INTERNATIONAL JOURNAL FOR TRENDS IN ENGINEERING & TECHNOLOGY
VOLUME 28 ISSUE 1 – APRIL 2018 - ISSN: 2349 – 9303

Iot Based Smart Health Care – A Review

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Abstract— Internet of Things, is an emerging field in today's world which have lot of applications in various activities of our day today life. It makes our life more comfortable and simplistic. In this paper we explain about the important applications of Iot in health care field. These IoT smart devices can be used to collect temperature, blood pressure, heart rate etc., which are used to evaluate the health condition of the patient. This data can be evaluated by the doctor and accurate decision can be take according to the health condition. This paper explains about the different mechanisms that involves in remote patient monitoring and about the medicine dispensing system.

Index Terms— Internet of Things, Medicine dispensing system, Remote patient monitoring, Wireless data transmission.

1 INTRODUCTION

In recent years, the growth of internet is tremendous and has been further extended to connecting things through internet. All devices are connected to one another with various smart technologies to create worldwide network called Internet of Things (IoT).The Internet of Things is an emerging technology across the world, which helps to connect sensors, vehicles, hospitals, industries and consumers through internet connectivity. The development of technologies such as IoT generates huge amount of data, leads to new age of information. Data generated by the IoT devices are used for analysis and decision making process. Each and every person is surrounded by smart devices, which is used to connect to the 3G/4G network, social networks and other intelligent technologies. The strength of IoT is its high impact on every person's day today life such as entertainment, work, and communication and so on. The applications of IoT can be grouped into domain like (i).Transport and logistics, (ii).Healthcare (iii).Smart Environment (iv).Personal and Social. The roles of IoT in all these domains are remarkably high.

Medical care and health care represent one of the most attractive application areas for the IoT. There are so many people in the world whose health may suffer because they do not have proper access to hospitals and health monitoring. Due to the latest technology, small wireless solutions which are connected to IoT can make it possible to monitor patients remotely instead of visiting the physical hospital. IoT-based healthcare services are expected to reduce costs, increase the quality of life, and enrich the user's experience. Here we are proposing smart health care model based on IoT. We propose a new schematic model for patient's e-health. Various medical devices, sensors, and diagnostic and imaging devices can be viewed as smart devices or objects constituting a core part of the IoT. The proposed outcome of this paper is to give proper and efficient medical service to patients by connecting and collecting data information through health status monitors and sends an alert to message with his currents status and full medical information. All the medical professionals can access and view the data, take decision accordingly to provide services remotely.

2. INTERNET OF THINGS

The Internet of Things (IoT) is a new concept that allows users to connect various sensors and smart devices to collect real-time data from the environment. Internet of things [1] as the name suggests, is the connectivity of everyday devices with each other. With the advancement in technology, numerous devices are using sensors, actuators, embedded computing and cloud computing. This has enabled communication between devices. To put it simply, the Internet of Things enables devices (things) to interact and co-ordinate with each other thereby reducing human intervention in basic everyday tasks. The aim of IoT is to extend the benefits of Internet with remote control ability, data sharing, constant connectivity, security [2] and so on. Using an embedded sensor which is always on and collecting data, all the devices would be tied to local and global networks. The definition of IoT is very wide and it includes many physical aspects. The figure 2.1 explains about the definition of IoT.

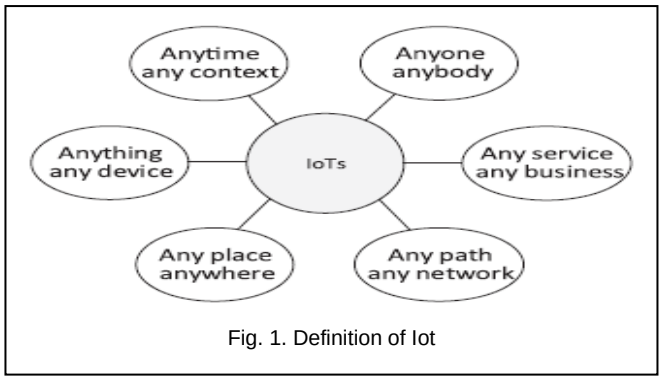

Fig. 1. Definition of Iot

The figure explains about the definition of IoT [3]. It can be access anytime by any person from anywhere. The Internet of Things involves a large number of smart interconnected devices and sensors that are often nonintrusive, transparent and invisible. The

communication among these devices as well as with related services is expected to happen anytime, anywhere and it is frequently done in a wireless and autonomic manner. In addition the services become much more decentralized and complex. Thus, to manage the complexity, IOT architecture is required. The architecture of IoT [1] consists of four basic layers. 1) Perception layer 2) Network layer 3) Middleware layer 4) Application layer 5) Business layer. The perception layer deals with the collection of various data that is required. The perception layer is similar to physical layer which consists of the different types of sensors [4] (*i.e.* RFID, Zigbee, QR code, Infrared, etc.) devices and environmental devices. The gathered information can be location, wind speed, vibration, pH level, humidity, amount of dust in the air, etc. This gathered information transmits through the Network layer for its secure communication toward central information processing system.

