

CONTINUOUS MONITORING OF HUMAN HEALTH USING INTERNET OF THINGS

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Abstract— In the modern world maintaining a good health has become one of the major essential thing in everyone's day-to-day life. Health issues are becoming higher and higher day by day. The improvement in Science and technologies has paved us a way to monitor the human health in the most efficient way. One such technology is the Internet of Things. Internet of Things is used in a variety of application devices. We have chosen Internet of Things applications in the medical field. Most of the newly invented medical devices are developed using Internet of Things. This paper describes the concept behind Internet of Things and how it works in remote monitoring of a patient along with its advantages and its other applications. Furthermore, this paper will present and discuss the technological solution for the best practice to adopt smart city in collaboration with the smart cities mission.

Keywords— sensor, monitoring, health care, data transmission

I. INTRODUCTION

The advancement in the technology has made us to enter into a different world where we can interact with the objects. The virtual view over the internet has been extended into the physical world on the objects surrounding us. The Internet of Things is the interface of physical devices nested with electronics, software, sensors, actuators, and network connectivity that enables the devices to transfer the data. In other words it can be specified as a simple way of connecting a physical device to an internet.

Everything is becoming smarter now-a-days with the help of Internet of Things. This includes everything starting from smart phones, smart homes, smart cities, intelligent transportation, etc.,

Each and every thing is uniquely identifiable through its computing system but it is able to interoperate with the existing internet infrastructure.

II. IOT IN HEALTHCARE

Recently many wearable devices such as wrist bands, watches are being developed using Internet of Things to help in monitoring the health conditions of the human beings. It helps in monitoring the heartbeat rate, sugar level, pressure level, calories burnt in the human body. The health monitors, pedometers, virtual reality headsets are some of the emerging technologies which will play a major role in monitoring the health of humans. The lack of awareness in the development in the technology among the people in the medical field lies as a great challenge for the adoption and use of medical devices [1]. The development in the medical devices can result in low morality rate, quick diagnosis, better treatment, reduction in hospital stays, increase in point of care etc.,

The key idea of this technique is to provide a better treatment by diagnosing the patients living anywhere in the world. Many pediatric and the aged people require an additional care with continuous monitoring. This is possible with Internet of Things technology. You can live anywhere in the world and provide them a better treatment regularly. "**Home is where your heart is**". As the saying goes, most of the people would feel better at home than the hospitals. They can stay at home and look after themselves on a regular basis without any clinical visits. A constant supervision on the patient's health can be provided without much strain [1]. In our project we have implemented this concept with the help of raspberry Pi module. This process consists of two sections namely a transmitter section and a receiver section.

III. REMOTE MONITORING – TRANSMITTER SECTION

The Transmitter section consists of a person from whose health records will be sent. In addition to this, it consists of sensors, Raspberry Pi module, a Pi cam and a Relay as specified in the fig 1. Sensor plays a major role in the continuous monitoring process. Sensors can raise the intelligence of life supporting techniques and also enable the monitoring of health to have a healthy and a long life. Sensors are small and sophisticated device which doesn't consume large amount of power. It can easily be placed in space constrained areas. There are a variety of sensors available in the recent days which can be used in various applications.

