this paper [1], mobile application is used. The mobile application provides the facilities of appointment generations, slot booking, doctor free hours and equipment's availability. The information is readily accessible by the doctors and updates can be made spontaneously without the lapse of time.

Keeping the patient data security in concern, using a unique identification has become more essential. In this attempt in the paper [2], the author has reviewed the existing healthcare architecture systems and proposed a new way of healthcare monitoring service of a patient remotely with pharmacy medicine delivery using RFID tags. For secure authentication, RFID card is provided for the patient in order to place order for medicine and receive the delivery of medicine, emergency services are also available in terms of the wearable technology devices data from patient real time analysis. After scanning the tag, there is a need to store/ access the data to/from cloud. To interpret and understand this data, the author of this paper [3], focused on the data analysis on cloud and presented an IoT architecture customized to deal with the data in healthcare applications. The proposed system of architecture collects the data from the sensor/user interface and transmits it on to the cloud where it is identified, processed, analyzed, understood and stored for further implementation. The results of basic performance evaluation metrics have exhibited the accuracy and efficiency of the proposed system, even when it is a cost efficient system.

Diving deep into the data of the patient, it is made convenient and customized to the patient's visualization. In the paper [4], the author has identified and clearly emphasized both the opportunities as well as challenges for Internet of Things, realizing its scope in the future of health care field. Highly intelligent equipment such as wearable sensors offers a lot of options to enable observation and recording of data at home for real time usage. This data when analyzed by scientists emphasized numerous challenges in the field of sensor analytics, as well as sensor data visualization and interpretation that needs to be identified and dealt with before designing the systems for consistent and coherent integration into medical practice. The goal of this paper [5] is to develop an architecture based on ontology efficient enough for monitoring the health and workout routine recommendations to

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patients with persistent diseases. This system is used as a substitute that will be used in helping patients affected with chronic diseases. Also, it is a solution with an aim to enhance the quality of life for the patients by improving and monitoring their food and workout routines. This paper [6] uses microcontrollers as a gateway to communicate and interpret the sensor data. Optimization of the data that is collected using various physical devices is of most significant. Introducing the more and more sensors and actuators can make the data collection easy. However updating the feedbacks and prescriptions was quite restricted to the doctor who has the RFID tag, this became inconvenient because there was constant need for scanning the tag for any modification. So introduction of more effective and efficient fingerprint scanner as one of the physical device adds up to deal with the authentication and during emergency purposes. It uses the temperature sensor and pulse oximeter sensor. The sensor data from the sensors is captured by the microcontroller and it is sent to the network in connectivity all the way through Wi-Fi. This facilitates the real time observation on the health parametric measures such as heartbeat, BP, Pulse rate etc. It also provides a buzzer alert to the caretaker. And these are also used for authentication and security purposes. The variations in the sensor output imply the fluctuations in health parameters. The doctor as well as the patient can access website which contains the details about the patient health and previous medical complaints.

Focusing on the data storage and retrieval, desire to look and switch for smart, centralized, authenticated cloud service/ cloud platform is rising up. In this paper [7], the author talks about the advantages of using Fog computing with IOT. This paradigm is a classical centralized cloud computing paradigm which faced various most challenged aspects like high latency, incompatibly lower capacity and failure in network. In order to address such challenges, fog/edge computing facilitates in bringing the cloud closer to the IoT devices. The most significant advantage of the fog is to provide IoT data pre-processing and IoT data storage at IoT devices, locally, instead of sending this data to the cloud. Contrary to the cloud server, the fog gives service with more rapid response and higher quality. For that reason, fog computing is believed the preeminent alternative to enable IoT to provide more effective and highly secure services for countless IoT clients. And hence in the above mentioned paper, there is a quick understanding of state-of-art of fog computing along with its integration with the Internet of Things devices. Also, discusses about the advantages, implementation challenges and issues.

As it is identified that Fog/Edge Computing would serve our necessity, a further research and understanding is seen in this paper [8]. The author discusses about Fog/Edge Computing-based IoT's (FECIoT) distributed architecture which augments the service provision alongside the Cloud-to-Things range, in so doing making it appropriate for task-critical applications. Moreover, the proximity of fog/edge devices to the actual location where the data is generated makes it be prominent in terms of resource allocation, service delivery, and privacy. From the perspective of business and marketing, FECIoT will direct to a boom and spring up of small-to-medium-sized enterprises (SMEs), thus encouraging enclosure for all. This paper is a comprehensive review on state-of-art on IoT literature over the period 2008-2018 and proposes the FECIoT framework which includes the enabling technologies, services, and open research issues. In this paper [7], computational model based on a 2 level architecture is proposed i.e. edge and fog levels. These 2 levels provide designing and developing a set of unique services based on new sort of functional information generated with the captured data by making use of embedded system devices at edge nodes as well as fog nodes. The Edge nodes/Fog nodes use a cloud platform service and IoT protocols namely Message Queuing Telemetry Transport. This Message Queuing Telemetry Transport protocol is proposed and researched as the communication level protocol flanked by diverse computing layers such as fog–edge, edge–cloud, fog–cloud etc. The cloud service platform is in order to develop a console with information panels, set to latest services on the Internet such as control, storage and communication actions. This platform is used in delivering diverse services by means of an API. This proposed system can develop these services in already existing and upcoming models.

