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IoT BASED ADVANCED HEALTHCARE ARCHITECTURE: A NEW APPROACH

Ahmed Shafkat[1], Ashik Hider Ankon[2], Mohammad Golam Sarwar Bhuyan[3]

[1,2]*Student, Dept. of CSE, Bangladesh Army University of Engineering and Technology, Natore, Bangladesh*
[3]*Associate Professor, Dept. of CSE, Bangladesh Army University of Engineering and Technology, Natore, Bangladesh*

Abstract - *Internet of Thing (IoT) is the most groundbreaking concept of this era that is leading the world toward total automation. The application of IoT in health care have inaugurated a new epoch that brought evolution in real time health monitoring. This paper proposed an advanced health care system architecture with remote monitoring that includes some new sensors, big data handling technique, diseases prediction feature, location tracking for weather report and some home appliance control feature for patient's betterment which makes our system advanced and unique. Through website or using android application doctor and relatives of patient or other authorized person can monitor the patient's health from remote location. To handle heterogeneous big data generated by sensors, proposed architecture used NoSQL database for efficient storage and fog computing for real-time prediction or decision making.*

Key Words: *IoT; Remote monitoring; Big data; Fog computing; NosSQL.*

1. INTRODUCTION

The Internet of Things (IoT), sometimes referred to as the Internet of object, will change every things including our life style [1]. The concept of each and every object or device connected to internet that can exchange information and interoperate through machine to machine communication is known as IoT. In different time various model have been proposed for IoT based healthcare system. By studying particular system, this paper proposed a combined IoT based healthcare architecture with some new concepts for better security, real time analyzing, long term efficient storage and scalability. In proposed system, Raspberry pi is connected to E-health sensors along with some other sensors which collects data, send them to fog, receive data as well as control the home appliance and buzzer. Sensors used in the architecture continuously generate enormous heterogeneous data which is often called as big data. It is very difficult to analyze and process heterogeneous big data. To overcome this difficulty this paper includes a layer based fog architecture. With big data handling techniques, this proposed system can analyze data as well as predict potential complexity according to collected data from sensors, weather report of patient's location and personal information. This system can show data and result through LCD display and role based user authentication website or android application. It also can generate alarm, SMS and Email as per need. By analyzing data, Raspberry pi can control home appliance automatically according to necessity of the patient.

The rest of this paper is written as follows. Section 2 describes some related work on IoT based healthcare architecture and section 3 introduced proposed system architecture. In section 4, conclusions and future work of this paper is described.

2. RELATED WORKS

Jayeeta Saha et al. [2] has proposed Advanced IOT Based Combined Remote Health Monitoring, Home Automation and Alarm System which can ascertain the size of saline levels, blood pressure, respiration rate, body temperature, body movement and heart rate of a patient. This model use Raspberry Pi to collect data from sensors and stores that to cloud. SMS & Email alert, role based authentication and one home appliance controlling feature have been added on that paper.

Yin Zhang [3] has described Healthcare Cyber-Physical System Assisted by Cloud and Big Data. To handle health data paper proposed collection layer consists of data nodes and adapters, a data management layer for storing the data and application service layer to provide analysis results.

S.M. Riazul Islam et al. [4] proposed a framework for health prescription assistant to remote monitoring a patient. User authentication and protected access to resources and services also designed for better security with the help of OpenID standard. A two-phase process for performing authorization model is also shown in the paper.

