Analysis of Different IOT Based Healthcare Monitoring Systems

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Abstract— The rapid advancement in Internet of Things (IoT) empowers the solutions to bring up new and intriguing applications. The smart Healthcare system is one of the key IOT application that connects smart sensors, patients, doctors, systems and other smart devices to the internet. In most effective manner, the IOT smart healthcare system has provided the possibility for doctors to monitor their patients at a remote location continuously. Internet of things compromises different technologies such as radio frequency identification, smart mobile innovations mart mobile innovations, wireless sensor network (WSN) which are interacting with one another through the Coap, 6LoWPAN, REST and other protocols. Various architectures based on IOT for the patient healthcare monitoring system has been discussed in this paper. The paper proposes the patient continuous healthcare monitoring system which consists of different sensors, web applications and a connected device-Raspberry Pi. The continuous healthcare monitoring system will supervise patient's body temperature, blood pressure, and heartbeats continuously. The doctor will be able to grasp patient's related information anytime from any locations.

Index Terms— Internet of Things, Smart Healthcare, Raspberry Pi, Sensors, (RFID), (WSN), Continuous Healthcare Monitoring.

I. INTRODUCTION

Internet of Things (IoT) or Web of things is the rapidly growing and updated technology that connects smart objects with one another over the internet. It provides the possibilities for communications between machine- to-machine (M2M), human –to- human (H2H), and human-to-machine (H2M) [1]. The European Commission Information Society has defined that IOT is compromised by the different group of technologies such as internetworking, sensing, communications, identifications, and informative devices [2]. Generally, it encompasses any type of devices and things such as smartphone, smart vehicles, home automation appliances, building infrastructure, industry-based devices, agriculture, healthcare related and so on which are used to share information in real time. The basic goal of IOT is to connect things anytime, from any locations, with anyone or any things by using any network, path, and system [3].

Internet of things has a huge number of applications which plays a vital role in human's life. Enhancing and improving healthcare architecture and a biomedical system is one the big challenging target of this electronic society (e-society). It is clear that delivering high-quality services to illness people and decreasing the cost of healthcare services and handling nursing staff is an essential issue. Current methods for patient observing, taking care, the executives, and supervision is frequently manually executed by the medical staff. This really provides a productivity bottleneck, which could be a reason for even terrible mistakes in practices [4]. As indicated by a recent report, the integration of Internet of Things (IoT) may get remarkable changes to the operational performance to health care centers and careful focuses on overseeing the day-to-day clinical tasks, and following of checking online health conditions of hospitalized patients [5].

In the process of designing of web things are impelling the improvement of technology based system to help and enhance healthcare services and other medical related procedures. Besides other available technologies, wireless sensor network (WSN), smart mobile gadgets or devices and ultra-high frequency (UHF-RFID) are the main enabling technologies that are used to implement the continuous healthcare monitoring system. The sensors network (WSN), acts as a focal point empowering innovation of web technologies that coordinates various spatially appropriated self-ruling sensors into a system and agreeably go their information through remote correspondence. This system can be associated with a more elevated amount framework by means of a system passage. The sensor network is fabricated from different nodes such as sensors, actuators hubs. the number of nodes may be in a large amount, may be more than thousands that each node is commonly compact, not heavy, ease, and essentially it would be deployment. The network of sense is stretched out to a system normally called USN which stands for Ubiquitous Sensor Systems, when it is coordinated into an arrangement of web of things [6]. The technologies of USN have the ability to provide high possibilities in the area of healthcare monitoring remotely.

RFID is a minimal effort, low power development which consists of BAP. BAP is a short form for passive and battery battery passive system which is called tags. It is ready to deliver Information that are controlled by the electromagnetic integrator called reader. Field generated by the integrator, called reader. So power is not required for the passive RFID tag, because it has a long lifetime which made the RFID technology compatible with diverse applications including healthcare system [7].

The UHF RFID has more sensing and computational capabilities that added extra value to the system[8].

As the RFID tag is playing a significant role in the smart healthcare system but the RFID tag has some drawbacks which operate merely below the reader of the converged area e.g 15 and 25 m once full and BAP tags are used. So explicitly, this kind of issue can limit the usage of UHF RFID technology which make problems in patient/object identification and super visioning within a small geographic area. In such type of situation, WSN and RFID are the two top technologies which could enhance the applications in the healthcare monitoring system. The prediction of the researchers shows that the method of healing system which is available now will be converted from healing -centered to healing -home-centered in 2020th and probably to house -centered in 2030th [9]. The IOT is in the progressive stage and it will redesign the smart healthcare system regarding of people economy and living requirement.