I. PROPOSED METHODOLOGY

Before proposing a system, it is essential to understand the requirements and functionalities of the system.

Identifying patient data

The first and foremost step is to identify the type of data doctor requires in order to examine the patient. This data consists of patients' general medical details like name, age, height, weight and blood group, blood pressure, etc., patients' physical examination which covers basic systems like heart system, lung system, gut system and nerve system examination and additional examination data depending upon specific clinical scenario. Each system has different parameters and terminology. The values of the parameters along with units have to be clearly mentioned while storing/updating the data.

Obtaining patient data

Once the parameters are identified, in order to create a patient record we need to get data from datasets. For our experiment purpose the medical datasets from online repositories are taken. And for each medical record a random fingerprint is added from fingerprint datasets.

Extracting and storing patient data

After obtaining the datasets, the data obtained may be in a relational database or a NOSQL database. In order to reduce the complexity of the records, easy storage and retrieval of data, it is better to convert out database into NOSQL database. The concept of conceptual mapping is helpful in order to convert data in Relational database to NOSQL data storage.

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The implementation is done in 4 phases of work.

Phase-1 Developing a web portal, making it convenient for user to register, update and consult doctors and patients. Authorization and authentication are the biggest constraints.

The web portal was build using HTML, PHP and CSS. The validation was done using JavaScript.

Phase-2 Choosing the appropriate cloud storage

We are dealing with a number of patients and doctors across various hospitals simultaneously, there is a need for a real time storage system. Firebase real-time storage is used to satisfy above mentioned properties.

1) Firebase is a NoSQL database. It doesn't contain any tables in it. The dates can be easily updated, modified or deleted by an authorized person.
2) The patient ID is assigned to be the primary key.
3) The portal can be accessed by the doctors and patients using their login credentials.
4) The doctor's login page contains his personal information, on-going patients list and a search option to search for other patients and fetch their medicals history.
5) The patient's login page contains their personal information, on-going medication and their medical history.
6) The web portal makes it convenient for the user to register, update and consult doctors and patients. Authorization and authentication are the biggest constraints.

Phase-3 Fingerprint module. Keeping in mind the data security and medical emergencies, for authorized usage and immediate treatments, respectively, identification through fingerprint scanning is developed.

1) We use the fingerprint module in order to deal with security issues.
2) Fingerprint identification is used in order to retrieve data of particular individuals during emergencies.
3) Finally, when the individual components are done we integrate it together.

Phase-4 Integration of the phases -- By connecting the hardware and IoT devices to the cloud along with the portal to develop a fully functioning Patient Health Informatics System.

The fingerprint system is connected to the cloud database using python program. For connecting the python with arduino py-serial library is used and for connecting firebase with python python-firebase library is used.

Understanding the requirements, we illustrated how and what our system should implement. The architecture diagram gives us an overview of how the user requirements are met and how the implementations are made. In the given architecture, the patient can access the website through his mobile as well as system, as it a web portal. Similarly, the doctor can access the website through his mobile as well as system, as it a web portal.

Patient can access his profile page, his medical history and doctor details. Doctor can access his profile page, particular patient's medical history (through fingerprint authentication) and general medical details.

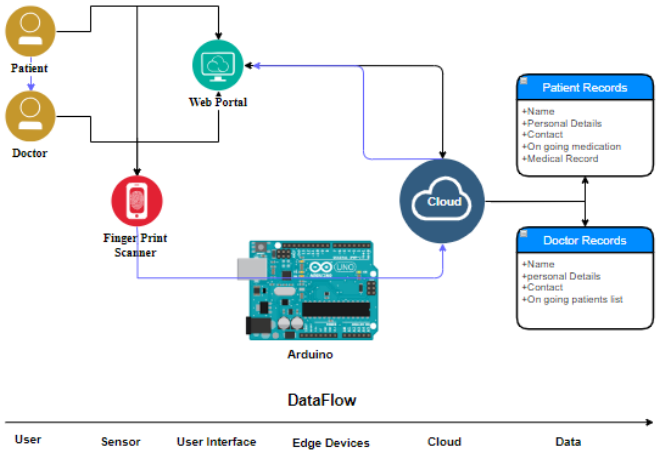

Fig1: Proposed system Architecture Diagram

Doctor can access patient's medical history, he can view prescriptions by previous doctor, and however, he can just add current treatments prescription.

