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Research Article

IOT Based HealthCare Remote Monitoring and Context-aware Appointment System

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Abstract

Health is Wealth. Any person who is healthy, he/she is rich, wealthy, etc. Healthcare is essential for developed and developing countries which do have a number of medical problems exacerbating from time to time. In order to ensure our healthiness in real time, Remote healthcare monitoring is an essential practice with the help of the modern technologies in offering healthcare services. IoT is a modern technology that plays a great role in Healthcare domain to provide better and latest services for a patient who is located at far apart from Healthcare centers. IoT technology can be applied to minimize the problems of accessing healthcare centers physically by offering better access and usage with limited number of resources. This paper proposes an innovative system that monitor remote patients healthy with the benefits of wearable sensors monitor ECG, HR, skin Temperature, Blood Pressure and establish follow up appointment reminder system based on patient's parameters captured values. Applying security mechanism for protecting an individual's data during transferred between devices and display healthcare center which is close to patient to get quickly treatment are our key contribution in this paper.

Keywords: *IoT, Wearable sensors, Remote Health, Context-aware, Follow-Up appointment, GPRS, Smart Phone*

1. Introduction

Internet of Things (IoT) is a recent technology which is coined by Kevin Ashton in 1999 in the context of supply chain management (K. Ashton, 2009). This youth technology now plays a great role in our daily life. This technology reconciled two words such as Possible and Impossible words to possible word. In IoT context object is not object but is smart object and it reveal a concept of connected set of anything, anyone, anytime, anyplace, any service, and any network. IoT is a lamp of our life which bring bright during we live on the earth and it is a discipline field that encompassing advanced technologies such as wireless sensor networks (WSN), artificial intelligence, and cloud computing plays an important role in many domains comprising of applications such as smart cities (O'Neill, D.*et al.* , 2017), traffic congestion, waste management, structural health, security, emergency services, industrial control, and health care. Medical care represents one of the hottest application areas for the IoT (Pang, Z., 2013).

In Healthcare application areas, IoT (Internet of Things) provide many useful features that facilitate remote monitoring of patients (Islam, S. R. *et al.* 2015; Sebestyen, G., Hangan, A. *et al.* . 2014; Rahmani, A. M. *et al.*, 2015). In the traditional health monitoring systems, there were many challenges that make patients suffer for the subject of health monitoring.

Now, IOT Based HealthCare Remote Monitoring and Context-aware Appointment System is one of the key contributor in the healthcare monitoring system to the improvement of the elderly people life. This system will perform a continuous remote monitoring of user's health without any burden on their everyday activities and on caregivers activities (Wood, A. D, *et al.*, 2008). It will provide benefit for patient's and health- care professionals since the real-time information collected in and retrieved from remote healthcare cloud (Mukhopadhyay, S. C.,2015) often insight in more accurate diagnosis on the person. To remotely know health status, healthcare monitor sensors has a responsibility in frequently to collect vital signs as signals to provide raw information for information systems (Kirsh, D. *et al.*, 2011). These signals are known as health-related data which reflects the patient's health status.

IOT Based HealthCare Remote Monitoring and Context-aware Appointment system provides *remote health monitoring and follow- up date reminder* functions. However, the follow-up date reminder is a useful function for the specialist's, patients and healthcare system management for giving and receiving treatment (Yan, H, *et al.,* 2010).

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In this study, we extend a system(You, I. *et al.* ,2017) by increasing its ability with adding security mechanisms for protecting patients data while outsourced to third-party from intruder's dangerous and GPS location based for searching close Medical center in patient's for the purpose of getting latest and quick treatment in a self-guidance way. Here, physiological sensors platform which is responsible to collect a user's physiological data worn by the user. These different sensors, such as ECG, temperature, blood pressure, blood glucose, heart rate, and oxygen saturation sensors, are comfortable while wearing, moving and convenient to use (Lee, Y. D. *et al.*, 2009). These devices collect real-time physiological data and relay it to the Smartphone which is then displayed on the user's Smartphone screen, and then send to a healthcare cloud for the further process. The contributions of this paper are as follows.

1) The proposed system provides real-time feedback, i.e., in case of normal vital sign, a response will be displayed from local server database SQLite. But in case of one or some of the vital signs, including temperature, ECG, HR, BP, BG, and SpO_2, of a monitored patient are abnormal, issuing alert messages and relay to remote server for treatment request.
2) We propose an innovative approach to synchronize the data collection from sensors, via Bluetooth protocol.
3) We propose an innovative approach to protect patient's information when outsourced to third-party.
4) We also propose GPS location Tracker based to find the nearest Healthcare Centre's based on the user's current location for the purpose of getting quick treatment in a self-guidance way.
5) It would be a Follow-up Reminder system based on context-aware approach if necessary for treatment.
6) The personal health information gathered in the healthcare cloud can be accessed by authorized body- medical professions and caregivers for monitoring purpose anytime and anywhere without restricting themselves in a specific geographical area.