II. MOTIVATION

In urban areas, the facilities of healthcare are much better and vast instead of remote areas. People who are living far from health care centers facing different problems. Even they don't have access to hospitals in a sudden situation. They are not able to reach hospitals on time and they cannot afford the cost of checking up every time. So various IOT based architectures and frameworks are developed which are easy, inexpensive and assured for health care. Internet of things brought so many facilities to their lives.

III. OBJECTIVE

The basic aim of this healthcare monitoring system is to get the online data on time about the patient and interpret these data by using IOT platform. Besides that, through IOT system we can analyze retrieved information and provide solutions to a patient any time from any locations.

IV. RELATED WORK

Designing of a continuous smart health monitoring system is the hot topic for researchers. A remote healthcare monitoring system has more advantages for those who are living in rural areas and not able to reach the hospital center on time and from the other aspect, the strain on hospital medical resources like doctors, patients, and wards would also have decreased. The continuous healthcare monitoring system is generally relying on wireless sensor network which decreases the rate of energy consumption and extend the coverage area for communication [10]. According to [11], smart healthcare monitoring and giving more attention to people health is the difficult tasks that people must be aware of.

The development of sensors has brought huge facilities to the hospital environment. Sensor is used for the evaluation of different signs like ECG, motion, temperature, blood pressure and heart beating. Besides WSN, RFID technology is also used to localize equipment in hospitals [11]. Wireless localization network is used to monitor the patient's present conditions and track the inner side area of the patient [8]. The three main standards WSN, RFID, and GSM are utilized jointly to check sick people in healthcare center, as well as supervise their psychological status. A healthcare platform that are using these three technologies for patients to monitor them in actual time is explained in [12].

6LoWPAN is another smart technology which is used to screen the healthcare of patients and provide a few smart healthcare monitoring services [13]. Constrained application protocol (Coap) also plays a key role in connection and monitoring of medical sensors. The adoption of CoAP in human services play an outstanding role, since the CoAP worked in highlights like, resource monitoring (particular advantageous for continuous checking of sick people' essential signs) and disclosure empower a dynamic condition where the accessible resources are directly found and designed [13]. Received signal strength indicator (RSS) and particle filters on which localization and tracking system relay while bi-axial accelerometers are utilized to categorize the patient's movement conditions [14].

Moreover, the different technologies and technological standards used for data access and storage, visualization and healthcare analysis techniques are essential parts of a continuous healthcare structures. The development of electronic healthcare monitoring platform has changed the traditional way of healthcare method, compromise IOT into these systems which have increased adaptability, intelligence, and interoperability [15]. The modern smartphones have the ability to generate continuous healing monitoring services by customizing the related applications. Not at all like the UHF-RFID standards, has the utilization of sense network given the sick people the power to be checked in a progressively proficient way at the cost of sophisticated functions and required for their exact examining and monitoring. Furthermore, in the literature review some of the proposed IOT architectures for healthcare monitoring are also discussed:

In [16], a model proposed for the implementation of an "IOT based smart healthcare kit" which used for immediate medical situations that provide assistance to services. INTEL GALILEO second generation board was used which could collect data from the sensors touched to patients and were able to send the data over the internet for further temperature clarification and LM35 sensors were used for patient record.

In [17], a paper has described proposed model "Implementation of a healthcare monitoring system using Raspberry pi". The primary purpose of this model was to track temperature of patient body and the heartbeat of sick one at runtime. Physical parameters are concentrated and many users can access it. B+ model of Raspberry pi is used, through which healthcare parameters are focused and supervised.

In [18], system is discusses as "K-healthcare" that has the four main layers such as internet, network, sensors and service layers. It has sensors like Raspberry Pi, Arduino, smartphones, RTX-4100, and pulse oximetry and IEEE 802.15.4, 802.15.6, IEEE 802.11/b//g/n, ZigBee are used for communications between layers. Cloud storage is used by the system to manage data storage.

In [19], "Real-time wireless health monitoring "system has proposed which has the below different components:

A. ECG Electrodes, a device which is attached to patient body like chest, arms, legs at the time of testing stage and track the electrical impulses when the heart beats.

B. LM35, which is used for sensing of body temperature.
C. Blood pressure sensor, which measures the patient blood pressure.
D. The Microsoft Pro Tablet which works as a mobile personal computer consists of display, recharge unit and circuit in a single chip.