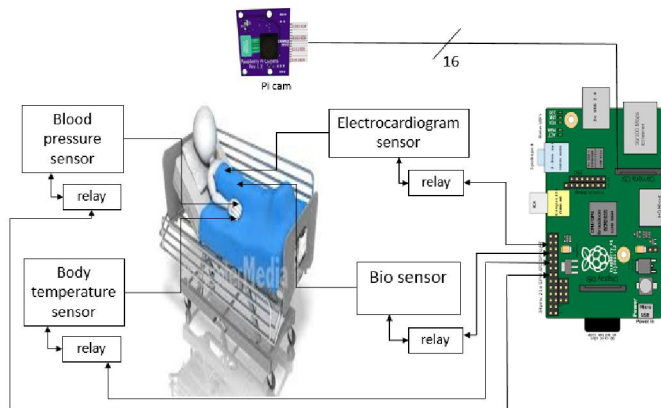


Figure 1: Transmitter Section

We have used four types of sensors in our project. They are pressure sensor, temperature sensor, electrocardiogram sensor, bio sensors will be connected to the body of the patients such as in nose, hand, fingers etc., and these connected sensors gather all the necessary details continuously about the health conditions of the patients which help in tracking of patient's details. All the information like sugar and pressure level, heartbeat rate, glucose level, calories burnt per day, etc., will be gathered on the basis of the health condition and will be transferred to the computer or a control system through the Raspberry Pi connected to it. The power supplies for the sensors are provided with the help of a relay. A Relay is an electrically operated switch through which the sensors can be switched ON and OFF. The relay usually uses an electromagnet to be mechanically operated as a switch. The Relay connected in this device provides +12 volts supply to the sensors.

A. Raspberry Pi:

Raspberry Pi is a credit card sized computer which can be plugged in easily in your TV or a computer. It can also be called as a mini computer because you can do operations similar to a computer. It has a 900 MHz quad-core ARM Cortex A7 CPU with 1 GB RAM. It has 4 USB ports and an ETHERNET port. In addition to this, it consists of a Display and a Camera Interface along with a video core IV 3D graphic core. It has 40 General Purpose Input Output pins arranged in two rows each of 13 pins next to the video socket. It doesn't

possess a specific and pre-defined purpose. It can be controlled by the user during the execution time and make it either as an input or output by making it high or low. It also consists of I2C and SPI. I2C is a useful communication bus that will allow us to exchange the obtained data from the peripheral device to the system or a computer. SPI is the Serial Peripheral Interface which can also be called as a cousin of I2C. This is because it has similar applications.

B. Working of Sensors:

- PRESSURE SENSOR:

The Pressure Sensor will be connected to the patient's hand. This will measure the Blood pressure levels and record it. It is a vital part in the anesthesia delivery machine and in the kidney dialysis machine.

- TEMPERATURE SENSOR:

The Temperature sensor will be placed along with the patient's finger. This will measure the temperature of the patient's body. This is also used in Organ Transplantation.

- ELECTROCARDIOGRAM SENSOR:

The Electrocardiogram sensor will be placed on the patient's chest and the other end wires will be connected to the Raspberry Pi and the relay unit. The sensor will record and display the patient's heartbeat [2]. It records and displays all the electrical pulses generated in the heart as shown in the fig.2.

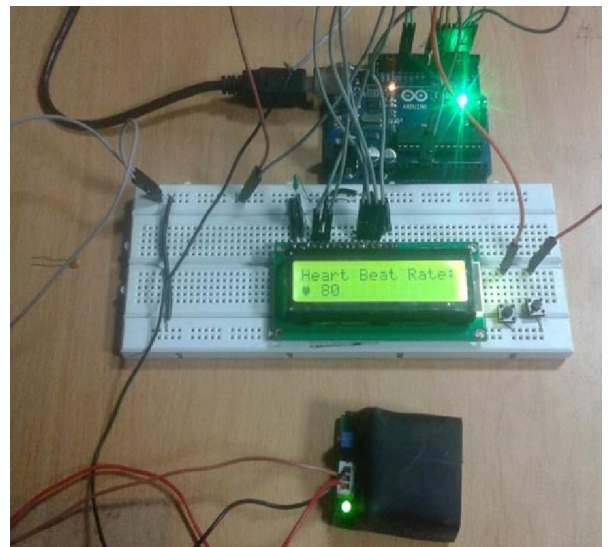


Figure 2: Heartbeat Monitoring

- BIO SENSOR:

Bio sensors will detect the blood glucose level and the cholesterol levels. It is also used for drug identification and in pregnancy too.

C. WebIOPi and GITHUB:

The Raspberry Pi module and the sensors connected with it can be controlled from any place using WebIOPi. The WebIOPi is a penknife for connecting things and transmit data. It runs only on Raspberry Pi. The General Purpose Input Output pins of the sensors can be debugged and controlled from a web browser or using certain apps by living anywhere in the world. The program for executing the necessary function is written with the help of PYTHON language. There are two libraries which will allow you to write the programs in PYTHON to control the device. The libraries are Writing Pi and Raspberry Pi. In order to install the libraries in the Raspberry Pi, GIT source must be installed at first by connecting the Raspberry Pi to the internet.