The Network layer plays an important role in securely transferring and keeping the sensitive information confidential from sensor devices to the central information processing system through 3G, 4G, UMTS, Wi-Fi, WiMAX, RFID, Infrared, Satellite, etc. depending upon the type of sensors devices. Middleware layer has two essential functions. 1) Service management 2) Store the lower layer information into the database. Application layer is responsible for inclusive applications management based on the processed information in the Middleware layer. The IoT applications can be smart postal, smart health, smart car, smart glasses, smart home, smart independent living, smart transportation etc…The business layer's functions cover the entirety of IoT applications and services management. It can create practical graphs, business models, flow chart, executive report, etc. based on the amount of accurate data received from the lower layer and effective data analysis process. The basic IoT architecture including all these layers and all the physical perspectives can be represented as the following figure. The figure 2.2 explains about the architecture of IoT.

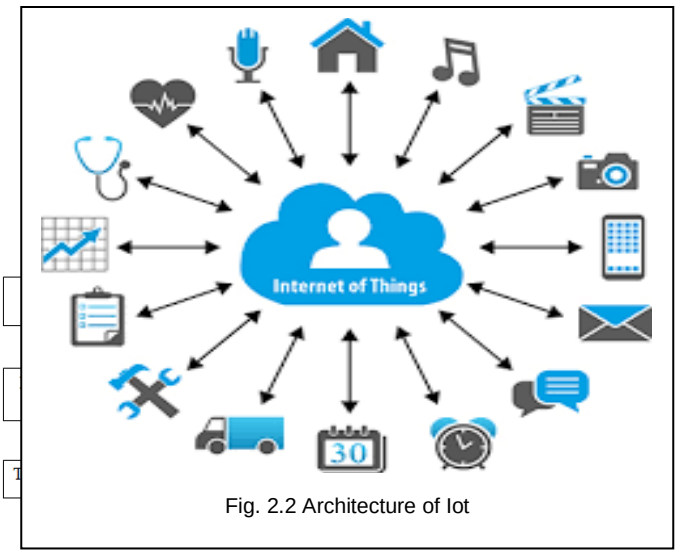

Fig. 2.2 Architecture of Iot

3 REMOTE PATIENT MONITORING

IoT can be incorporated in the field of smart health care for better advancements. IoT devices are used to collect, monitor, evaluate and notify the patient with the information. The remote monitoring of a patient by the doctor is a challenging task. To analyze the health condition of the patient, various medical parameters are needed about the patient. Collecting the parameters and communicating them to the doctor through the proper networking channel is another challenging task. The main three characteristics of remote patient monitoring are:

1. The data acquisition must be done with the help of sensors.
2. The collected data has to be transmitted through various networks.
3. Analyzing the data by a physician and necessary decisions taken by the doctor must be transmitted.

IoT based remote health monitoring system has massive advantages over 'widely used health monitoring system. Health sensing components have become very compact and portable, allowing patients to wear them for monitoring. If these monitoring devices are equipped with unique identifiers like RFID [5], then those devices can be uniquely identified over the Internet. It acts as an information retriever, retrieving information from the physical world to the digital world. An IoT enabled health monitoring device attached to a patient can be considered as a virtual patient in the digital world. The virtual patient has the exact physiological conditions as the real patient. A doctor can monitor a patient only a few times a day but critical health issues can occur at any moment. So 24/7 monitoring of health data is necessary. As IoT enabled patients can be accessed over the Internet and by other machines, the health condition of a patient can be monitored continuously, allowing critical illness to be detected at the right time so that proper actions can be taken. Also, IoT can help to collect health records. Generating statistical information related to health condition, can be performed by machines.

There are so many people in the world whose health may suffer because they do not have proper access to hospitals and health monitoring. Due to the latest technology, small wireless solutions which are connected to IoT can make it possible to monitor patients remotely instead of visiting the physical hospital. A variety of sensors which are attached to the body of a patient can be used to get health data securely, and the collected data can be analyzed (by applying some relevant algorithms) and sent to the server using different transmission media (3G/4G with base stations or Wi-Fi which is connected to the Internet). All the medical professionals can access and view the data, take decision accordingly to provide services remotely. The k-health care [6] system forms the basic foundation of the remote health monitoring. The four basic layers of the k-healthcare based remote monitoring system are:

1. Sensor layer
2. Network layer
3. Internet layer
4. Services layer

These sensor layers can be represented as the following figure 3.1.