In [20], proposed "U-healthcare system" is the prominent machinery which provides suitable healthcare facilities for those who are suffering from illness. The architecture of this system is compromised from three main parts: Body Area Network (BAN), Intelligent Medical Server (IMS), and Hospital System (HS). In BAN, patient are using sensors which are attached to their body to track temperature signals, blood pressure, and breathing of them. IMS is the core system which works like a central hub between healthcare centers and patients. HS is the part which related to healthcare center staff that can make corrections based on IMS report.

In [21], presented "Secured Smart Healthcare Monitoring System based on IOT", in this system for collecting sensing data, Microcontroller PIC16F877A is used and delivered the data through the internet of things. The data is saved and doctors are able to access the recorded data from any place, anytime by using smart devices and track the health conditions of the relevant patients.

In [22], is designed "Patient Health Monitoring System(PHM) Using IoT devices", in this system body network is used to collect the health data and values from patients. Various sensors are there for collecting diverse parameters. Sensors are used for blood pressure, heartbeats and body temperature of a patient and Wi-Fi or Bluetooth is the transmission device. Every 60 seconds record of data is updated.

In [23], an IOT based system has proposed for healthcare monitoring securely. ATMEGA8 microcontroller was used with this system which can collect sensors data and deliver it to a server. Doctors could access this data by typing the website URL. The architecture of healthcare monitoring system which has proposed already consists of three-tier layers, such as Wireless Body Area Network(WBAN), Communication and Servicer layers [24]–[30]. So there are many healthcare monitoring systems which are more accurate and able to analyze patient status every time from any locations.

V. COMPARISON AND CONTRAST OF DIFFERENT ARCHITECTURES

By analyzing the reference papers, we have found that several authors have proposed new frameworks and plans which are actualized to convey IoT in the zone of medicinal applications and healthcare services. Some of the analysts pursue IEEE papers to structure their Internet of Things framework to give remote checking and crisis help while a few of the authors utilized other standard papers for their models. Some have basically clarified the utilization of IoT's applications in healthcare services. A high effort will be carried to evaluate and analyze some of the recent smart healthcare monitoring systems. In table 1 we are going to present the basic differences of the proposed IOT frameworks based on the parameters of emergency aid, a standard used, multi-devices supporting and technology involved.

A. Urgent aid: Utilizing web of things in healthcare monitoring area, more attention should be given to data and on providing assistance in emergencies. An alarm must be generated to patients and doctors.
B. Standard: there are varieties of standards and protocols supported by IOT such as IEEE 802.15.6 IEEE 802.11/b/g/n, IEEE 802.15.4, WBN, ZigBee.
C. Multi-device support: through multi-device support, different models and system can be compared. The effective system supports many architectures such as RFID sensors, smart devices sensors, body sensors, wearable devices sensors.
D. Technology: the latest technology like RFID, WSN, 4G, 5G, are supported by IOT. By implementing these technologies, we can access information related to patients and forward it to a server located

Ref#	New Model	Emergency aid	Multi device	technology	Application
16	No	Yes	Yes	Wi-Fi,3G, GPRS	System is used for efficient healthcare and monitoring services
17	No	No	Yes	Raspberry pi	the model was proposed for healthcare data, access and storage
18	Yes	No	Yes	RFID	Smart phone and body sensors are used in this model
19	Yes	Yes	Yes	WiFi	The proposed system was used to track patient any time and send data to internet
20	Yes	Yes	Yes	Wi-fi, 4G	Patient can be monitored online
21	Yes	Yes	Yes	GSM Modem	Is used to deliver patient data over internet
22	Yes	No	Yes	Wi-Fi, Bluetooth	Used for real time checking and monitoring of the patient status
23	Yes	Yes	Yes	GSM Module	The model was designed to provide real time supervising of the pati health

at remote area for next procedures and storage [31].

Table 1. Analysis and Comparison

So different IOT architecture and models can be compared

and analysis on the bases of these technologies and parameters. The application domain of the different

frameworks is also very huge and each one has their own particular area of usage where people can utilize and take Advantages from them. Some of the main systems with their related technologies and application are defined in Table 1.

