© 2017 IJSRSET | Volume 3 | Issue 6 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Importance of Electronics in Health Monitoring System

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ABSTRACT

This paper illustrates the design and implementation of an e-health monitoring networked system. The architecture for this system is based on smart devices and wireless sensor networks for real time analysis of various parameters of patients. This system is aimed at developing a set of modules which can facilitate the diagnosis for the doctors through tele-monitoring of patients. It also facilitates continuous investigation of the patient for emergencies looked over by attendees and caregivers. A set of medical and environmental sensors are used to monitor the health as well as the surrounding of the patient. This sensor data is then relayed to the server using a smart device or a base station in close proximity. The doctors and caregivers monitor the patient in real time through the data received through the server. The medical history of each patient including medications and medical reports are stored on cloud for easy access and processing for logistics and prognosis of future complications. The architecture is so designed for monitoring a unitary patient privately at home as well as multiple patients in hospitals and public health care units. Use of smartphones to relay data over internet reduces the total cost of the system. We have also considered the privacy and security aspects of the system keeping the provision for selective authority for patients and their relatives to access the cloud storage as well as the possible threats to the system. We have also introduced a novel set of value added services through this paper which include Real Time Health Advice and Action (ReTiHA) and Parent monitoring for people with their family living abroad. Keywords—e-health monitoring; wireless sensor networks; smart devices; remote health advice.

Keywords : Internet of Things, Defense and Public Safety, Smart City, Health Monitoring System, Industry.

I. INTRODUCTION

Wireless Sensor Network (WSN) has paved the way for advancements in various aspects of sensing. These advancements have been possible with arrival of smart sensing techniques, smaller transceiver and sensing modules as well as stronger processing units. Applications of WSNs range from military applications to global climate monitoring applications and from applications in underwater networks to applications in structural health monitoring and beyond. An important aspect of WSN has been the design of health monitoring systems centering on wearable sensor modules for patients. With the ageing population around the world, research into health monitoring application has gained prominence over the recent years.

The proposed e-health monitoring is highly suitable for the following four scenarios. Firstly patients with unstable physiologic regulatory systems for e.g. a patient suffering from respiratory congestion as a result of drug overdose or anesthesia. The second situation for patients is those with a suspected life threatening situation, e.g. diagnosis predicting possibility of a heart attack. Thirdly are patients with a high risk of developing a life threatening condition (e.g. a baby born with an abnormality in the heart or lungs). The fourth type of patients requiring monitoring is those with a critical physiological state, for e.g. patients with a major trauma or recovering post accident. Our system is also designed for the elderly people who require regular monitoring for multiple instances of the above mentioned cases. This system is aimed at facilitating accelerated diagnosis of diseases and also increased efficiency and accuracy in the process. It is also designed to instill a sense of security in the patient at all times by providing instantaneous attention for emergencies. In our architecture for the system, the smart device plays a major role in processing as well as relaying of data acting as a gateway hence reducing

costs in the process. We have developed this architecture keeping in mind the prospect of this being used in rural parts of India, where health care units and hospitals are not as well equipped as their urban counterparts. In these regions, this system with mobile sensors and smart devices can be implemented for prognosis of patients. The rest of the paper is organized as follows. The underlying framework and architecture of the system for monitoring of patients is mentioned in Section II. Section III illustrates in detail the design of this system. The privacy and security issues regarding this system are taken into consideration in Section IV along with countermeasures to these issues. Section V and VI illustrates a use case and stateof-the-art respectively. We have discussed the prospects of this system and its applications in the concluding section.

Monitor parameters of the room including room temperature, oxygen levels and beyond. The data accumulated by the sensors are relayed to a processing device which attaches several data like unit, timestamp etc. and thereby creating metadata. With that, one unique id is attached to each unit data in order to distinguish which report is for which patient. The data is sent to the next layer in the hierarchy through Gateway . The data is transmitted in the form of Sensor Markup Language.