The GITHUB provides a control repository and an internet hosting service. It provides all the necessary codes for operating the Raspberry Pi. It can also be stated that it is the largest host of source code. The GITHUB consists of the firmware, documentation, noobs required for the Raspberry Pi. Noobs is an easy way to set up your Raspberry Pi [6].

Noobs is an Operating System install manager which is required for the Raspberry Pi. It provides a lot of features like bug tracking, task management, accessing and controlling the device. The installation process can be done in two ways namely online and offline format. In an online format it can be directly downloaded from GITHUB using internet connection. The offline format is done using a SD card with the help of Zip file.

The program can be loaded and executed using a structure commonly called as setup and loop functions. Nearly more than 30 devices like sensors, actuators can be controlled with a single module at the same time. It consists of two important web applications namely the GPIO Header web application and the Device Monitor web application. The GPIO Header web application is used for debugging and controlling the General Purpose Input Output pins. The GPIO module will be installed in the Raspberry Pi by default. The Device Monitor web application will allow us to debug, control the sensors that are plugged in GPIO pins, I2C, SPI as shown in the fig. 3.

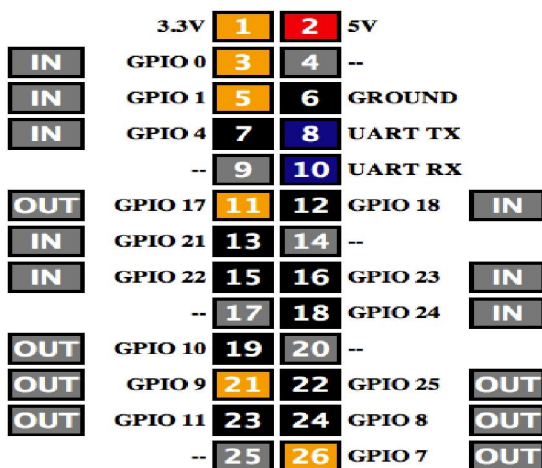


Figure 3: Controlling of GPIO pins using WEBIOPi

JAVA script or HTML client libraries can be used to make a web user interface. Similarly PYTHON or the JAVA clients can be used for the pi-to-pi and android applications. This also provides a CoAP support. CoAP is a Constrained Application Protocol which is said to be the best Internet of Things protocol. It is a special web transfer protocol which is designed for the machine to machine application within the constrained networks or nodes in the Internet of Things.

D. Pi Camera:

A Pi Camera is used for visualizing the patient from any place. A Pi Camera is a combination of autonomous high definition video system and an embedded web server. It uses OMNIVISION 5647 sensor which will offer a detailed resolution approximately of 5 Mega Pixel. It provides a multi day recordings which is depended on the memory capacity available on the SD card. It possesses a large surveillance area. The camera has a tilt function of about 360 degree view. The Pi Camera can be enabled and controlled using the PYTHON PICAM. It acts as a pure interface to the Raspberry Pi Camera module.

In order to enable the camera you can choose the command given in the fig. which is available in the menu bar. A reboot will be required for enabling the camera after choosing the commands. The necessary library files for the Pi Camera will be available in this. You can also change the configurations of the image like brightness, saturation and contrast levels by editing the values. The SLEEP option can be used for enabling the pause mode and for adjusting the time duration.

Both the Raspberry Pi and the Pi Camera can be accessed using SSH from any other computer. SSH is defined as the Secure Shell which is a cryptographic Network Protocol. It will provide a secure channel over the unsecured channel. This means that the data transmitted between the physical device and the computer will be safe and secured one. The information and the data transmission cannot be interrupted by an unauthorized person.

IV. REMOTE MONITORING- RECEIVER SECTION

The Receiver section consists of the person to whom the data must be sent commonly referred as Receiver for example a doctor. They must possess mobile phone [3] or a Computer/laptop as shown in the fig. 4. The receiver can stay anywhere in the world and have a control over the transmitter section to receive the appropriate data. When it comes to a mobile it can be done with the help of certain Android Applications like Connect Bot, Terminal Emulator and Cayenne. This can be downloaded from the Google Play Store. Emulator application lets you to access and run various Linux command line shells which are built in every Android Phones.

