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COMPARISON OF VARIOUS TECHNIQUES IN IoT FOR HEALTHCARE SYSTEM

Suriya Begum[1], Venugopal[2]

[1]Prof., Department of Computer Science and Engineering, New Horizon College of Engineering, VTU, India

[2]Student, Department of Computer Science and Engineering, New Horizon College of Engineering, VTU, India

suriyabegumnotes@gmail.com

Abstract- As the saying goes, health is wealth, and as the number of various diseases have increased in the past few decades, it is very important to monitor the health of the patients on daily basis. Internet of Things(IoT) has become one of the popular area for various applications. IoT will create technological revolution in a large number of applications, such as, smart living, smart home, healthcare systems, smart manufacturing and environment monitoring and within these, healthcare system is one of the most important challenge that our society faces today. Now a days there is ever growing demand for healthcare system to improve human health. In this paper we have discuss various methods adopted for healthcare issues in the IoT by a number of researchers. The majority of the survey is mainly focused on the different healthcare techniques used in the IoT, such as, Wireless health monitoring, U-healthcare, E-healthcare, Age-friendly healthcare systems and some security techniques for healthcare applications.

Keywords– Environment Monitoring, E-Healthcare, Smart living, Security Techniques, U-Healthcare

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I. INTRODUCTION

Internet of Things (IoT) is a promising model to incorporate several technologies and communication solutions [4]. The IoT defines where every physical objects to be connected anyplace and anytime using internet and be able to identify themselves to other devices [2]. In recent days there have been significant advances in the field of IoT. It will create technological revolution in a large number of applications such as healthcare systems, smart living, environment monitoring and smart homes. There are many IoT applications, and within those healthcare systems considered one of the most important challenges in the present world [3].

Health and wellness is one of the most promising application areas of IoT technology. Remote health management, managing lifestyle-related diseases and conditions, fitness

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programs, care at home, chronic diseases and care for the elderly are some of the important use cases. Other use cases include improving a patient's compliance to treatment and medication in hospitals, clinics and other care facilities. Medical devices such as personal home-use diagnostic devices or low-end diagnostic and imaging devices that are used by mobile health workers are one of the key technology components [11].

A modernized healthcare system should provide better healthcare services to people at any time and from anywhere in friendly manner. Health is one of the global challenges for humanity. Healthy individuals can reduce pressure on the already overwhelmed hospitals and clinics. So to keep individuals healthy, an effective modern healthcare system is essential [1]. IoT have many advantages in healthcare, through the use of sensors, detectors and equipment, etc. These allow the identification and patient tracking online, the locations of the doctor and keep track of the medical report of the patient [3]. The healthcare progress is based on improving the human life quality and wireless sensors are placed on the body of the patients in order to monitor their health state. Real time patient monitoring systems are implemented for the purpose of early detection of clinical emergency. They are used to continuously track the vital signs of the patient, for example: Pulse Oximetry, Respiration rate, Temperature, Heart rate, Heart rate variability, Arterial blood pressure, Skin temperature and conductance, Blood alcohol concentration, etc. Besides the Vital signs information, other typical concepts of the response to a clinical emergency are the patients Electronic Health Record (EHR) and assignment of the doctor, based on physical location information [12].The sensors are possible to capture various information about the patients, about their physical, psychological and behavioral state. Sensed data is sent to a medical central unit carried by any authorized person. The medical central unit analyzes the received data and shows the results to medical professionals to understand patient's health state [5]. Wireless body sensors will provide the possibility of continuous monitoring, early detection and quick involvement in emergency conditions [2]. It helps healthcare professionals to avoid move from one place to another and also it helps to patients to avoid stand in queues. Sensors will help monitoring for the elders and those all are having chronic diseases such as diabetes, cancer, asthma, memory decline and congestive heart failure, etc. They can avoid travelling to hospitals from one place to other and time to time to check their health state [6]. As they all are in unstable condition that may develop to emergency at any moment, for this condition the sensors will warn the medical staff remotely in order to mediate them [6]. The patients can also use the wireless sensors themselves for tracking their health daily and even remotely through the internet.