The bottom layer of the model is called a sensor layer which is the heart of the model, there are different sensors lying on this layer, e.g., RTX-4100, wireless two-lead EKG, Arduino & Raspberry Pi, blood oxygen sensor, pulse oximetry, and Smart Phone sensors. The base of the sensor is Body Area Network. Body Area Network (BAN) is designed to collect the required data from the patient. The parameters used to diagnose the disease may vary from one disease to another. Therefore each parameter is sensed by separate IoT devices which are connected to the patient. All the devices attached in the body of the patient are known as BAN in the data collection phase. Blood pressure module, heart rate monitor, temperature etc. are the basic devices used to collect the blood pressure, heart rate and temperature of the patient [8]. The data collected in the collection phase is communicated to the doctor to evaluate the parameter for diagnosis.

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The Network layer plays the key role in communication to connect the devices with WAN using different protocols (TCP/IP), technologies and standards like 3G, 4G, ADSL, DSLAM, and Routers. The sensor device sends the data to a connected device, e.g. smart phone or RFID reader which is connected to home gate or the Internet via Ethernet / Wireless. The gateway device then sends the data to a particular server for further processing and updating the databases. The network layer provides the functionality of data storage and management. For this purpose, we use the cloud storage. The cloud storage provides the facility to store the data into logical pools. The physical storage may be one server or multiple servers, typically owned and managed by a hosting company. The cloud provides different services and algorithms on demand like cloud storage, cloud data store, cloud SQL, BigQuery, RESTful services for iOS [7], Android, JavaScript and machine learning algorithms. Cloud storage and processing plays an important role in this context. The figure shows the relation between the user and IoT devices [10]. The figure 3.2 explains the relation between cloud and the user.

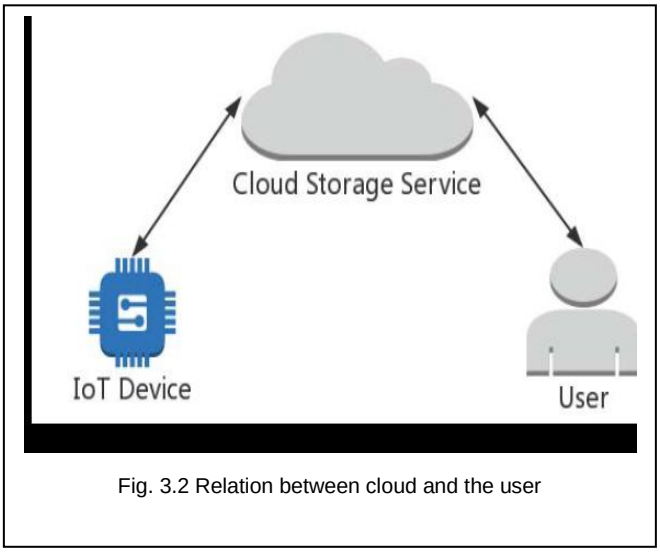

Fig. 3.2 Relation between cloud and the user

Cloud Processing [11] has three distinct components: storage, analytics, and visualization. The system is designed for long term storage of patient's biomedical information as well assisting health professionals with diagnostic information. The user can control the IoT devices by indirect methods via cloud storage services. A system that enables remote controlling IoT devices [10] should at least implement the following operations of a user:

1) Receiving (by the user) data generated from the IoT devices.
2) Delivering data (from the user) to the IoT devices.

Although the cloud storage services are designed for storing files, not for controlling IoT devices, we see that using storage services the above two operations can be implemented as follows:

1) When data are generated by some IoT device, the data are wrapped in a file and uploaded to some cloud storage account; then, a user of this cloud storage account will immediately receive the notification of an update of this file and can read the file in any place over the internet that has the cloud storage service.
2) Conversely, when a user wants to send data–could be some instruction–to some IoT device, these data are wrapped in some file and uploaded to some cloud storage; then, some software running in a device at home that shares with the same cloud storage account will receive the notification of an update of a file and immediately download the file. This file will be locally processed and sent to the corresponding IoT device.