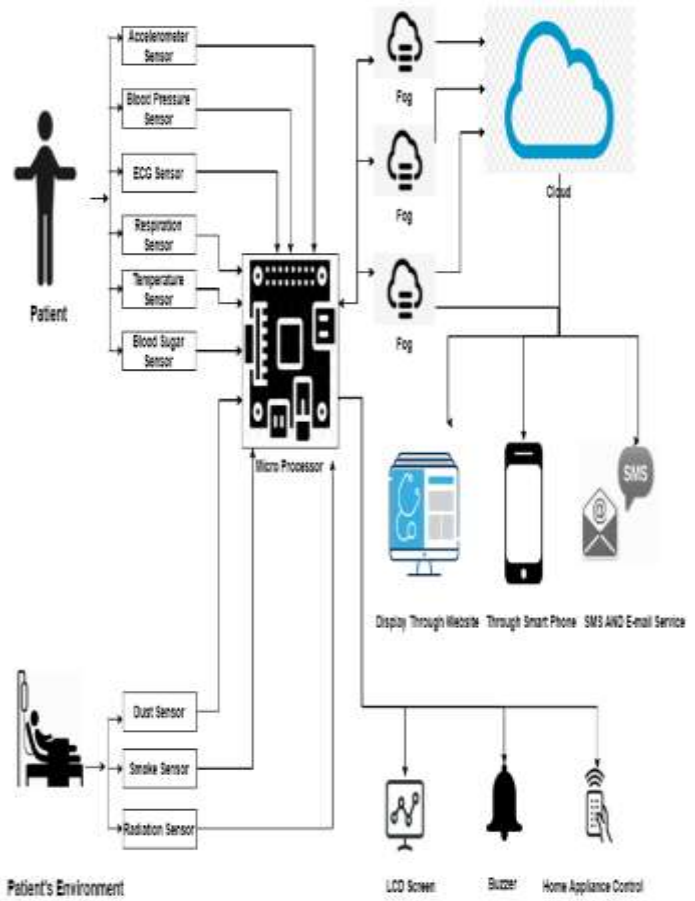
Boyi Xu et al. [5] has designed a m-Health monitoring system based on a cloud computing platform with a aim to treatment complex diseases in a low cost. The paper proposed an architecture divided into cloud storage and multiple tenants access control layer, healthcare data annotation layer, and healthcare data analysis layer for handling heterogeneous data to make analysis result.

Min Chen et al. [6] has proposed a wearable 2.0 with the purpose of remitting the disadvantage of present health care system. Paper define a smart clothing containing sensors and big data analysis on cloud. The paper focus on improving quality of experience and quality of service.

3. PROPOSED ARCHITECTURE

Proposed architecture divided into three parts. Section 3.1 portrays sensor integration part, section 3.2 describes microprocessor part and section 3.3 defines Storage, User interface and Analysis part of the system.

Fig -1: Block diagram of proposed architecture.



3.1. Sensor Integration

In previous models of IoT based healthcare system, many sensors especially e-health sensors have been used. However the proposed architecture introduce some new sensors in physical layer that will bring radical change in healthcare model, research and analysis. In sensor integration portion total nine sensors have been used for data collection from patient's body and surrounding. This sensors can be categorized into two categories as follows.

A) Body Sensors

. Body sensors will be connected directly to the patient's body area network (BAN). In this category, six sensors have been used to get data continuously from patient's body.

I. Accelerometer Sensor

Accelerometer sensor have been introduced to the architecture to detect acceleration forces of patient subject to x, y and z axes.

II. Blood Pressure Sensor

To measure systolic, diastolic and mean arterial pressure blood pressure sensor has been used.

III. ECG(Electro Cardio Gram) Sensor

In proposed architecture ECG sensor have been used as diagnostic tool for accessing heart muscle function and measure heart rate.

IV. Respiration Sensor

Respiration sensor have been utilized to determine respiration rate from breath waveform.

V. Body Temperature sensor

This sensor have been used to measure patient's body temperature.

VI. Blood Sugar Sensor

Blood sugar sensor measure glucose level in fluid around the cell of human body.

B) Environment Sensor

Environment sensor have been included into the architecture to get knowledge about patient's environment. For instance, in individuals who have hyper sensitivity and asthma manifestations can be activated by taking substances called allergens or triggers. It is vital to know one's triggers. Dust is a typical trigger [7]. Hence environment data is crucial for further analysis, better treatment and alarming. IoT based Advanced Healthcare Architecture comprise three environment sensors.

I. Dust Sensor

Dust sensor measures air quality based on dust concentration as well as identifies asthma triggers.

II. Radiation Sensor

Radiation sensor identifies degree of radiation in it's environment.

III. Smoke Sensor

Smoke sensor senses smoke which might be dangerous for a patient and detects fire of surrounding. It also admonish user at any abnormal situation.

This physical layer integrated sensor network provide sensor data to microprocessor.

3.2. Microprocessor

In proposed system a microprocessor is used to collect data from sensors, make real time decision, take actions and send data to fog. In this article, latest version of Raspberry Pi (Microprocessor) that is Raspberry Pi 3 Model B+ has been proposed. Python programming language is used to

configure decision support system of Raspberry Pi. In this case Raspberry Pi is connected to the network edge through Wi-Fi and it sends collected data to the fog continuously. Exact location of the system can be tracked based on IP address. LCD screen, buzzer, home appliance are also connected to the microprocessor. LCD screen is used to display data that has been sensed by sensors. If any problem or critical situation occurs then the microprocessor will buzz the buzzer. Raspberry pi is also responsible for controlling the home appliance. For example, a patient is suddenly suffering from fever then he will feel cold and according to patient's need the microcontroller will turn off the air condition or fan. Figure 2 shows a flowchart for real-time decision making in physical layer as an example.

