Internet of Things (IoT) Framework for u-healthcare System

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Abstract

The IoT plays an important role in healthcare applications, from managing chronic diseases at one end of the spectrum to preventing disease at the other. IoT devices can be used to enable remote health monitoring and emergency notification systems. IoT aims to provide means to access and control all kinds of ubiquitous and uniquely identifiable devices, facilities and assets. In this paper we discussed the background of Internet of Things (IoT) and its application to u-healthcare. This also presents the idea of framework of IoT which works for u-healthcare.

***Keywords:** IoT, u-healthcare, mobile computing, cloud computing*

1. Introduction

In this paper we have presented the u-healthcare system in the Internet of Things (IoT) environment with the support of the mobile gateway which makes it possible for integration. We have presented here the mobile gateway architecture in which the main purpose is to receive the sensing data and make a local analysis and generate keywords and then will be sent to remote medical server for analysis.

IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants, such as pacemakers or advanced hearing aids. Specialized sensors can also be equipped within living spaces to monitor the health and general well-being of senior citizens, while also ensuring that proper treatment is being administered and assisting people regain lost mobility via therapy as well. Other consumer devices to encourage healthy living, such as, connected scales or wearable heart monitors, are also a possibility with the IoT. More and more end-to-end health monitoring IoT platforms are coming up for antenatal and chronic patients, helping one manage health vitals and recurring medication requirements. Distinct advantages over similar products from the US and Europe are cost-effectiveness and personalization for chronic patients. Doctors can monitor the health of their patients on their smartphones after the patient gets discharged from the hospital.

For the satisfactory information transmission of the mobile healthcare, seamless data transfer must be supported. To construct a seamless data flow, the heterogeneous network integration, the disconnected operations and the communication link redundancy are important issues. Sensor mobile gateway should ideally be hosted on a small and portable device, suitable for daily use, such as a smartphone or PDA. The majority of smartphones and PDAs currently do not support typical WSN or Near Field Communication interfaces, but there already are some exceptions which are announcing their comprehensive implementation.

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This paper is organized as follows: Section 2 discuss the background of the study, Section 3 discuss about the u-healthcare and the Internet of Things (IoT). Section 4 IoT Framework for u-healthcare System and Section 5 is the conclusion.

2. Background of the Study

This section discusses the underlying technology and concepts behind IoT and u-healthcare. The integration of different technology and computing system enables the u-healthcare system in IoT perspective.

2.1. Internet of Things (IoT)

The idea is applied to u-healthcare to improve access and interconnection of devices used in u-healthcare. Embedded technologies will take an important role to deliver u-healthcare to people in remote locations and monitoring system that provide a continuous stream of accurate data for better healthcare decisions. As the technology for collecting, analyzing and transmitting data, IoT continue to improve; the IoT-driven healthcare applications and systems emerge. In the Internet of Things (IoT), devices gather and share information directly with each other and the cloud, making it possible to collect record and analyze new data streams faster and more accurately. That suggests all sorts of interesting possibilities across a range of industries: cars that sense wear and tear and self-schedule maintenance or trains that dynamically calculate and report projected arrival times to waiting passengers. Communications are via sorts of long-and short-range wired or wireless devices in different kinds of networking environments such as Intranet, extranet, and Internet that are supported by technologies such as cloud computing, SaaS, and SOA based on regulated data formats and transmission standards.

2.2. Cloud Computing

Cloud computing is a new computing paradigm where in computer processing is being performed through internet by a standard browser. Cloud computing builds on established trends for driving the cost out of the delivery of services while increasing the speed and agility with which services are deployed. It shortens the time from sketching out application architecture to actual deployment. Cloud computing incorporates virtualization, on-demand deployment, Internet delivery of services, and open source software. The Cloud Computing Architecture of a cloud solution is the structure of the system, which comprises on-premise and cloud resources, services, middleware, and software components, geo-location, the externally visible properties of those, and the relationships between them. The term also refers to documentation of a system's cloud computing architecture. Documenting facilitates communication between stakeholders, documents early decisions about high-level design, and allows reuse of design components and patterns between projects. The benefits of cloud computing are many. One is reduced cost, since you pay as you go. Other benefits are the portability of the application is that users can work from home, work, or at client locations. This increased mobility means patients and physicians can access information anywhere they are.

