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Healthcare Monitoring System Using Smartphone

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ABSTRACT: It is very important to ensure various medical parameters and post operational information. To access the patient's medical parameters in local and remote area healthcare communication using Internet of Things (IoT) method is adapted. The main intention of this project is to transmit the patient's health monitoring parameters through wireless communication. This input information is uploaded to a cloud LPU or local LPU and transmitted to the computer and mobile for family and doctor's reference.

KEYWORDS: Internet of Things (IOT), Security, Raspberry Pi, Arduino

I. INTRODUCTION

The healthcare remote monitoring systems have turn out to be a key contributor to the enhancement of the elderly people's quality of life. The market division of healthcare remote monitoring systems has greater than before significantly due to several reasons. The number of elderly people is greater than ever over the time where today in developed countries it is quite normal that elderly people usually live independently in their homes. Furthermore, Internet of things (IoT) [1] makes this healthcare remote monitoring systems technically feasible (IoT as the concept of a monitorable and adjustable world in which sensors and actuators over the living and non-living objects) and the even falling cost of sensors makes it economically possible. Due to the infiltration of smart mobile technology, it is also predictable that population is already ready to accept this kind of solutions collecting in real time people's private and sensitive information such as temperature, blood glucose, heartbeat, the pulse oximetry sensor to name a few. For example, healthcare personal analyzers such as smart beds automatically report to who are occupying them and even more, they are able to inform about different patient's physiological levels, making real smart home medication dispensers too, for instance, automatically alert when medication is not taken. Some healthcare remote monitoring systems using dissimilar technology for monitoring and/or tracking patients and/or biomedical equipment's inside Hospitals and at their homes. Unfortunately, as far as we know, most of these solutions are not flexible at the moment of adding new sensors during runtime. Neither has it permitted normal users to create ad-hoc alerts directly with the new sensors added.

II. RELATED STUDIES

Tao Liu and Dongxin Lu [2] summarize the concepts of IoT (the internet of things), introduced the different comprehensions, history of IoT, and illustrated the key technologies of IoT, and applications of IoT. The EU estimates that the IOT is not yet mature, and just a few promising prospects for the technology is expected to be after 5 to 15 years, will greatly change our society. Chinese media think that the IOT as the wave of the third information technology as a trend in the next few to stimulate economic development, bringing huge investment in related industries but China is still developing the standard of IOT; the relevant technology is not mature. But the IOT will change our life and we will be much smarter.

CodeBlue [3], [4] is based on BSN developed at Harvard Sensor Network Lab. In this architecture, several bio-sensors are positioned on patient's body. These sensors sense the patient body data and send out it wirelessly to the user's device (smart phones, laptops, and PCs) for additional examination. The initial plan of the CodeBlue is simple, a medical expert gives a statement for patient health information using their individual smart phones, which is depends

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on an available and subscribed architecture. Besides, Code Blue's experts recognize the requirement for security in medical applications, but security is still pending for future work.

IulianaChiuchisan, Hariton-Nicolae et al. [5] proposed architecture for a health-care system to monitor patients at threat in smart ICU. The architecture counsels and alerts in immediate to the medical experts about mutable of vigorous constraints or the progress of the patients as well as main changes in environmental parameters, in order to get prediction.

In 2006, Chakravorty provides a wide-area mobile patient monitoring system known as MobiCare that facilitates permanent and periodic monitoring of the patient's physiological status. Although, Chakravorty [6] recognized the safety measures in MobiCare, but only addressing safety measures are not enough for real-time healthcare applications. Thus, security and privacy is left for future work.

III. ENFORCEMENT OF SECURITY IN HEALTH CARE SYSTEM

We partition all security into two parts: network security, and data security. Network security comprises authentication, anonymity, and secure localization. On the other hand, data security includes data privacy, data integrity, and data freshness. Now, to the best of the knowledge, there is no two-party authentication protocol which can achieve all the foresaid properties of the network security. Hence, in order to accomplish all the network security requirements here, we propose a lightweight anonymous authentication protocol. Subsequently, to accomplish all the data security requirements we adopt OCB authenticated encryption mode.

Data Privacy:

Keeping data privacy does not defend it from outer changes. Deficiency in security mechanism is risky particularly in case of life-critical data is altered. Information loss can also take place due to the bad communication environment.

Data Freshness:

The opponent can collect data time to time in transmission and replay them later using old key in order to confuse the end user. It implies that data is fresh and nobody can replay the old message.

Authentication:

All the sensor nodes send out their data to a coordinator. Then the coordinator sends episodic updates of the patient to a LPU. In this situation, it is highly very important to ensure both the identity of the coordinator and the LPU. Authentication helps to verify their identity to each other.