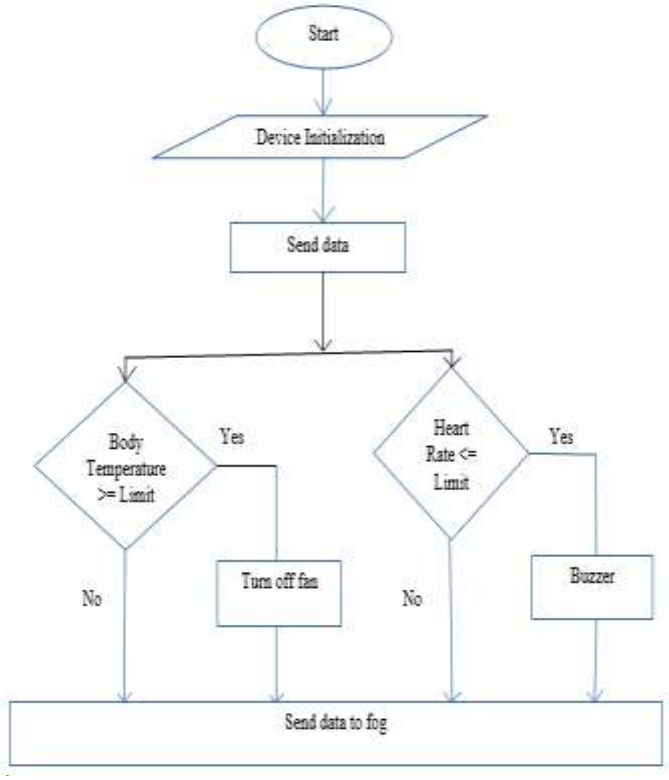


Fig -2: Decision making flowchart of microprocessor.

3.3. Storage, User Interface and analysis part

Fig: 3 represents the layered architecture of this part. Proposed architecture is divided into five layers. Fog layer stores every kind of data related to the system those are in structured, semi-structured or unstructured way. Data preprocessing layer process and groups all these data according to need. Analysis layer applies different procedure and algorithm to make decision. After that cloud layer stores reduced data received from previous layer and do further analysis. Top most layer is application layer, users interact with the system through this layer.