II. APPLICATION OF ELECTRONICS IN HEALTH MONITORING SYSYTEM

1.E-Health Application and Service Layer

The third layer of the system is a terminal layer offering outsourcing services for the monitored data. This layer offers E-health Advice services to the patient. This process involves prescribing medicines or providing suggestions to the patient correlating to the values of parameters that are being received from the sensors. Based on the pattern of data from the previous medical records of the patient, the e-health services offer advice comparing the previous trends with the current trend of sensor data. The emergency response system plays the role of informing the doctors and the caregivers in accordance with the level of emergency. Depending on the level of emergency the response team takes required action. The hospital module monitors the patient remotely from the location of the patient, if the monitored patient is at home or a remote location. This module also allows analysis of all patients under monitoring centrally in the hospital or health care centre.

2. Data quality modeling over e-Health monitoring applications

Our vision of data quality concerning e-Health monitoring applications is inspired on exiting data quality approaches as [26], [24], [23], [22]. We argue that the data quality can be defined according to several perspective or categories (Figure 5). Such categories can be defined according to several views of quality over the system [19], [18]. In our particular analysis, each view refers to each data management and processing levels depicted in Section 3.3 (data collection, data processing, data delivery). With this, we try to preserve a “product view” of the quality allowing a more clearly quality issues tackle. We estimate that these views are not exhaustive and they can be extended or modified according to systems characteristics and quality goals. Figure 5. Conceptual model of quality Data quality can be measured by a set of quality dimensions. Each dimension refers to one or several quality criteria (factors or attributes) representing the characteristics which data has to meet. Also, each quality criteria is evaluated by a quality metric and being measured applying measure methods (qualitative or quantitative). A quality measure enables to specify the set of quality indicators that are used to control, maintain or improve and information system. All these quality elements are related to a quality evaluation procedure, traditionally developed as a framework. In our case of study, we observe that the big picture of data quality is generally illustrated by the accuracy and reliability of data. The more accurate and reliable data is, more confident and relevant decision will be taken by the actors (patients, medical experts, medical services…). However, as we state before, other complementary perceptions of quality are also necessary in our context. Thus, in order to define the optimal data quality criteria, we decide to analyze, at first place, the pertinence and usefulness (or applicability of the basic and most used quality criteria in the healthcare domain [23]. Such criteria are: Accuracy, Precision, Accessibility, Currency or Freshness, Consistency, Relevancy, Comprehensiveness.

3. Data quality issues on e-Health monitoring applications:

To correctly identify data quality issues, we must recognize the source of quality problems, analyze its impact and, where possible, propose a solution. In our particular application domain, there are many contextual reasons why it is difficult to maintain a good quality of data. Some difficulties are related to technology (i.e.

equipment, body sensors, QoS – Quality of Service), to human intervention (wrong manipulation, input errors, misunderstanding…), or to process of data transformation (i.e. optimal analysis and processing). Figure 4. Data management, processing and delivery levels on e-Health monitoring application To tackle this aspect, mainly focused on STM3 project scenario, we study at first the characteristics of this kind of applications according to data flow (from data source until destination). We try to identify where, when and how an impact over data quality occurs. For this, we define three main levels of data management and process over the system (Figure 4), defined as: Data collection, Data processing and Data discovery.

4. Tracking Threats

An adversary can obtain someone's health status while he/she is busy exercising in a health-club. Based on a sensor's captured data a malevolent user can guess the current activity of a patient and he may send the wrong exercise tips to the patient that could cause them severe pain. Considering another example, an athlete is being monitored using a wireless sensor network while he/she is practicing in the club. Medical sensors are placed on the athlete's body, which sense health data, e.g., heart-rate, time and location, and send health feed back to the base station, so it might be possible for an adversary to modify the athlete's health data, which may bring the athlete under suspicion in doping tests that could even spoil the athlete's career.

5. Privacy Issues

As wireless healthcare applications are not limited to monitoring the patient's physiological data, but they also include emergency management, healthcare data access, electronic health records, *etc.* Further, individuals share their data with physicians (in a doctor-patient relationship), insurance companies (for insurance protraction), and health-coaches (as sports team trainers) or with family (as relatives' support for recovery). So there is value in addressing the privacy issues that are ethical from a social point of view. We adopt the privacy definition from National Committee for Vital and Health Statistics (NCVHS), which is consultative board of the United States Department of Health and Human Services. "Health information privacy is an individual's right to control the acquisition, uses, or disclosures of his or her identifiable health data ". To maintain privacy, patients should have the rights to determine which data should be collected, used or disclosed. Any unauthorized collection or leakage of patient data could harm the patient. For example, an unauthorized person may use the patient data (such as, patient identity) for their personal benefit, such as for medical fraud, fraudulent insurance claims, and sometimes this may even pose life-threatening risks . As the medical data is very sensitive by the European Union Data Protection Directive , thus, there questions arise: who owns medical information, and how to control the access to medical data? Further, in wireless healthcare applications, huge amount of health and life-style data are gathered that need close attention to who controls it, what is gathered, who has rights to access it and where/how/whether that data is stored or not .