II. EXISTING TECHNIQUES IN HEALTH CARE SYSTEM

A. Real Time Wireless Health Monitoring:

Abdullah [1] has discussed the implementation of the Wireless Health Monitoring System and its components as follows :

1) *ECG Electrodes*: It is a device attached to certain parts of the patient's body like arms, legs and chest during testing procedure. It detects electrical impulses when each time heart beats. The electricity that electrode detects is transmitted through

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wire to a machine, which translates the electricity into wavy lines recorded on a piece of paper.

2) *LM35 Temperature Sensor*: The LM35 temperature sensors output voltage is linearly proportional to the temperature in Celsius.
3) *Blood Pressure Sensor*: It is a device that measures the pressure of the blood in the arteries as it is pumped around the body by the heart.
4) *Blood Glucose Sensor*: It is a medical device uses to calculate the blood glucose level.
5) *Microsoft Pro Tablet*: It is a mobile computer includes display, battery and circuitry in a single unit.

The system operates as the medical professional used three electrodes of ECG on the patient's body and connect the arduino shield with a temperature sensor, a blood glucose level sensor and a blood pressure sensor.From the arduino shield we connect a wireless node and the Tablet or the Smartphone that has Lab View software running on it to take reading of the patient's physiological data[13].The data are saved according to the time and presented in a report format and the data is then published in the internet by using tablet or smartphone so that the patient's report can be accessed by the authorized healthcare persons from remote locations at any time.

B. U-Healthcare System:

Yvette [2] has discussed about ubiquitous-healthcare system. It is an emerging technology that provide convenient healthcare service to patients, and to make it easy to diagnose patient's health condition. It promises increases in accuracy, efficiency and availability of medical treatment so people can monitor their health through online without visiting the hospital or clinic.

The traditional U-healthcare System Architecture is mainly divided as follows:

1) *Body Area Network (BAN)*:In this System Sensors are attached to body area to capture bio-signals, blood pressure, body temperature, pulse and breathing. It also divided into two parts that is, Wireless Body Area Network (WBAN) and Personal Monitoring Devices (PMD). The patient's PMD can be a personal computer or mobile phone. It gets information from WBAN and it contains logistics to determine whether to send this information to Intelligent Medical Server (IMS) or not through internet.
2) *Intelligent Medical Server (IMS)*: It is a backbone of the entire system and serves as a hub between the patient and hospital. Based on the data received from the BAN an agent determines whether patient is in a critical or normal condition. If it determines the patient is in a critical condition, the data is transferred to the hospital system. If it is not emergency, the data is simply stored in the IMS. Data stored in the IMS will be deleted after certain period of time unless there is an emergency and the necessary

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is regularly saved to the central database of the hospital and this data is available to doctors and support staff in the hospital.

3) *Hospital System*: In this system the hospitals staff will take corrective actions for the particular patient based on IMS report.

C. Security For Healthcare Systems :

LobnaYehia [3] has discussed about security for healthcare techniques. It plays an important role in healthcare applications. Introducing new technologies in healthcare system without considering security makes patient privacy vulnerable. The physiological data or report of an each and every individual patient is highly sensitive. The wireless medical sensors produce or collected large amount of data which must be secured from security attacks. To overcome from this problem by applying various algorithms or techniques, we can prevent many malicious attacks of data when transmitting to the remote locations. The success of healthcare applications mainly depends on patient security and privacy. Some of the secured healthcare applications based on wireless medical sensor network are as follows:

1) *Remote Monitoring*: It can be used to securely capture patient health data from sensors, apply complex algorithms to analyze the data and then send it through wireless connectivity with medical professionals.
2) *Physical Activity Monitoring for Aging People*: Body Sensor Network Measures (BSN) measures temperature, blood pressure, heart rate and records activity data.
3) *Patient's self-care*: Body Area Network on a diabetic patient could be helpful to auto inject insulin through a pump, as soon as their insulin level decreases.
4) *Chronic Disease Management*: Patient monitoring systems with comprehensive patient statistics could be available for remote residential monitoring of patients with chronic diseases such as diabetes and heart problems.