One of the oft-cited advantages of cloud computing is its elasticity in the face of changing conditions. For example, during seasonal or unexpected spikes in demand for a product retailed by company, or during an exponential growth phase for a social networking Website, additional computational resources can be allocated on the fly to handle the increased demand in mere minutes. Similarly, in this environment, one only pays for what one needs, so increased resources can be obtained to handle spikes in load and then released once the spike has subsided. However, getting additional computational resources is not as simple as a magic upgrade to a bigger, more powerful machine on the fly; rather, the additional resources are typically obtained by allocating additional server

instances to a task. Having u-healthcare server in the cloud will give advantage in fast and elastic computing.

Cloud computing offers significant benefits to the healthcare sector: doctor's clinics, hospitals, and health clinics require quick access to computing and large storage facilities which are not provided in the traditional settings. Moreover, healthcare data needs to be shared across various settings and geographies which further burden the healthcare provider and the patient causing significant delay in treatment and loss of time. Cloud caters to all these requirements thus providing the healthcare organizations an incredible opportunity to improve services to their customers, the patients, to share information more easily than ever before, and improve operational efficiency at the same time [3].

U-healthcare server in the cloud will give faster data retrieval and flexibility. The medical center or hospital can provide access of the patient information ubiquitously. Cloud u-healthcare sever provide wide access to patient data to any device regardless of the location.

2.3. U-healthcare System

Ubiquitous healthcare is an emerging technology that promises increases in efficiency, accuracy and availability of medical treatment. U-healthcare system is to provide convenient healthcare service to both caregivers and patients, and to make it easy to diagnose patient's health condition. People can monitor their health without visiting the hospital or clinic.

Pervasive computing has made the interaction between humans and computational devices completely natural and user can get the desired data in transparent manner. The newly introduced devices like mobile phone, laptops and PDAs have made ubiquitous computing possible. They are available anywhere at any time. Pervasive computing is used in hospitals, emergency and critical situations, industry, education, or the hostile battlefield.

Figure below shows the Traditional U-healthcare System Architecture. The system architecture is mainly divided into-

- Body Area Network (BAN)
    - Wearable Body Sensor Network
    - Personal Monitoring Devices
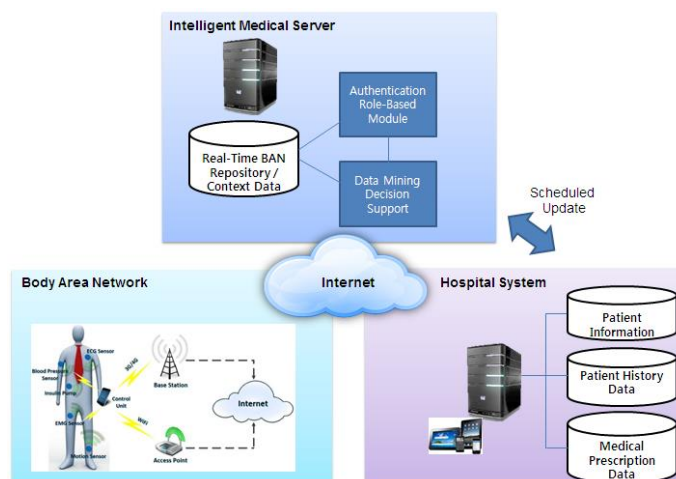- Intelligent Medical Server
- Hospital System

Figure 1. Traditional U-healthcare System Architecture

A. Body Area Network (BAN)

In BAN system sensors are attached to body area in order to capture bio-signals, including blood pressure, body temperature, pulse and breathing. It is mainly divided into two parts *i.e.*, WBSN and PMD.

Wireless Body Area Network (WBAN). The wearable Body Sensor Network is formed of wearable or implantable bio-sensors in [3] patient's body. The sensors collect necessary readings from patient's body and sends to the central node in form of low frequency electromagnetic waves.

Personal Monitoring Devices (PMD). The patient's Personal Monitoring Devices can be a personal computer or a cell phone or PDA device. It gets information from WBSN by means of Bluetooth or Zigbee. PMD contains logics to determine whether to send this information to IMS or not. Personal Computer based PMD communicates with the IMS using Internet. Mobile devices based PMD communicates with the IMS using GPRS / Edge / SMS technology. The IMS will act as the service provider and the patients PMD will act as the service requester.

B. Intelligent Medical Server

The second part is the Intelligent Medical Server (IMS) which receives information from the BAN. It serves as a hub between the patient and hospital. It is the backbone of the entire system and is capable of learning patient's specific thresholds. An agent determines whether a patient is in a critical condition based on medical data transferred from the BAN System. If it is determined that there is an emergency, the data is transferred to the hospital system for enacting emergency measures, immediately after being stored in the IMS system. If it is not an emergency, the data is merely stored in the IMS. For data stored in the IMS, necessary data is regularly saved to the central database of the hospital. These real-time data will be deleted after a certain period of time unless there is an emergency. Data stored in the IMS is available to doctors and support staff in the hospital.