The service layer provides direct access of data to professional medical facilities and stakeholders such as doctors, emergency centers, hospitals, and medicine supply chains. The doctor can easily manage the patients, view the medication history and provide remote support in case of emergency. The patient can also access the data on provided interface any time anywhere. This layer supports different protocols and techniques like HTTP, HTTPS, JavaScript, RESTful web services etc…

4 WIRELESS DATA TRANSMISSION

The wireless transmission between patient and centralized unit can be done by using Arduino, Raspberry pi, Zigbee module etc…

Zigbee [12] is one of the wireless mesh networks also it reduces the cost. Zigbee is also preferred over Bluetooth and infrared wireless communications because it is energy efficient, has low cost and long distance range. Bluetooth only has maximum of 8 nodes connected at a time whereas to have large network area Zigbee is used. Zigbee performs many to one routing algorithm when more than 40 nodes are there at a time. Zigbee acts as a receiver node acting as a coordinator, receiving data from all the patient units serially. At patients unit it act as a transmitter and at central unit as a receiver. It has radio antenna which works on RF frequency. A central station announces the emergency without generating false alarms. The information from patient unit goes to the central unit through wireless communication i.e. Zigbee. For configuring Zigbee modules X-CTU software is used. Through this software, Zigbee modules are configured as routers and as coordinator.

Another method for the wireless transmission of data is using Raspberry Pi. Raspberry Pi [13] is a powerful, low cost and a small card sized device which is a perfect platform for interfacing with many devices. The board contains a processor, graphics chip, RAM memory, interfaces to other devices and connectors for external devices, of which some are necessary and some are optional. There are much versions of Raspberry Pi but the CPU (BCM2835) of all the models of Raspberry Pi remains same. The CPU is somewhat cheap, powerful and efficient and it does not consume a lot of power. It works in the same way as a standard PC requiring a keyboard for giving commands, a display unit and power supply. Here, in Raspberry Pi, SD card is used in the same way as the hard disc in the computer. The connectivity of raspberry pi to the internet may be via a LAN (Local Area Network) cable / Ethernet or via a USB modem. The main advantage of Raspberry Pi is that it has a large number of applications. The Raspberry-Pi runs on Linux based OS, an open source operating system. In this system we used Raspbian OS which is Linux based OS. The programming language for the Raspberry-Pi and for the system implementation is Python.

5 MEDICINE DISPENSING SYSTEM

Many of the people around us forget to take medication on time. Failure to take a medication of the right dosage, at the right time causes minor healthcare problems to become worse. This is extremely problematic for the elderly patients who have difficulties in keeping track of their medicine. Elderly patients that have ageing issues, such as dementia or Alzheimer's disease have difficulties to remember their responsibilities. Poor eyesight as one of the contributors for medicine consumption errors such as misdosage since the elderly finds it troublesome to read the instruction on the medicine case, and identifying the right dosage of the medicine. Research was carried out on existing system to analyze the tracking and dispensing method of the devices. The literature is categorized as passive medication reminder, alarm-based medication reminder, software based medicine tracker, and robotic- based medicine tracker and remainder. The lists of table of already existing medicine dispensing systems [14] are shown below:

No	COMPARISON OF MEDICAL DISPENSING SYSTEM		
	Existing system	***Advantages***	***Disadvantages***
`1	Medication Remainder System	Keep track on the immediate next time of medicine intake	Dispense manually from the bottle Not adaptable for all bottle sizes.
2	Intelligent Medicine Case System	Can detect dose of dispensed medicine. Promoted correct dosing and correct time	Cannot differentiate type of medicine No alarms.
3	Microsoft Health vault	Tracks medicine intake. Monitors BP and other parameters	No alarm No immediate remainder
4	Add-on medicine dispenser timer	Avoid adaptability problem	No alarm User manually dispense from the bottle.

In [14] there introduces the iMedbox which is a platform that is built based on the integration of the iMedPack and smart sensors via various wireless links. The focus is to regulate and optimize the accessibility of medical drugs and efficiently provide home-based healthcare services. The developed IoT system connects the individual home environment with hospital, emergency center and other medical facilities and provides remote prescription and medication non-compliance service. The key innovation and functionality include: 1) Remote Prescriptions. 2) Medication remainder. 3) Medication non-compliance control. 4) Intelligent analysis and First aid alarm.

Here we are proposing the model of smart medical box which is an assistive device for people who suffer with short term memory loss. It is an alarm based device that helps in reminding patients about their medication. As the doctor receives an alert message he can check out the health conditions of the patient through the webpage and can make necessary changes in the medication time through the webpage itself. The proposed model is a medicine dispensing tray which rotates at correct medication time decided by the doctor. Doctor can control the medication time of each medicine in the tray by webpage itself. Motor attached with the tray will rotate to avail correct medicine to the patient.

4 Conclusion

Innovative uses of IoT technology in healthcare not only bring benefits to doctors and managers to access wide ranges of data sources but also challenges in accessing heterogeneous IoT data, especially in mobile environment of real-time IoT application systems. The big data accumulated by IoT devices creates the problem for the IoT data accessing. The remote patient monitoring by IoT techniques can bring new developments in health care field.

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