2. Related Work

With the increased age, age related diseases highly increase overall the world to make elderly people is supper (dinner). There are many reasons why and how chronic disease increase with age. Some of them are:

1) Lack of body (physical) exercise
2) Lack of feed diet food
3) Lack of timely get diagnosis
4) Failure of tissues
5) Give prior for transmissible diseases and so on.

Nowadays, the advancement of technology (comprises wearable sensors, smart Phones, microcontrollers, communication protocols) increase the innovative solution from time to time to monitor a people's health. Jovanov, E., and Y. T. Zhang (Jovanov, E. *et al.* , 2004) proposed m-Health system which represent new evolution from traditional desk top telemedicine to wireless and mobile computing to monitor human vita sign. Patient's related data transferred to remote server for the further process via GPRS technologies.

Similarly, (Abo-Zahhad *et al.*, 2014) proposed a wireless emergency telemedicine system for patients monitoring and diagnosis of chronic diseases, it provides expert-based healthcare in intelligent data analysis devises to make decision on sensed data values. Here, for the further actions taken if any abnormal data result displayed, such result is transferred in real-time model via GPRS to remote server cloud because of it require quick treatment while normal via internet.

(Poon, Carmen CY *et al.* , 2015) proposed BSN-body sensor Network which is called WBAN-Wireless Body area Network that designed to connect and operates sensors with a human body for the subject of monitor patient's vital sign remotely.

Similarly, (Yi, Won-Jae *et al.*, 2013) proposed Smartphone system for BSN health monitor remotely. Here, some sensors attached on human body to collect patients vital signal and communicate with gateway through different wireless communication protocols(Bluetooth, NFC, Zigbee) to transferred sensed data. Smartphone used as a bridge between sensors and remote storage cloud to provides analysis, process, store data and also used to relay data from sensors to cloud from where specialists access.

(Wu, Taiyang, *et al.* , 2017) proposed an autonomous

WBAN-wireless body area network that enhances the connection of health monitoring devices in the monitoring operations. This system in addition to provide monitor it also increase the life time of wearable sensors.

(Chang *et al.*, 2016) proposed an Interactive mobile health (IMHS) that monitor blood glucose in two communication ways. A system is accomplished with three devices (GPRS BGM, Android App, Cloud).GPRS BGM is an android dependent responsible to collect the patients BG information values in discontinuous time (i.e. before/after meal, night, before/after activity etc.) and upload data to cloud server via GPRS protocols, in XML format then if critical risk happened, IMHS notify caregivers on their android phone through the best and real time IoT protocol MQTT.

(Pierleoni *et al.*, 2014) implemented an android based heart monitoring system to detecting CVD-cardiovascular diseases remotely with the help of Zephyr BH sensor which is inbuilt Bluetooth to transfer heart rate related data into mobile phone which is inbuilt Bluetooth, Wi-Fi, GPRS, 3G communication relay information into remote cloud server from which doctor, medical staffs, patients parent able to access their respected patients data without any obstacles and bounded places.

(Sharma *et al.*, 2016) proposed the healthcare application for android phone using IoT concepts to provide an operation for users who require Blood from Blood Bank Center during urgent events. In addition, this system track where the location of Blood Bank center is and reminder of child parents for giving pill at a right day and time for their child. In the Blood Bank center weight of blood is measure by Load sensor and inserted to a system.

(Kumar, R. *et al.*, 2016) proposed an IoT based system using Raspberry Pi that monitor patients physiological data (T skin Temp, RR, HR, Accelerometer) within special sensors. Sensed data is collected on Raspberry Pi microcontroller via amplifier circuit then sent to web.

(Zanjal *et al.*, 2016) proposed a system which bring mind for a user who lost their mind to take their medicine. This system gives a response before a risk comes to user after they forgot the day of taking their insulin.

(Li, C *et al.*, 2017) proposed a pervasive healthcare system which provides remote monitoring services of patient's heart attack disease problems. The system measure EC, SPO2, and PB and send value in real time into remote server.

3. Proposed System

In our proposed system there would be wearable sensors, wireless communication low cost, Arduino Uno, Smart phone and local and remote (i.e. cloud storage) that we use to complete our tasks. Now a day, Smartphone is integrated with our daily activities and wherever we go our smartphone is with us. So, we have been used our Smartphone and Arduino Uno as a gateway-middleware. In addition to this, our smart phone is built in Wi-Fi, 3G, 4G, GPS module, GPRS module, GSM module indispensable parts. So, it save us from purchasing each module separately. Our proposed system has ability to track a current location of patients and calculate a distance from a close healthcare center location.