C. Hospital System

The third area is a hospital sub-system. If necessary, data is registered, retrieved, changed, updated and deleted by doctors, patients and hospital support staff. Depending on the IMS output or report the hospital staff will take the preventive or corrective actions for the corresponding patient.

3. U-healthcare and the Internet of Things (IoT)

The IoT can be used in clinical care where hospitalized patients whose physiological status requires close attention can be constantly monitored using IoT-driven, noninvasive monitoring. This requires the sensors to collect comprehensive physiological information and uses gateways and the cloud to analyze and store the information and then send the analyzed data wirelessly to caregivers for further analysis and review. This technique improves the quality of care through constant attention and lower cost of care by eliminating the need for caregiver to actively engage in data collection and analysis.

A revolution in healthcare is quietly brewing. The "Internet of Things" a global system that could eventually comprise billions of devices and applications including sensors, actuators, microcontrollers, mobile-communication devices, nano-pumps and more will make health monitoring, diagnostics and treatment more personalized, timely and convenient, while also lowering costs. The internet of things provides the means to access and control two categories of ubiquitous and uniquely identifiable devices- those that

have inherent intelligence and those that are externally enabled via all sorts of wired and/or wireless communications in all kinds of networking environments, supported by cloud computing technologies with adequate security measures, to achieve pervasive connectivity and grand integration and to provide services such as monitoring, locating, controlling, reporting, decision support and so on.

A general mobile gateway structure that suits various sensor networks with homogeneous or heterogeneous nodes from the hardware and software point of view. Such mobile gateway should integrate interfaces to sensor network technologies such as ZigBee, Wireless HART, 6LoWPAN and ANT on one hand and interfaces to other well established data communication technologies including Bluetooth, Wi-Fi and GSM/UMTS on the other. BAN devices may be embedded inside the body, implants, may be surface-mounted on the body in a fixed position Wearable technology or may be accompanied devices which humans can carry in different positions, in clothes pockets, by hand or in various bags.

The Figure 2 is the Smart Health IoT platform presented by Vermesan, O *et al.*, [10].
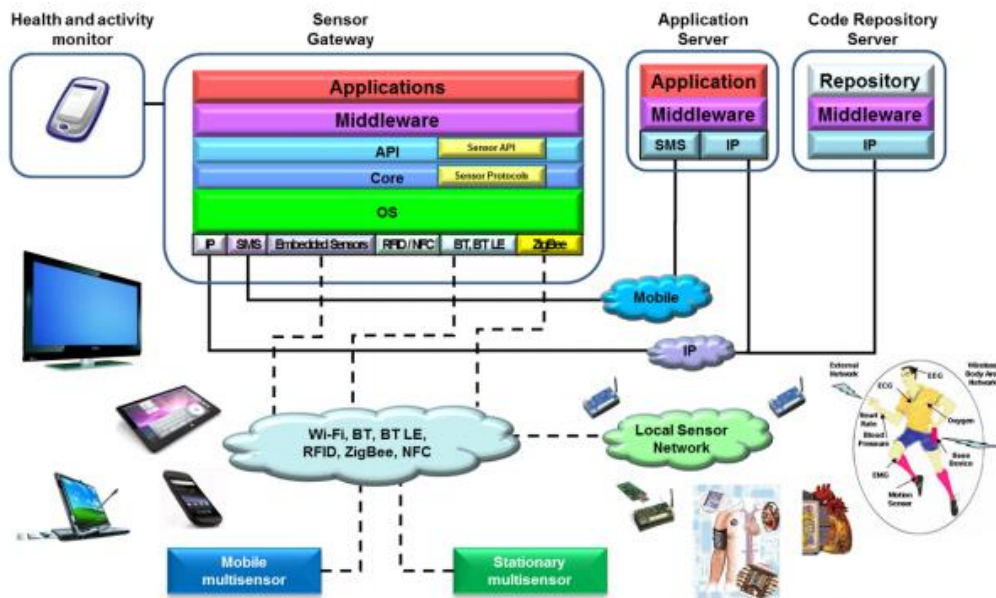

Figure 2. Smart Health IoT platform [10]