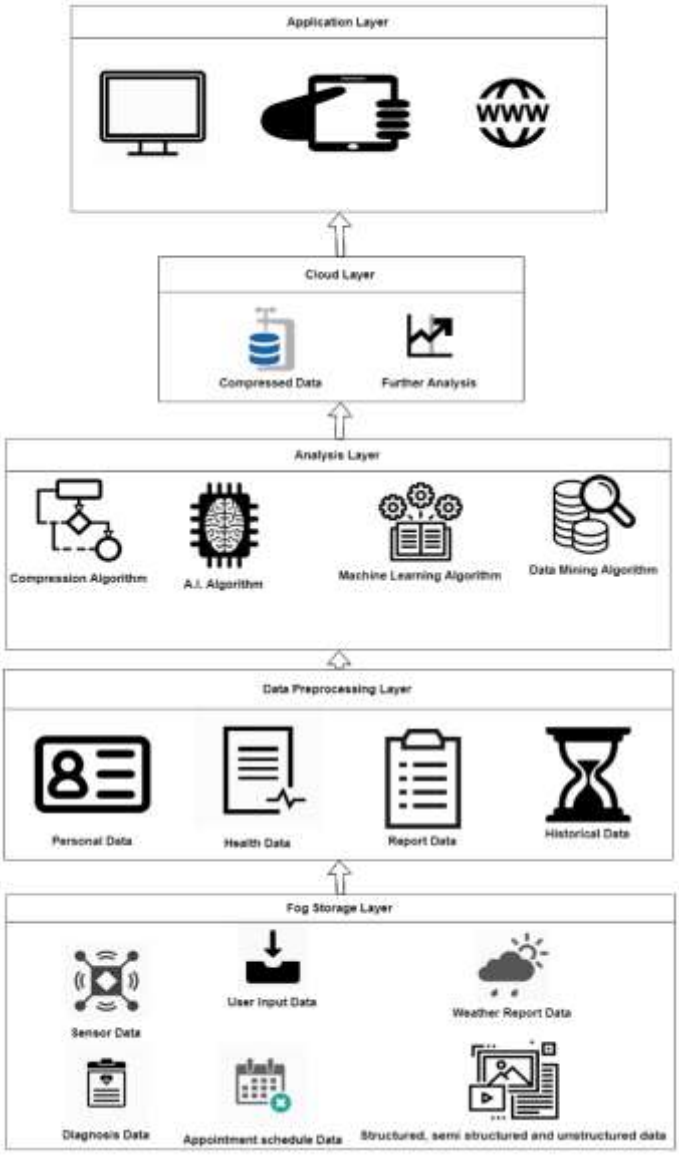


Fig 3: Layered Architecture of Storage, User Interface and Analysis part

A) Storage

All sensors will generate tremendous amount of data 24×7. Fog computing is used for improving the efficiency and to reduce the volume of data that needs to be transferred from the physical devices to the cloud. Fog stores sensor data, patient or user personal data, weather data of that location. These data are very crucial for patient, hospitals, public health, research institutions, network operator, financial institution, device manufacturer, drug maker etc. [3]. These heterogeneous big data handling is a challenging task. Conventional distributed computing models move the whole data from the system edge to the server, causing more dormancy. Also, cloud servers just deal with IP, not with the endless different protocols utilized by IoT gadgets. So using Fog in IoT based system is secured and time efficient. Proposed architecture used NoSQL database because weakness have been shown in managing large amount of data by relational databases, noticeably to get horizontal scalability [9]. NoSQL databases is used with the intention to handle big amount of data, providing auto scaling, better

performance, and high availability [10]. Based on scalability, real time processing, security, spatial data handling and data aggregation, Couchbase shows better performance among other NoSQL databases [11] which has been proposed for the architecture.

B) User Interface

Based on different user and their interaction with different medium, three different user interfaces has been proposed in this paper.

I. LCD display

LCD display is connected with microprocessor which will show the data that are continuously sensing by sensors.

II. Website and Android Application

Doctors and care giver of patient's can observe patients health condition details and predictive analysis through website and android application. Proposed architecture includes Identity Provider system for better security. Identity provider will provide user authentication to users (doctor, patient and care giver of patient). Additionally a system named Authentication Controller delivers role based login service. This role based system comes up with more security. This paper also includes DOS attack tackling algorithm for ensure safety. A patient's personal information, treatment details, diagnosis reports, appointment schedule can be entered by authorized user through these interfaces.

C) Analysis

Analysis layer applies unique techniques to make more accurate prediction, effective decision making and efficient storage. For better analysis result different data mining and machine learning algorithms have been used. Since weather have impact on human body hence weather report generation and analysis have been introduced as a new approach. Analysis part also collects historical data of similar patients over internet to generate better prediction. As the volume of IoT data is increasing rapidly so it is a challenging issue to allocate storage and longevity of storage. For example an ECG sensor might generate several GB of data in a week. Therefore this layer collects Fog Storage Layer data and reduce volume using data compression technique (Like mean) then transmit it to cloud in daily basis. In this work Decision Tree algorithm have been used for heart disease prediction because it performs better in this scenario. [8]. This layer also send buzzer and home appliance control command to microprocessor as well as alert message to user based on analysis result.

4. CONCLUSION AND FUTURE WORK

This proposed IoT Based Advanced healthcare architecture having the ability to change the existing health care systems. A few new sensors , distributed fog computing, prediction making, big data analysis, location weather report, NoSQL database and real time alarm alert has have taken this architecture to another dimension. All these features have made the architecture unique, secure, feasible and user friendly. This article also proposed layer based architecture of "storage, user interface and analysis part" and automatic home appliance control which will be most beneficial part of the system. The proposed architecture will bring the quality health care service in reality, and will ensure the fruitful real time analysis and treatment.

In future, the analyzing part of the architecture can be developed by applying more efficient datamining algorithm. Automated diagnosis repost analysis and prescription generation can be added to the system.

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BIOGRAPHIES

Ahmed Shafkat.
B.Sc in Computer Science and Engineering (Pursuing).
Bangladesh Army University of Engineering and Technology, Natore, Bangladesh.

Md. Ashik Hider Ankon B.Sc in Computer Science and Engineering (Pursuing).
Bangladesh Army University of Engineering and Technology.

Mohammed Golam Sarwar Bhuyan. B.Sc in Computer Science and Information Technology, IUT.
M.Sc in Telecommunication Engineering.
Associate Professor, Dept. of CSE, BAUET