VI. PROPOSED SYSTEM

We have studied various literatures and different healthcare systems. From the literatures we are proposing the IOT based patient healthcare monitoring system. The proposed IOT based system for continuous healthcare monitoring is used to decrease the problems of those people who are living far from healthcare center. Through this system we can automatically track patient's health conditions any time from any place remotely. Generally, when patient operated and he/she stays at home at rural area, after the operation they need a medical caretaker for checking up repeatedly. Sometimes it happened that the caretaker might not available and the patient may need some sudden checking up, so in this case, the patient will put in more troubles and the patient condition can become worse on. The recent advancement in technology, especially in the internet of things can be used for solving this kind of problems. In this piece of paper, we are going to design a system that patient can be monitored from any place, any time continuously, besides that the patient family members also know about the patient health status without staying with him. The doctors are also able to track the patient's body temperature, heartbeats, blood pressure, and body movement from any place remotely and any location.
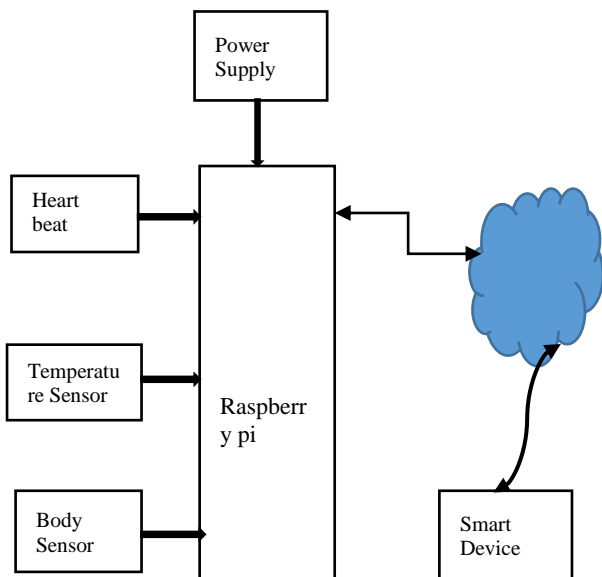
VII. ARCHITECTURE

Fig. 1. Patient Healthcare Monitoring System

framework we imagine ought to have the capacity to gather the patient's physiological parameters and convey them to a control focus. The system has these three modules

- Health checking part

- Emergency alert part
- Healthcare predication part

The health checking part of the system consists of hardware components for the purpose of enabling IOT to collect patient related parameters and information. The device that acts as the main server is Raspberry Pi, a bank card size device just like a small pc that all sensors are connected to it by the GPIO pins. The real-time values are read by the pi and updated to MySQL database after that show it on the web pages. The second part is that as the name implies if there is any sudden suffering from any kind of disease to a patient, the system immediately detected it and give the signal to his/her family members or to the healthcare center. In this case, some threshold values are set, if the patient crosses it, the system notifies to directly to hospitals or relatives. The last point is the prediction section which uses recorded health data and discussing it with the knowledge to make the system more expert by using any kind of data mining structures.

VIII. METHODOLOGY

The three sensors (heartbeat, temperature, blood) in the IOT based healthcare monitoring system fed their parameters to Raspberry Pi for further operations which are then transferring to the gateway sever by the Pi. Input coming by the sensors are continuously read through Raspberry Pi and send it to the Cloud. After receiving the urgent information from the rural patient, the related experience doctor will take immediate actions and save the life of the particular patient.
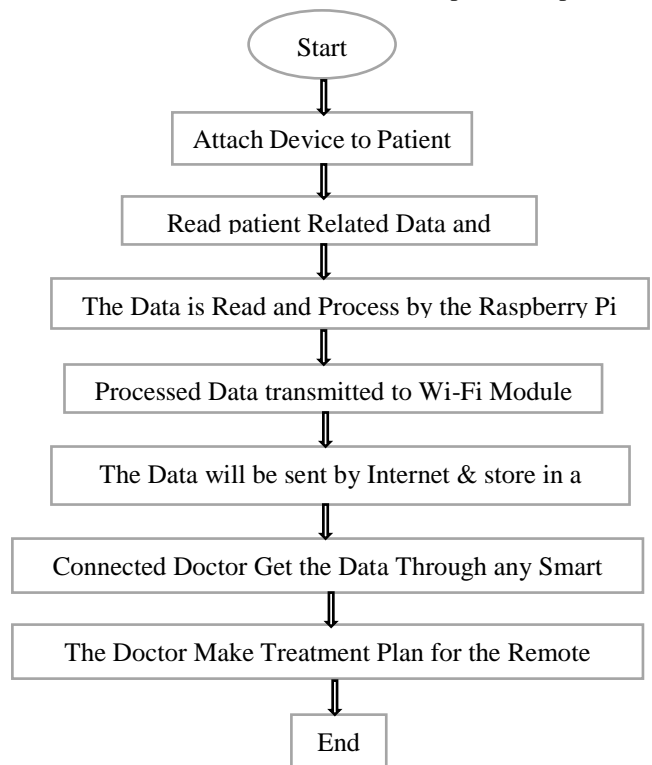

Fig. 2. System Flow Chart

IX. IMPLEMENTATION

The proposed system which examines the patient blood pressure, body movement, heart rate, and the temperature is