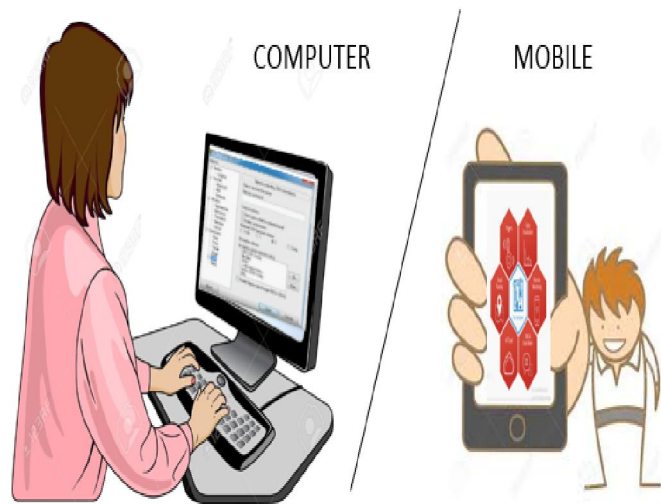


Figure 4: Receiver Section

A. Connect Bot:

The Connect Bot is a Linux based application. It is an Open source Secure Shell client for all the Android Operating systems. It lets the users to login very securely in remotely to the appropriate server which runs a safe and secured shell daemon. It enables the user to enter the necessary commands from their android device which will run on a remote server rather than a local android device. A standard encryption is being used by the Secure Shell for keeping the commands and data very safe. It also prevents the data from getting eavesdropped across the network by any of the potential listeners. You can transfer the data back and forth to your phone using for this application.

B. Cayenne:

Next to this lies the Cayenne. Cayenne is a very simple way to use for scheduling the trigger and the events. You need not use a cron job on your Raspberry Pi. There are many advantages in Cayenne like it runs very faster when you connect a Raspberry Pi as it provides a codeless setup from the Mobile applications. It is a great device monitoring application and a status notification for the buttons. The Raspberry Pi will be automatically plugged into power when you connect it to the ETHERNET. This makes the sensors ready for the usage.

C. PuTTY:

When it comes to a system or a laptop, it can be done with the help of PuTTY. PuTTY is a free and an open-source terminal emulator. It mostly supports several network protocols like SCP, SSH, TELNET, RLOGIN [7]. It provides a free implementation of Secure Shell and TELNET for the WINDOWS and UNIX platforms. It acts as a versatile tool for the remote access to another computer who wants remote shell access to UNIX and LINUX system than for any other purposes.

V. DATA TRANSMISSION

RTU – Remote Terminal/ Tele control Unit. It is a type of micro controlled electronic device that interfaces the objects in the physical world to a distributed control system or SCADA system by transmitting telemetry data to a master system, and by using messages from the master supervisory systems to control connected objects. Thus it acts interlink between the physical world and a connected control system. Now all the collected information will be stored in the Remote Terminal Unit.

Thus the stored information in the RTU has to be transmitted. The transmission of the stored information can be done by three ways as shown in the fig. 4.

- VSAT connectivity
- Wired Connectivity
- GSM/GPRS Connectivity

VSAT- Very Small Aperture Terminal connectivity.

It is known as small private earth station that is used to transmit and receive data using satellite. The VSAT user needs a box that acts as an interface between the user's computers and an outside antenna with a transceiver. The transceiver receives or sends a signal to a satellite transponder in the sky. This type of communication is helpful while transmitting a data between people living in different countries.