IV. SYSTEM ARCHITECTURE

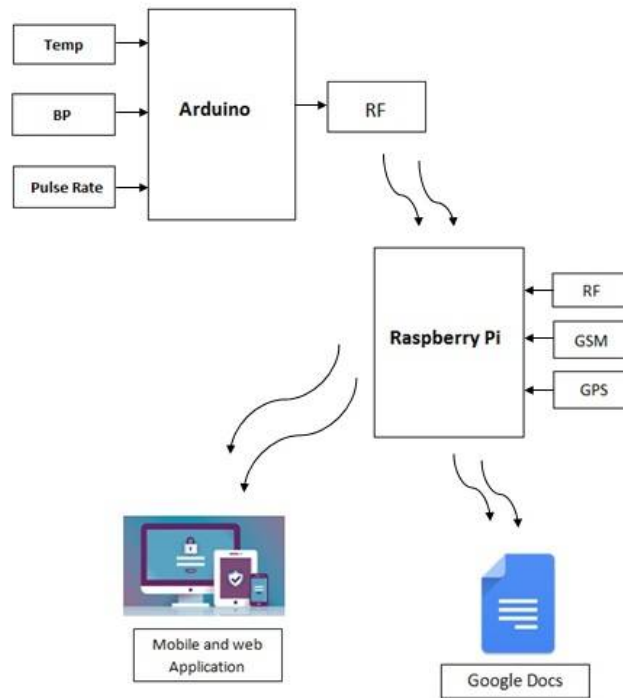
Body Sensor Network (BSN) allows the combination of intelligent, small sized low-power sensor nodes around human body to monitor body parameters and the adjacent environment. It has a large prospective to transform the upcoming healthcare technology and attained a many researchers from the academia and industry in previous years. Generally, BSN contains on-body sensor networks. On-body sensor network allows communication between non-invasive/wearable devices and a coordinator. Now, our BSN-Care (shown in Fig. 1) is a BSN architecture collected of wearable and implantable sensors.

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Each sensor node is integrated with bio-sensors such as Blood Pressure (BP), Temperature (TP) and Pulse Rate (PR) etc. These sensors gather the physiological parameters and forward them to a Local Processing Unit (Raspberry Pi), then Raspberry Pi forward parameters to the portable device such as PDA, smart-phone by using the wireless communication medium such as mobile networks 3G/CDMA/GPRS. Besides, when the Raspberry Pi detects any abnormalities then it provides an instant alert to the person that wearing the bio-sensors. For example, in general, BP less than or equal to 120 is normal, when the BP of the person reaches say 125, the LPU will give alert to the person through the LPU devices (e.g. SMS in a mobile phone).

When Raspberry Pi receives data of a person (who wearing several bio sensors), then it analyzes that information. Subsequently, based on the degree of abnormalities, it may interact with the relatives of the person, local physician, or even emergency unit of a nearby healthcare centre. Precisely, considering a person (not necessarily a patient) wearing some bio sensors on his body and receives periodical updates from these sensors through LPU. Now, our LPU maintains an action table for every category of sensors information that it receives from LPU.

Temperature (⁰ C)	Pulse Rate (bpm)	BP Systolic (mm Hg)	BP Diastolic (mm Hg)
37	72	104	64
42	91	88	77
38	75	96	68
40	80	114	71
32	70	94	76

Table 1.Example of Action Table Using BP Data

Table I denotes the action table based on the data received from BP sensor, where we can see that if the BP rate is fewer than or equal to 120 then the LPU does not carry out any action. Now, when the BP rate becomes greater than

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130, then it informs family members of the person. If BP rate becomes larger than 145 then LPU will contact the local physician. Furthermore if the BP rate of the person cross 160 and still there is no response from the family member or the local physician then the LPU will inform an emergency unit of a healthcare centre and securely provides the position of the person. Here, the response parameters “FR” (Family Response), “PR” (Physician Response), and “ER” (Emergency Response) are the Boolean variables, which can be either true (T) or false (F). If the value of some response parameter is false, then the LPU repeats its action. It should be noted that our BSN-Care system is not only designed for the patient, instead of that it can be useful for providing a decent quality of life for the aged people.