Providing the result from the given parameters. The raspberry pi receives the signals from the different sensors put on the patient's body. The raspberry pi which is a small size device that operates on a Linux operating system sends the retrieved data to the database, after that these data can be monitored by any place any time through the internet. Python language is used to program in raspberry pi for delivering patient- related data by using TCP/IP protocols to the server unit which is connected to the internet. The information over the internet can be accessed and checked by authorized people. The
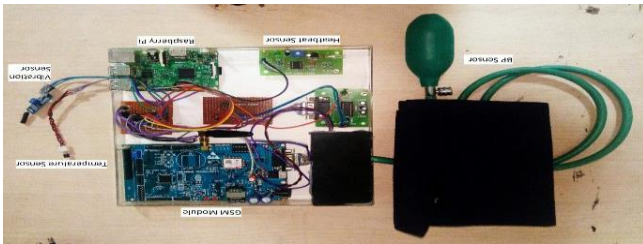

different hardware parts which are used in the system are discussed below.

Fig. 3. Main setup [32]

A. Raspberry Pi:

Raspberry Pi is one of the microcontrollers which is like a bank credit card size that has the characteristics of a tiny personal computer. It works on Linux operating system that provides connectivity in a single component and it is easy and inexpensive. In the raspberry pi system, GPIO pins are there which is used for the purpose of input/output that can be programmed when required. In this proposed system we will be using raspberry pi version 3. Raspberry Pi and IOT

together open the door for innovations in healthcare technology [32].

Fig. 4. Raspberry pi [32]

B. Body Sensor

Digital blood pressures are available but in this system, we have used manual blood pressure monitor which is known as the sphygmomanometer and sensors are also there used for reading. Air pressure is used to measure blood pressure and raspberry read those digital signals converted from reading which was in the form of electrical signals.

Fig. 5. Body sensor [32]

C. Temperature Sensor

LM35 is an example of heat sensor that is used to determine temperature with the support of analog output proportional to the temperature. It is also called an IC sensor [23]. The LM35 is much better to compare to liner temperature sensors which consist calibration in Kalvin, to obtain the Celsius value, there is no need to eliminate the extra voltage from the output. This feature of LM35 sensors make it easy to interface with any circuit.

D. Heartbeat Sensor

Microcontroller with LED and LDR is used together for

Fig. 6. Temperature Sensor [32]

measuring the heart rate and it operates on the optoelectronics. The surface reflects the infrared light and IR emit the radiation of infrared. If the density of the inner ray is more than the large value of the voltage in resistor will be obtained. To measure heart rate, we need just to press the tip upon the sensor with finger, immediately the LED will start blinking and output would be forwarded to the microcontroller or circuit to determine the heart rate. BPM the measurement unit for the heartbeat sensors.

Fig. 7. Heart beat sensor [32]

X. ADVANTAGES

Below are some of the system benefits:
1. The patient can monitor their health conditions at any time from any locations continuously and not required to visit hospitals all the time.
2. So the status can be determined from any place of the world online and the doctor can examine the patient health conditions all the time by using different smart devices such as tablets, smartphones, and laptops.
3. The family members can also track patient's health in an emergency situation.
4. The illness people are not required to stand in a long queue for doctors, thus save more time and cost.
5. Through this system distance barrier is eliminated.

XI. CONCLUSION AND FUTURE WORK

Till now, we have reviewed various pieces of literature and demonstrated the model for a continues healthcare monitoring that ensures a

consistent checking of different healthcare parameters and expectation of any sort of sickness or confusion that keeps the patient from paying more attention to visit the healthcare centers. The various systems that we have analyzed from the literature review and the proposed prototype architecture show that the IOT based designs provide more accuracy and ability to progressive track the patient healthcare conditions from any locations in real time. The paper also discussed the main components of the system such as raspberry pi, sensors, and modules. The proposed framework can be set-up in the healing centers and a huge amount of information can be acquired and put away in the online database. It will be possible to access the patient record through smartphone, tablet, and iPhone by using applications. Even though it is a prototype model, but prove that we can implement it in the real world.

As the global IOT market is growing rapidly. According to a research carried on remote healthcare monitoring system, the research shows that in 2014 nearly $58,4 billion was expected but it will reach more than $300 billion in 2022[33]. The present framework of IoT based healthcare monitoring system can be additionally enhanced further by adding artificial intelligence designs and concepts to bring more opportunities for patient, doctors as well as for the healthcare centers. Data mining is another good option to explore the information that is stored in the database systems from many different patients and their corresponding consequences.

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