Data security, location tracking and follow up reminder rely on context aware is our main contribution in this proposed system. Context-aware process follows a series of sub processes like context acquisition, context processing, and context usage. In context acquisition, with the help of sensors, data like Blood pressure, Skin temperature, Heart Rate etc. would be captured and sent to remote server for the further process that make healthcare givers to establish follow up process improvement. We have classified into three layers for the purpose of express clearly and make more understandable.

Layer 1: Local care unit- includes Sensors, Arduino Uno, Smartphone, short distance communication protocols

Layer 2: Storage unit-Persistence storage - includes Microsoft Azure, Firebase, ThingSpeak, Amazon, VMware etc.

Layer 3*:* Remote Management unit- includes Decision making with Application

Layer 1: Local care unit: This layer expresses (comprises) every components that used in patients side and every activities performed by patients. Encryption is carried out in this layer. Here, the communication of this layer called Local Body Area Network (LBAN) which is performed via Bluetooth, ZigBee, and Hotspot etc. We have used Bluetooth protocol in this layer platform.

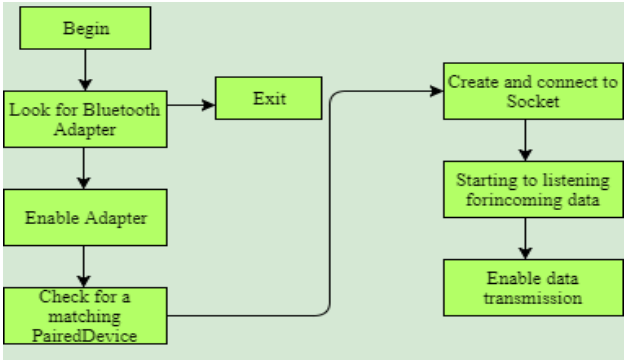

Fig 1: Bluetooth Workflow Operation

Sensor-has a responsibility to collect vital signs from a patient's body and data is collect on Arduino Uno R3.The Arduino Uno process and transfer collected data from each sensor to intelligent data analysis device-Smartphone via Bluetooth.

Arduino Uno -is selected as a gateway devices because of small size, latest design, and most famous board and cheapest.

Bluetooth-is one of a communication protocol which we consider in this layer 1.

Smart phone: has ability to get, store locally, analysis and aggregate information from sensors and send analysis and secured data to a second layer via Wi-Fi/GPRS/3G/4G/Internet. Every patient's information is secured here before going too outsourced to third party using AES 128-bit encryption algorithm- selected due to its simplicity in implementation.

Layer 2:This layer express a permanent container of individual patients in internet (online) from which every authorized user and patients family can access through Wi-Fi/GPRS/3G/4G/Internet on their phone or PC .

Layer 3: This layer express authorized users (Doctors, patient's Families) who has a privilege to access patients information online. The following figure demonstrates the above layers platform.

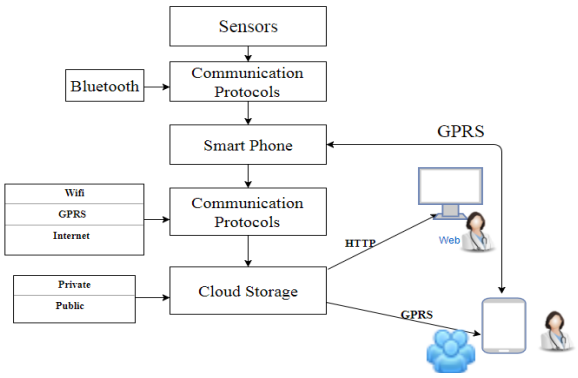

Fig.2 Block Diagram of three layers platform

4. Methodology

A methodology can be simply defined as a set of procedures that one follows from the beginning to the completion of the proposed system. The nature of the methodology is dependent on a number of factors, including the system development environment, the organization practices, the type of system being developed, user requirements, and availability of software and hardware components.

5. Architecture of Proposed System

This system architecture shows the overall of our functional system and its components.

The Proposed system has five functions including sensing, communication, security, management and appointment reminder.

The first function, i.e., sensing, is to employ a set of physiological sensors embedded on the patient's body to measure their physiological signals

The second function, i.e., communication, is referred to the processes of delivering physiological data to backend devices it might be gateway, local server, and remote server via Bluetooth, WLAN (i.e., Wi-Fi) and 3G/4G transmission protocols.