D. Intelligent E-Health Gateway Based U-Healthcare Systems In IoT :

Niranjana [4] has discussed about Intelligent E-Health Gateway based U-Healthcare system and classified as follows:

1) *Intelligent E-Health Gateway*: The main requirement of a gateway is to support different wireless protocols andinter-device communication. It is used to support several features such as a temporarily store sensors and users information by bringing intelligence and enhancing with data fusion, aggregation, and interpretation techniques by essential to provide preliminary local processing of sensors data to becoming an Intelligent E-health gateway. It receives data from different sub-networks, performs protocol conversion.
2) *Medical Sensor* Network: In ubiquitous identification and sensing communication capacity, biomedical and context signals are captured from the body used for treatment and diagnosis of medical states[7,8].

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Then the signals are transmitted to the gateway through wired or wireless communication protocols such as Serial, Bluetooth, SPI, IEEE 802.15.4 or WI-FI.

3) *Intelligent Medical Packaging*: Some of them senior citizens have chronic diseases and it is critical to follow the doctor's advice to take their prescribed medicine at the proper time. However noncompliance with medication is becoming more prevalent. The levels of noncompliance may be affected by psychological factors such as the patient's level of anxiety, attitude towards their illness, motivation to recover, as well as the fact that many senior citizens suffering from amnesia often forget to take the prescribed medicine on time. Prescribing clinicians frequently do not often detect or ask about noncompliance and are not always good at recognizing when patients stop taking their medication. If possible, it is important to maintain routine contact with the doctor to discuss, among other things, compliance issues. An intelligent medication administration system is desirable to timely remind and dispense the medicine to individuals, and in the meantime, register and track their medication history.

E. E-HealthcareKey Management Proposed Solution:

AnassRghioui [5] has discussed about E-Healthcare monitoring system where the patient carries a set of WBAN devices and can move from one place to another, but still always on the reach of the gateway that bind the sensors with the medical central unit. These devices communicate remotely through the internet with a monitoring medical central unit installed in a hospital or clinic responsible for monitoring patient's health status[14,15]. Caregivers can connect through the internet via computers or mobile devices to the medical central unit to supervise patient data processed and analyzed by dedicated applications. The object is to address the data privacy of the mobile WBAN sensors exchanged with the remote medical central unit.

This scheme is based on the symmetric cryptography with a session key management system and a node authentication model with an identifier ID. Each node has a unique identifier stored in the server database, which must be kept secret and must never be communicated in plaintext.

1) *Assumptions*: It consist of the medical central unit (MCU), a gateway G and WBAN sensors. Each one of WBAN sensor has a unique identifier ID that must be already registered on the MCU or registered by the user at the time of the WBAN deployment and a secret number Ns that must never be disclosed.
2) *Key Establishment*: Every sensor will obtain two symmetric keys. One unique key shared with the MCU that the sensor will use to encrypt sensed data and the other is a group key shared with the G that will be used only to encrypt non sensitive updates of the system.

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3) *Key Update*: Rekeying pays the system protection by changing the security keys in a specific time interval. All the old session keys must be deleted after generating the new key and constraint in the rekeying is the good choice of changing key frequency and a change in very short time interval will consume nodes resources and the choice of a longer period will offer to attackers more time to compromise the keys.
4) *Node Revocation*: MCU detects a compromised node or an intruder, firstly it marks it as malicious in its database and signal an alarms about it.
5) *Integrity*: It is to exclude any changing to be made by an unauthorized intruder and to assure that the data coming from the sensor have not been tampered by this intruder.
6) *Mobility Case*: It created solution to deal with mobility, as the sensor is linked directly to the MCU by its symmetric key, so even if it changes the gateway, the service will continue working normally and the data still always secured.
7) *Key Connectivity*: It is determined by the number of keys that every node must have to ensure the stability of communications within the network. Each node has two different keys: the first is a single and unique, the unique key shared between each sensor and the MCU. The other key concerns the group key shared between the sensors and the gateway.
8) *Scalability*: It is flexible regarding changes in network topology and supports scalability; it suffices that the sensor been stored in the database of the MCU to make it able to join the WBAN network.