BSN BP Data	Action	Response
BP ≤ 120	No Action	Null
BP > 130	Inform Family Members	FR:T/F
BP > 160 and FR:F	Inform Local Physician	PR:T/F
BP > 160, FR:F and PR:F	Inform Emergency	ER:T/F

FR: Family Response; PR: Physician; ER: Emergency Response

Table 2. Different body parameter Readings

Algorithms:

AES Algorithm for Encryption: Advanced Encryption Standard (AES) algorithm provides security and speed. Both the hardware and software execution are faster still new encryption standard suggested by NIST to replace DES. Encrypts data blocks of 128 bits in 10, 12, 14 rounds depends on key size as shown in figure. It can be executed on various platforms particularly in small devices. It is suspiciously tested for many security applications. 128-bit encryption is a file encryption technique that uses a 128-bit key to encrypt and decrypt data or files. It is one of the most secure encryption methods used in most modern encryption algorithms and technologies. 128-bit encryption is considered to be logically unbreakable.

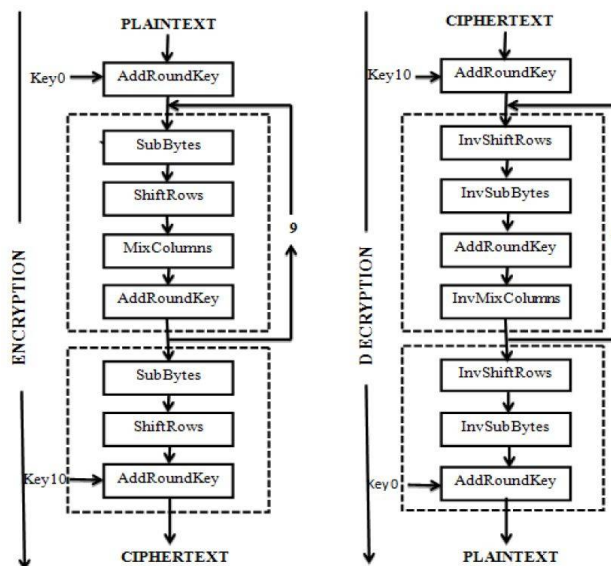


Fig 2. AES Algorithm

V. SYSTEM IMPLEMENTATION

Here, researcher designed health monitoring system using Raspberry pi microcontroller with Wireless Body Area Sensor Network (WBASN). In this work, the sensors are used here Temperature sensor, Blood pressure sensor, Heart

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beat sensor. These sensors are placed on human body which are helps to monitor the health condition without disturbing the daily routine of the patients and these health related parameters are then communicated to physicians server using long range wireless technology.

In the conventional approach the healthcare experts will play the main role. They require to stopover the patient's ward for essential analysis and advising. There are two fundamental issues associated with this method. Initially, the healthcare experts must be present on site of the patient continually and another is the patient remains admitted in a hospital, bedside biomedical instruments, for a given time period. So to overcome these two problems, the patients are given knowledge and information about disease diagnosis and prevention. Our model uses temperature sensor to check the temperature level of human body. Blood pressure sensor is used to measure the blood pressure of human body, Heartbeat sensor is used to calculate the heart beats per second. The system is connected to this application using internet connectivity for communication. It is Raspberry Pi certificated and designed to be hardware, software, and pin compatible with large range of Raspberry Pi shields.

The app is android & web based which is connected to the internet thorough either Wi-Fi or GSM service.

Modules

Raspberry Pi:

The Raspberry Pi 3 is the third generation Raspberry Pi. It replaced Raspberry Pi 2 Model B. The Master-card sized computer is able to do many things that your desktop computer does, like spreadsheets, word-processing and playing HD video and games. It is compatible with several versions of Linux. Here we used Raspberry Pi for collecting data from RF sensors, process that data and send it to the user through internet.

Temperature sensor:

The LM32 is a digital temperature sensor that measures 3 temperature zones and has a single-wire interface compatible with National Semiconductor's Sensor Path bus. Sensor Path data is pulse width encoded, thereby allowing the LM32 to be easily connected to many general purpose microcontrollers. The LM32 measures the temperature of its own die as well as two external devices such as a processor thermal diode or a diode connected transistor. The LM32 can resolve temperatures up to 255°C and down to -256°C. The operating temperature range of the LM32 is 0°C to +125°C.

Blood Pressure sensor:

Blood pressure (BP) is the pressure exerted by circulating blood upon the walls of blood vessels. BP usually refers to the arterial pressure in the systemic circulation. Blood pressure is usually expressed in terms of the systolic (maximum) pressure over diastolic (minimum) pressure and is measured in millimeters of mercury (mm Hg). It is one of the vital signs along with respiratory rate, heart rate, oxygen saturation, and body temperature. Normal resting systolic (diastolic) blood pressure in an adult is approximately 120 mm Hg (80 mm Hg), abbreviated "120/80 mm Hg".