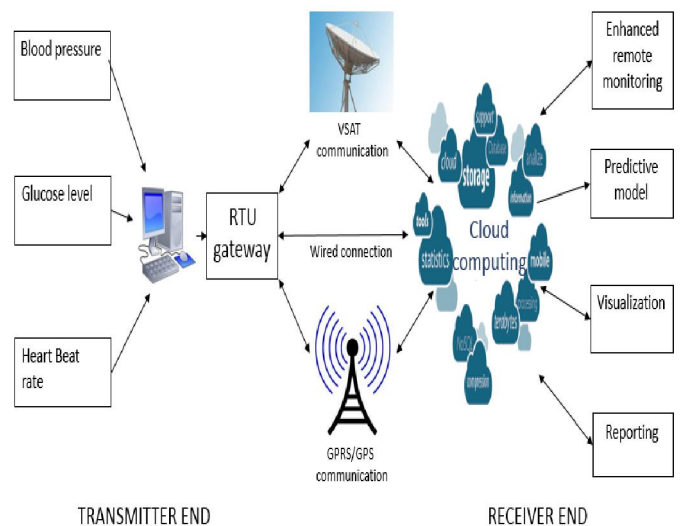


Figure 5: Transmission of Data

The **wired connectivity** means your computer is physically connected to a modem or a router using cables. This type of connectivity is helpful in communication within a campus or a certain area. It cannot be applied for data transmission for larger areas.

GSM-Global System for Mobile Communication or

GPRS- General Packet Radio Service

This is a technology between the second (2G) and the third (3G) generations of mobile telephony. It provides moderate speed data transfer by using unused time division multiple access channels. This type of connectivity can be given for the persons living in two different areas within the same country.

On comparing all the three types of connectivity VSAT connectivity is the most speed one in transmitting the collected data to the hospitals or doctors. Finally the data has got transferred from the RTU gateways to big data frame work.

The cloud computing technology is used to save and transmit the data. All the collected information will be transferred to cloud and will be saved in it [5]. The cloud computing technology is the practice of using a network of remote servers hosted on the internet used to store, process, manage data rather than a local sever or a personal computer.

The cloud computing technology is now being implemented in almost all the recently invented IoT devices. The cloud computing is the major key factor in the IoT devices to transmit and store the data using internet. This will lead to a greater development in the medical fields and in other fields also. Now all the data which is transmitted from the connectivity will be stored in the cloud [9]. The analysis of the data will be done now. This analysis can be separated into four types as

Enhanced Remote Monitoring Centre – This is the analysis about the location from where the data is getting transferred. This determines the location of the patient. This will be helpful in certain emergency cases in situations like when patients are in a critical condition and are in need of an ambulance.

Predictive Model or Rule Base Engine – This is the analysis about predicting the body condition or the problem in the human body [4]. This is used to predict the levels such as glucose, sugar, pressure levels in the human body. The values can be obtained on a daily basis or a monthly basis according to the specified duration

Visualization – This is the analysis about the viewing of the result in an image format such as graph, etc., this is necessary for the patients to make them understand their body condition in an easier way [4]. And it also helps in comparing the results of the person with the results which has come before in a diagrammatic manner. This also includes the images and the videos that can be captured using the Pi Camera. The images and the videos will be recorded according to the pre defined duration along with the date of recording.

Reporting – This is the analysis of the final results in a numerical manner or a diagrammatic format. This is the final result which goes to the doctor who will examine the condition of the patient's body [4]. The final reports are the most important one for identification and diagnosis of the

problem. Thus the doctors will receive the final results and will be able to give advice and prescribe medicines according to the patient's body condition.

All these will sum up to maintain an Electronic Health Record (EHR) and Personnel Health Record (PHR) of the patient that can be obtained and viewed by living anywhere in the world.

The main advantage of his setup is that it is very small and portable one. This can provide a right treatment at a right time. It is very easy to use and wear it. It reduces the work load and also a fast process. You can acquire the result in few minutes.

Conclusion

This paper will play a vital role in changing the face of the health care with the best treatment outcomes. The standard of living can be improved to a greater level with the help of the Internet of Things. All the nations across the globe are struggling to improve the point of health care to provide a prosperous life to their people. The Internet of Things technology in the Medical Devices can create a great impact and will be a leading path way for the implementation of smart cities. This will be possible with the help of some development program with the support of our government. Moreover, the improvement in the sensors, cloud computing technology, internet resulted in the availability of the Medical Devices at affordable prices. The increase in the usage of Internet of Things based Medical Devices can increase its potential leading to further changes in the devices.

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