F. IoT For An Age-Friendly Healthcare:

Evdokimos [6] has discussed about age-friendly healthcare system. It consists of two distinct components, namely Controller Application Communication (CAC) framework and an XMPP network. Both components enable real-time communication between different entities. The CAC framework integrates multiple controllers and provides input to systems and applications such as exergaming platforms. On the other hand, medical devices, software components, disease management and elderly support services such as Decision Support System (DSS) communicate with each other using the XMPP protocol.

1) *Adoption of the XMPP protocol and its extension*: XMPP is a real-time communication protocol used for instant messaging, file transfer and IoT, uses TCP as a Transport layer, but can also communicate over HTTP using Bidirectional-streams over Synchronous HTTP. To integrate medical devices into our system, we have adopted the sensor data XMPP Extension Protocol (XEP-0323) which provides a framework for sensor data communication taking into account hardware limitations of sensors and peripheral devices.
2) *The IoT Enabled Glucose Meter Sensor*: It consist of an off-the-self glucose meter device, the Life scan One Touch Vita[7], and an intermediate hardware IP ready device. The intermediate hardware is responsible for the connectivity of the glucose meter to the XMPP server by acquiring measurements of the

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glucose device (wired connectivity) and transforming them to XMPP (XEP-0323) compatible messages. The intermediate hardware scans the glucose meter periodically for any updated measurement. In case a new one exists, it is transmitted to the XMPP server.

3) *Physical Training*: As usual, a diabetic senior regularly measures his/her blood glucose levels. The emerging platform takes the advantage of the IoT enabled glucose meter by prompting the user to postpone the exercise until glucose in blood is in the appropriate levels. In this approach, the system checks if a glucose meter is connected to the XMPP server. If it is connected, then it makes a request to the glucose meter and measurements shown to the user along with some suggestions. For example, if the blood glucose level is too high, a message is shown to the user suggesting them to continue the exercise later on. Moreover, it request for a new glucose level if the date of the last measurement exceeds a defined time interval.
4) *Disease Management*: On the server side, a service is constantly connected to the XMPP server and collects the users' available measurements by querying periodically the medical devices through XMPP messages. The implemented service is responsible for pushing the measurements to a database in order to make them accessible by the USEFIL components.The USEFIL DSS was designed as a spatio-temporal model consisting of artificial intelligence methods manipulating data related with user activity and physiological classification.

III. CONCLUSION

In today's world, health monitoring is becoming very important as there is an increase in health graph due to various unpredictable diseases. In this paper we have discussed various a health monitoring systems, taking smart phone as a tool. By using such monitoring systems, the healthcare professionals can monitor, diagnose, and advice their patients from a remote location at all the time and doctor or patient can access report through online. Also the study analyses the U-healthcare system with respect to the IoT perspective. U-healthcare system is the integration of different technologies and computing system. These include sensor devices to gather patient's physiological data.This paper also discussed some security techniques that are used in data security for healthcare applications that can be applied in IoT environment security issues and presented security keys for symmetric cryptography to ensure the privacy of the WBAN sensors in the context of IoT. It also proposes to exhibit the step by step development methodology concept in prototyping the Intelligent E-health gateway including intelligent medical packaging and medical sensor networks. For purpose of demonstrating the feasibility of the approach, an exergaming platform and a disease management tool were used as a test case scenario.

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