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A Smart System Connecting E-Health Sensor and Cloud

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Abstract- **This presents the design and implementation of an e-health smart networked system. The system is designed to prevent delays in the arrival of patients' medical information to the healthcare providers, particularly in accident and emergency situations. The engineering for this system is based on medical sensors which measure patients' physical parameters. These sensors transfer data from patients' bodies over the wireless network to the cloud environment. Internet of things is a system that connects physical objects, people etc to the internet by assigning an IP address (IPV6) to everything on the earth. We propose a smart health monitoring system whereby IOT technology is implemented to monitor the health status of the patient and alert the doctor in case of emergency and cloud computing to store the information. We use Raspberry Pi 3 model to collect data from various respective sensors and display them on the web page in real time. Therefore, patients will have a high quality services because the e-heath smart system supports medical staff by providing real-time data gathering, eliminating manual data collection, enabling the monitoring of huge numbers of patients.**

Keywords: Internet Of Things; Cloud Computing; Raspberry Pi; Sensors.

1. INTRODUCTION

In this paper we focus on the idea of integration between wireless sensor network(WSN) and cloud computing. After health sensors that are connected to patients' bodies collect and transmit data to the cloud, services which are available in this cloud are responsible for receiving, storing, processing, and distributing this data. We suppose that this solution offers an appropriate scenario to provide a comprehensive telemedicine service which automates the processes from collecting patients data to delivering compatible medical decisions based on patients' current conditions and their historical medical data. Wireless Sensor Networks (WSNs) have facilitated the way for development of various aspects of sensing. Cloud Computing is a general expression for any technological services provide through the Internet.

II. MOTIVATION

Providing healthcare services is very important for people specially who have chronic diseases. Those people need continuous healthcare which cannot be provided outside hospitals. There are a variety of technologies around us, so to get benefits from connecting such technologies to build a new e-health system platform could help to achieve high quality health care services. There are many reasons which motivate us to build this platform: (1) making healthcare more accessible for people who do not have access to healthcare providers in their communities; (2) making healthcare easier for people who do not have access to public transportation in order to go to hospitals; (3) increasing bed capacity in hospitals, especially during public events where a large number of people are meeting in one place; (4) preventing delays in the arrival of patients' medical information to the healthcare providers, particularly in accident and emergency situations; and (5) reducing manual data entry for patients' data which prevents real-time monitoring.

III. PROPOSED WORK

The architecture of the proposed solution is based on the integration between medical sensors which are responsible for collecting patients physical parameters and the cloud environment to provide a smart health system.

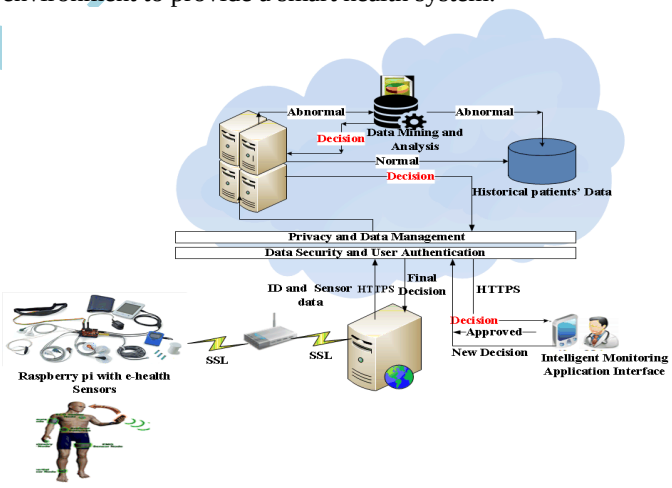


Figure 1: Proposed System

As shown in Figure 1, the wireless health sensors are connected to a Raspberry Pi. This Raspberry Pi is responsible for collecting data from sensors and transmitting this data through wireless communication channels to platform services hosted on the cloud. This platform has many services: (1) storage service, which is responsible for storing sensors' data; (2) data mining service, which is responsible for providing a medical decisions based on patients historical medical data; and

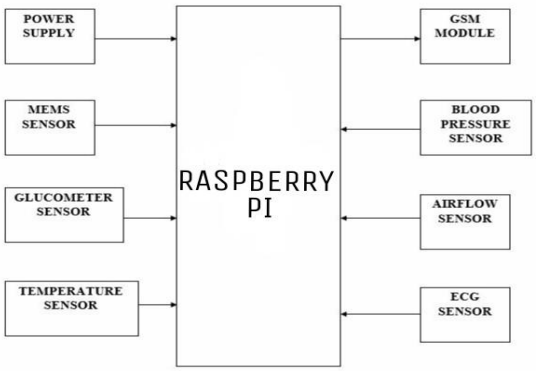
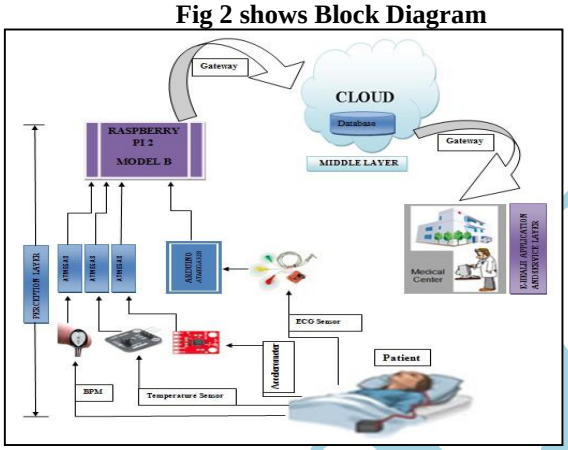


Fig 2 shows Block Diagram



(3) managing service for updating, reviewing and testing patients' data which is needed by medical staff. Medical staff and patients can utilize the application from different mobile and stationary devices connected to the Internet.