4. IoT Framework for u-healthcare System

The Figure 3 shows the mobile gateway architecture for u-healthcare. The interoperability of different devices is needed to develop IoT driven u-healthcare system. One of the limitations is to enable different devices to work together. To address this limitation, this paper presents the mobile gateway architecture for u-healthcare system. This enables the integration of different devices which extends the capability to IoT perspective.
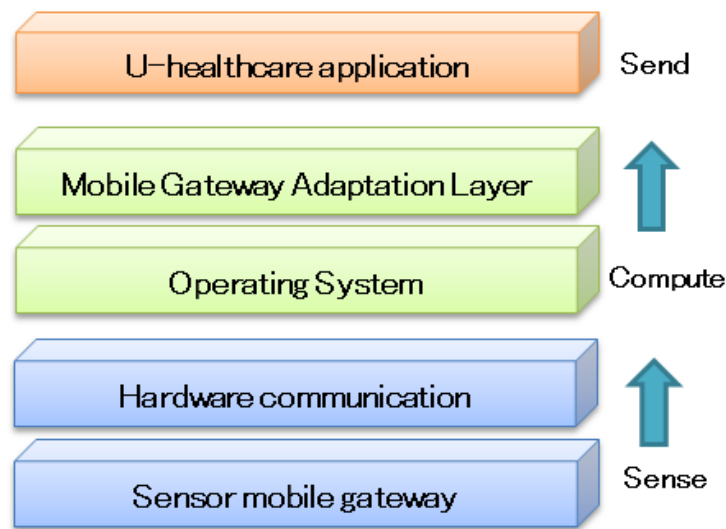
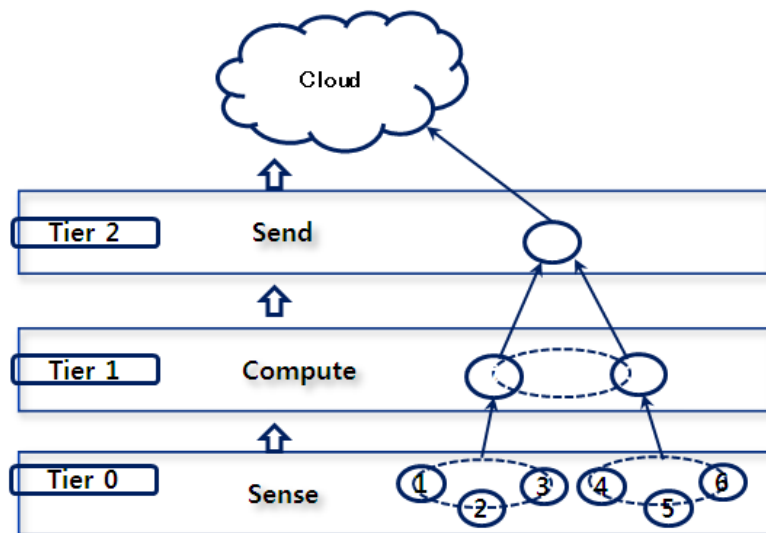**Figure 3. Mobile Gateway Architecture for u-healthcare**

Figure 4. Tiers of u-healthcare System IoT

In this study, we have also presented the tiers of u-healthcare system IoT. First, in the Tier 0, the body sensor senses the data and transmits to the mobile phone. Mobile phone is capable of processing the data received through multi-purpose gateways and compute the received information in Tier 1. The mobile phone will transmit the data to be analyzed in monitoring center in Tier 2. The mobile phone will compute the received sensing information and generate keywords and transmit to the monitoring system through mobile phone. Then the monitoring center received the keywords and give diagnosis as a result. The monitoring system is hosted in cloud u-healthcare server. With the Internet of Things (IoT) this u-healthcare system is possible. The data is filtered by using the semantic meanings. Local analysis is performed by program installed in mobile phone. Internet provides interesting u-healthcare information as feedback to the mobile healthcare client layer.

4. Conclusion and Future Works

The IoT can be used in clinical care where hospitalized patients whose physiological status requires close attention can be constantly monitored using IoT -driven, noninvasive monitoring. This requires sensors to collect comprehensive physiological information and uses gateways and the cloud to analyze and store the information and then send the analyzed data wirelessly to caregivers for further analysis and review. This paper studies the u-healthcare system with respect to the Internet of Things (IoT) perspective. Mainly, the mover of IoT for u-healthcare is the integration of different technologies and computing system. These include sensor devices to gather patient's physiological data, u-healthcare cloud server and wireless technologies. To address the interoperability limitations of different devices the mobile gateway architecture for u-healthcare and the tiers of u-healthcare system IoT was presented. The future works of this study includes the detailed design framework and thorough study of other requirements.

Acknowledgments

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