The third function, i.e. security, is referred to a mechanism employ on the data collected from sensors to protect from intruders when transferred from one device to others.

The fourth function, i.e., management, represents that server-side is responsible for collecting, analyzing and monitoring the physiological data, and furthermore, being able to issue warning messages to medical professionals or caregivers whenever the physiological data are abnormal.

The last fifth function, i.e., appointment reminder, which is based on context-aware that remind the date of treatment.

The architecture of proposed system platform as shown in Fig. 1 comprises two main systems, the wireless body Area network system (WBANS) and the healthcare monitor system. The WBANS provides two functions, sensing physiological data for a patient and then forwarding the data to middleware device (Arduino board, Smartphone).Then the collected information is stored in the healthcare monitor system-cloud storage from which medical professionals and/or caregivers can retrieve and diagnose the individual's physiological condition remotely. The following figure shows the system architecture.

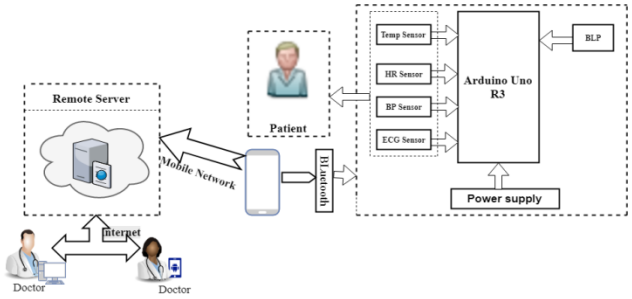

Fig.4 The architecture of proposed system platform

1) WBANS: WBANS consists physiological wearable sensors which are used to collect patient's vital signs. Then physiological data are sent to a Smartphone which serves as a Base Station (middleware), through a built-in Bluetooth protocol. Figure 5 below show Hardware Design of WBANS. Figure 6: The working flow of smart phone.
2) Healthcare Monitor system: This part provides remote access and stores all physiological data sent from middleware devices. Authorized Doctors can log into the system anytime and anywhere to monitor patient's vital signs as well as offer timely and appropriate medical care or treatment when necessary by their Smartphone or PC.

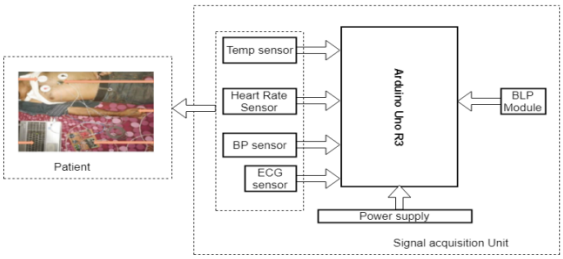

Fig.5 Hardware Design of WBANS

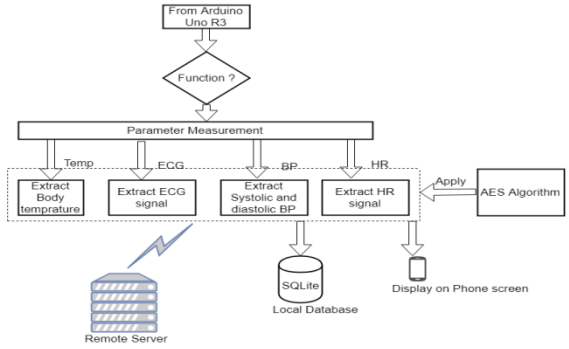

Fig.6 The working flow of smart phone

Conclusions

In this paper, we have proposed IOT Based HealthCare Remote Monitoring and Context-aware Appointment System. The proposed system here has tried to solve problems which make remote patients fuss for checking their health condition and getting accurate diagnosis.

We also have discussed a concept of a context-aware how follow up reminder system will be developed. Here context-aware system benefits doctors to provide diagnosis, deliver treatment, and establish follow up appointment with patients for the future continuous treatments. This paper is till now not achieved a result-it is in a progress. So, our work is very much needed for all users.

Future Work

In this paper, we proposed a framework which can develop and use remote system in easy ways. Beyond, it is also on a progress which we must do future time.
The main points of our future works are: While information is transferred from source to receiver either in store and forward mode or in real- time mode, a delay time makes our system to go back direction. So, ensure delay time of data transmission is one of our future works. In case of patients location tracking using GPS model, if cloud is not clear-sky is not visible (such as dense forests) it does not provides accurate location of patients.

Therefore, investigate another model that solve such like problem is our second future work. The last one which is indispensable in our future work is increase a battery life time of sensors. Every devices battery life is limited for use. We can charge our sensors with solar, wireless for long time continuous operation.

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