Blood pressure changes depending on situation, activity, and disease states. It is regulated by the nervous and endocrine systems. Blood pressure that is low due to a disease state is called hypotension, and pressure that is consistently high is hypertension. Both have many causes which can range from mild to severe. Both may be of sudden onset or of long duration. Longterm hypertension is a risk factor for many diseases, including heart disease, stroke and kidney failure. Long term hypertension is more common than long term hypotension in Western countries. Long term hypertension often goes undetected because of infrequent monitoring and the absence of symptoms.

Heart rate sensor:

A heart rate monitor is a personal monitoring device that allows one to measure one's heart rate in real time or record the heart rate for later study. It is largely used by performers of various types of physical exercise.

Result:

According to the proposed plan and design platform, this project is implemented using Raspberry Pi, sensors, GSM module. The complete system helps to solve the problem of daily health check up and emergency condition as well as it helps to create communication between patient and doctor.

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A sensor connected to patient's body, senses the body parameters like Temperature, Blood Pressure and Heart rate and gives analog output to the microcontroller.

Microcontroller consists of integral analog to digital convertor so the analog values are converted into digital values using analog to digital convertor. Digital values show on the LCD screen.

If the digital values surpass the threshold values then GSM module is used for emergency SMS alert. GSM module sends an emergency SMS alert to the doctor's Smartphone. It also predicts the disease from the calculated values.

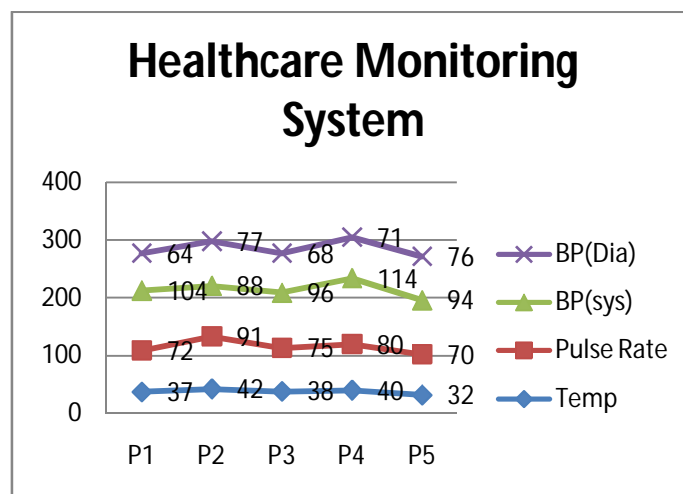


Figure 4. Graph for Different body parameter Readings

Action occurred from change of sensors values:

- **Temperature**

R1: If (39 > Temp => 38) then Action 1 - Send Message "You have chances of Fever"

R2: If (40 => Temp => 39) then Action 2 - Send Message "You have High Grade Fever" also send message to family members.

R3: If (Temp > 40) then Action 2 - Send Message "You have Extremely High Fever" and Also sends message to relatives, nearby physicians and nearby hospitals.

- **Pulse Rate**

R1: If (171 => PR => 152) then Action 3 - Send Message "You're Heart Beat is Immoderate"

R2: If (190 => PR => 171) then Action 4 - Send Message "You're Heart Beat is Maximum (High Intensity Zone)" and sends message to relatives, nearby physicians and nearby hospitals.

- **Blood Pressure: (Systolic / Diastolic)**

R1: If (90 => BP => 70) then Action 5 - Send Message "You're Blood Pressure is LOW (Systolic)"

R2: If (60 => BP => 40) then Action 6 - Send Message "You're Blood Pressure is LOW (Diastolic)"

R3: If (140 => BP => 120) then Action 7 - Send Message "You're Blood Pressure is INCREASING (Systolic)"

R4: If (90 => BP => 80) then Action 8 - Send Message "You're Blood Pressure is INCREASING (Diastolic)"

R5: If (190 => BP => 140) then Action 9 - Send Message "You're Blood Pressure is HIGH (Systolic)"

R6: If (100 => BP => 90) then Action 10 - Send Message "You're Blood Pressure is HIGH (Diastolic)"

VI. CONCLUSION

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Internet of Things has many applications in different areas. It has been developed for health monitoring. This system presents the architecture of Remote health monitoring. There are some problems found in IoT and existing health monitoring. New technologies could help to minimize them by achieving the better quality as well as web-based security concept. This system presents the problems and challenges that could come.

New technologies and methodologies which are already used to improve applications of IoT have been discussed in this project. Raspberry Pi kit, temperature, blood pressure, heart beat rate sensors are used for implementation of Mobile Healthcare monitoring systems.

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