Security and privacy are the significant factors related to the cloud environment. The cloud computing environment provides numerous computing resources that are shared. Therefore, in order to achieve data security and privacy in our system, we apply two techniques, which are:

1) Socket Secure Layer (SSL), which is a popular technique for establishing an encrypted channel between a web server and the Raspberry Pi to transmit patients' data to the cloud application through secure channels.

2) Data will be stored in the cloud in encrypted format, using the AES (Advanced Encryption Standard) algorithm. The decision making process is depicted in Figure 2.

Data Collection

Patients' physical parameters are measured using medical sensors that are connected to a raspberry pi. The raspberry pi is responsible for collecting data from the sensors and transferring it, over SSL, to the cloud environment. The sensors transmit real time data to the application in the cloud continuously based on the delay time which is set in their configuration program.

Decision Making

We use data mining techniques in order to build our algorithm. The data mining procedures are responsible to create appropriate medical decisions based on three parameters which are patient id, sensor type, and sensor current data. When the application receives the data from the sensors, the algorithm will check if the sensor data is normal or abnormal, based on the normal ranges of laboratory medical tests and patient's medical policy which are define in the system. In health-related fields, normal range of laboratory medical tests usually describe the variations of measurements or values in healthy individuals. Reference ranges are usually determined by taking either the lowest and the highest values (range) of results obtained on a normal population. Every patient has a medical policy profile in the system based on the sensor type to assist the system to create compatible medical decisions.

If the data is normal, the algorithm will store this data in sensors information tables in the database to populate patients' historical data. Otherwise, the algorithm will create a medical decision based on a patient historical medical data. If the patient does not have any historical medical data for the same condition, the system will make a medical decision based on historical statistical data of patients who have a similar health condition. The system is responsible to encrypt the data before storing it in the cloud. The objective of these algorithms is to protect the system against malicious users, and secure information against advanced threats.

Decision Approver

After the system makes the decisions, they will be sent to the medical staff who are responsible for the patient's healthcare for approval. There are different ways to notify medical staff including, SMS and email. They can use a web browser from any device to review and update decisions as needed. Once they have reviewed the patients' historical information, medical staff can decide if the current decisions which are created from the system are appropriate for the patient's condition or they need to change and update them. After the medical staff approve the decisions, the system will notify the patient with the necessary instructions for dealing with that situation or condition.

IV. FUNCTIONAL COMPONENTS OF THE ENGINEERING

A. Raspberry pi

The Raspberry Pi is a Linux-based microcomputer that connects with a computer monitor or TV, and uses a keyboard and mouse. It includes 2 USB ports, HDMI and Ethernet port, SD card slot, memory, video/audio outputs, and power source. We used C++ or python to implement the application (on the raspberry pi) for reading the data from the sensors and sending it to the cloud. We utilized TCP sockets to establish a connection between the Pi and the application in the cloud. The server program was written in C#. In the cloud, we selected Amazon Web Services (AWS).

B. Temperature Sensor

The LM35 series are precision integrated circuit LM35 temperature sensors, whose output voltage is linearly proportional to the temperature in Celsius (Centigrade). The LM35 sensor thus has an advantage over linear temperature sensors, calibrated in °Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. The LM35 sensor does not

require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full.

C. Blood Pressure Sensor

Blood pressure sensor is a device that measures the pressure of the blood in the arteries as it is pumped around the body by the heart. When our heart beats, it contracts and pushes blood through the arteries to the rest of our body. This force creates pressure on the arteries. Blood pressure is recorded as two numbers the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats).

D. Blood Glucose Sensor

Blood glucose sensor is a medical device for determining the approximate concentration of glucose in the blood. A small drop of blood, obtained by pricking the skin with a lancet, is placed on a disposable test strip that the meter reads and uses to calculate the blood glucose level. The meter then displays the level in mg/dl or mmol/l.

E. Electrocardiogram

The electrocardiogram (ECG or EKG) is a diagnostic tool that is routinely used to assess the electrical and muscular functions of the heart.The electrocardiogram (ECG) has grown to be one of the most commonly used medical tests in modern medicine. Its utility in the diagnosis of a myriad of cardiac pathologies ranging from myocardial ischemia and infarction to syncope and palpitations has been invaluable to clinicians for decades.

V. CONCLUSION

The integration between wireless sensor networks and cloud computing will create a new generation of technology in many aspects such as patient monitoring with minimal cost, reducing the number of occupied beds in hospitals, and improving medical staff performance. In addition, applying various data mining techniques help to extract and analyze patients' data. The system introduced in this paper provides decisions based on patients' historical data, real-time data gathering, and thus eliminating manual data collection. For future work, we are planning to enhance the functionality of the system by adding more sensors and using it to collect data from a larger sample size of patients.

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