III. CONCLUSION

A lot of research and effort has gone into the making of a better and well improved healthcare monitoring system, even for remotely located patients. Only a few of these researches have taken into consideration of the environmental factors that affect the human health state. Thus, this paper puts forth the necessity, method and various trends in using both medical and environmental sensors. Further, taking advantage of the advanced technology available to the general public, a remote healthcare monitoring system that is capable of providing health parameters by wireless means to Smart Phones of both patient and physician, it is possible to provide immediate diagnosis simply through the click of a button.

IV. FUTURE WORK

In order to implement future improvements to the health monitoring network we can introduce new sensors such as cameras, ECG sensors as well as location tracking capabilities. We can also plan to integrate alarm triggering algorithms and advanced security techniques in Wireless Sensor Networks which would be essential in a health monitoring environment. Another aspect to consider is involving wearable sensors or wearable sensors that may well be cheaper and more diverse in utility which can lend a hand in improving the already existing systems.

To implement a remote healthcare monitoring system. In these sensors to monitor the medical parameters such as Blood Pressure, Heart Rate and Temperature are designed and interfaced to the microcontroller

ATmega16. This microcontroller having inbuilt ADC which converts the sensors input analog signals to digital signals. These days, wearable sensors such as heart rate monitors and pedometers are in common use. Several products are already on the market, such as the Lifeshirt, developed by Vivometrics, the body monitoring system developed by BodyMedia and the Nike-Apple iPod Sports kit which facilitates individualized feedback control of performance during exercise periods. The Heart Beat Sensor provides a simple way to study the heart's function. This sensor monitors the flow of blood through Finger. As the heart forces blood through the blood vessels in the, the amount of blood in the Finger changes with time. Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. It consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. When the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heartbeat. The proposed design has a significant advantage: introducing environmental sensors that collect context information will help in analysis of the medical data. When, e.g., a patient is doing sports, medical parameters like heart rate or O2 saturation have to be interpreted differently compared to the same person sleeping in bed. It is estimated that 70% of all illnesses are preventable, and if suitable screening measurements were introduced, this could produce dramatic reductions in costs for treatments and medication. The environmental sensors mainly include temperature sensors, humidity sensors, and in case of emergency, an alarm signal from smoke detectors. It happens to be very important that the inclusion of special circumstances sensors such as smoke detectors be included so that the attending physician may communicate the appropriate course preventive diagnosis even when the patient is remotely stranded. The processed signals from the respective medical sensors and the environmental sensors are now sent to ATmega16 Microcontroller that process the received signal and displays on the development kit, but more importantly now proceeds to the next phase of the monitoring system, that is to communicate the received results to the patient and physician. The received data is communicated by simple means of Bluetooth via UART serial communication. In the proposed system we use two RF Bluetooth that are Transceivers and may act as either a transmitter or a receiver. We should note that communication is possible only when one Bluetooth acts as a transistor and the other as a receiver.

Communication is not possible for a pair of transmitters or a pair of receivers. The received information is sent to the respective Smart Phones via UART. The Smart Phone is capable of displaying, monitoring, recording and sharing the received information, thus saving cost on display, and recording devices. This solution not only gives patient more freedom, but also provides early diagnosis of cardiac diseases with its alarming properties.

Different methods with similar goals have been researched and implemented. Shibu J and Ramkumar.R proposed a technique that provides a non-invasive approach to health care monitoring that allows the individual to keep record of their own health records, by use of smart card.This methodology effectively reduces the time of the patients to be spent within the hospitals additionally it permits us to access the health parameters from anyplace by swiping the smart card in the smart card reader.

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