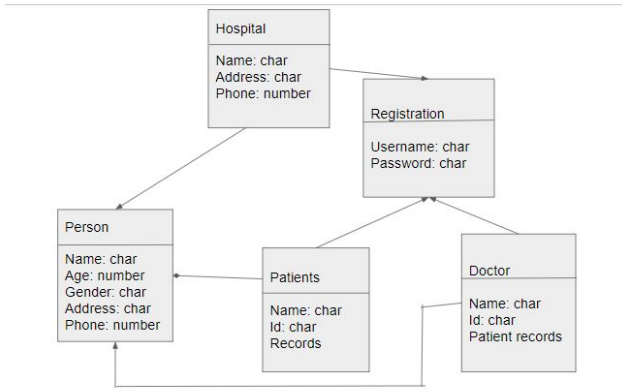

Fig 2 UML diagram

I. RESULTS AND DISCUSSION

As the above implementation has three modules, we have three levels at which we get partially results.

Module 1 represents the web page login creation

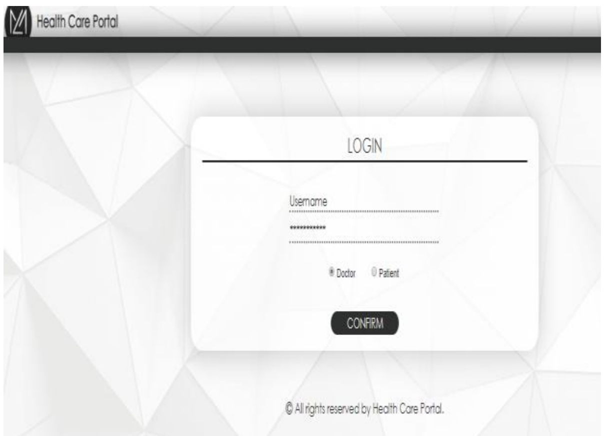

Fig 3 Web portal (Login page)

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Module 2 represents the cloud connectivity and storage

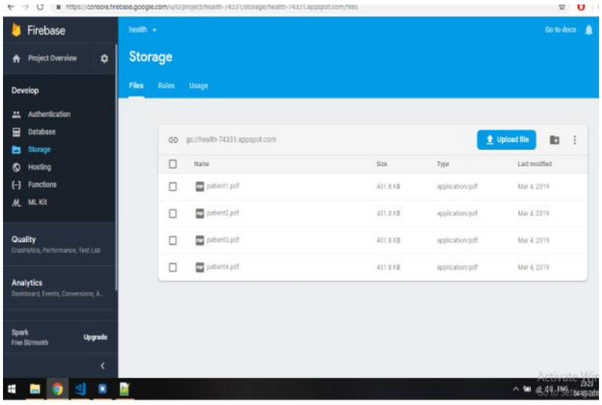


Fig 4 Patient history Records

Module 3 represents fingerprint module enrollment and matching and data retrieval

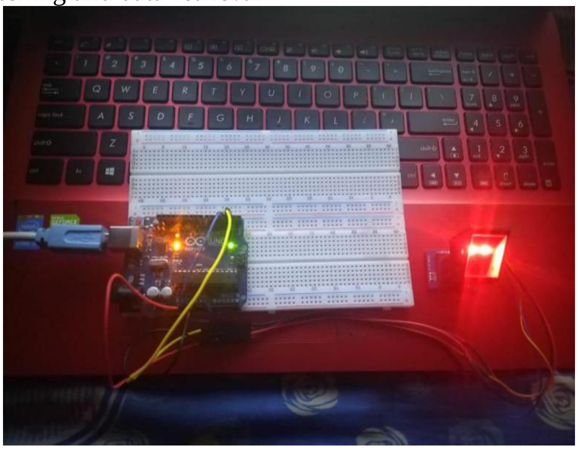
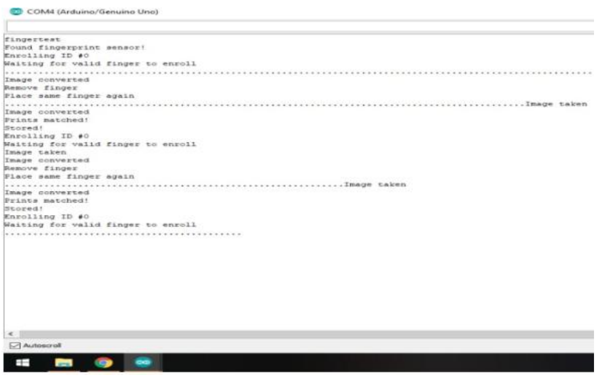


Fig 5 Fingerprint module



Accessing the medical history details of the person by with the help of the patients fingerprint scanning.

Fig 6 Record fetch after scanning fingerprint

II. CONCLUSION

The Patient Health Informatics system developed, here, is a centralized cloud storage system which can be accessed by anyone with proper authentication. With the help of the fingerprint module an authorized person can retrieve a person's medical record at the time of emergency. This project helps in maintaining a centralized medical history record for a particular individual which helps the doctor to know the complete medical history and the treatments that patient had previously undergone. This model can further be developed across related sectors/field. For example, viewing the medical records of the patient, certain banks can pay the bills for the expensive operations the patient had to undergo. Insurance companies can give sanctions understanding the severity of the disease or patient. But there has to be proper authentication and confidentiality for accessing the patient data. It has to be used among various hospitals to maintain a proper record eliminating duplication of the individual's medical record.

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