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A Portable Remote Health Monitoring System

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Abstract—**In the present scenario diseases are increasing day by day and people are becoming very health conscious. Proper diagnosis of health conditions and time to time normal or abnormal biological changes detection is necessary to avoid critical conditions. Hence the system designed for this purpose periodically monitors the patient and uses sensor nodes for detecting biological changes that should be measured and kept under observation of all patients and at the same time it can be done using body sensor network. The body sensor network (BSN) technology is one of the core technologies of IOT developments in healthcare system, where a patient can be continually monitored using a collection of tiny-powered and lightweight sensor nodes. Our main objective is to implement a monitoring system which monitors the B.P, pulse rate, heartbeat, body temperature and body movements, by using embedded technology. These sensed signals are transmitted to the Raspberry pi to update the data continuously via ADC which will convert these analog signals into digital signals. Through GPRS, the data is sent wirelessly to the monitor screen of the doctor. So, the doctor can visualize the patient's data at any place. In this proposed system we cansimultaneously measure and monitor the patient's condition. It is operable and available at an affordable cost.**

Index terms: **Raspberry Pi3 Model B, Sensors, GPRS.**

I. INTRODUCTION

The rapid growth in physiological sensors, low-power integrated circuits, and wireless communication has enabled a new generation of wireless sensor networks, now it is used for purposes such as monitoring traffic, crops, infrastructure, and health. The body area network field is an interdisciplinary area which could allow inexpensive and continuous health monitoring with real-time updates of medical records through the Internet. A number of intelligent physiological sensors can be integrated into a wearable wireless body area network, which can be used for computer-assisted rehabilitation or early detection of medical conditions. This area relies on thefeasibility of implanting very small biosensors inside the human body that are comfortable and that don't impair normal activities. The implanted sensors in the human body will collect various physiological changes in order to monitor the patient's health status no matter aboutheir location. The information will be transmitted wirelessly to an external processing unit. This device will instantly transmit all information in real time to the doctors throughout the world. If an emergency is detected, the physicians will immediately inform the patient through the computer system by sending appropriate messages or alarms. Currently the level of information provided and energy resources capable of powering the sensors are limiting. While the technology is still in its primitive stage it is being widely researched and once adopted, is expected to be a breakthrough invention in healthcare, leading to concepts like telemedicine and Health becoming real. In this paper we discuss various techniques and innovation of new trends in wireless sensor network for continuous health monitoring.

II. SYSTEM DESCRIPTION

The problem found in the existing wireless monitoring system is due to lack of doctors and the electronic devices. The doctor asses the patients condition by measuring the parameters such as temperature, blood pressure, drip level etc. In case of emergencies, the nurse intimates the doctor through some means of communication like mobile phone etc. A growing selection of innovative electronic monitoring devices is available, but meaningful communication and decision supports are also needed for both patients and clinicians. Health care monitoring systems can help people by providing healthcare

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services such as medical monitoring, memory enhancement, medical data access, and communication with the healthcare provider in emergency situations through the SMS or GPRS. Continuous health monitoring with wearable or clothing-embedded transducers and implantable body sensor networks will increase detection of emergency conditions in at risk patients. Not only the patient, but also their families will benefit from these. Nowadays, more and more urban residents are living in the Community and these communities became ever larger. In general there is a medical center in a medium community which can provide some treatment to those common diseases. With the aging society in China, more and more elderly will live in urban community. Community health centers can also be a feature that is perfect for the elderly on a regular basis to provide some basic health care, such as measurement of the blood pressure and heart rhythm once a month for the elderly, and keep record of the physical condition for them. Meanwhile, the elderly people are also looking for this kind of health care, and hope to have a professional to make some reminders according to his own body status. Usually the medical center could allocate some medical staff to examine on-site for elderly people regularly, but with increased number of older persons in the community, such on-site service is becoming increasingly costly. Therefore, we need to design a family telemedicine system, which will enable the residents to examine the health themselves in home with electronic Sphygmomanometers and other home medical tools. [9] discussed about an eye blinking sensor. Nowadays heart attack patients are increasing day by day."Though it is tough to save the heart attack patients, we can increase the statistics of saving the life of patients & the life of others whom they are responsible for. The main design of this project is to track the heart attack of patients who are suffering from any attacks during driving and send them a medical need & thereby to stop the vehicle to ensure that the persons along them are safe from accident. Here, an eye blinking sensor is used to sense the blinking of the eye. spO2 sensor checks the pulse rate of the patient. Both are connected to micro controller.If eye blinking gets stopped then the signal is sent to the controller to make an alarm through the buffer. If spO2 sensor senses a variation in pulse or low oxygen content in blood, it may results in heart failure and therefore the controller stops the motor of the vehicle. Then Tarang F4 transmitter is used to send the vehicle number & the mobile number of the patient to a nearest medical station within 25 km for medical aid. The pulse rate monitored via LCD .The Tarang F4 receiver receives the signal and passes through controller and the number gets displayed in the LCD screen and an alarm is produced through a buzzer as soon the signal is received.

III. PROPOSED METHODOLOGY

The main aim of this proposed system is to monitor the patients health during critical situation. So to save the life of a patient who is in critical position, we use wireless sensor network/BSN(body sensor network) which plays an important role in monitoring**.**

IV. HARDWARE DESIGN

The System Architecture has two sections. They are:

1. Patient Section,
2. Monitor Section

Patient Section:

In this section we are performing Data Acquisition. It is performed by multiple wearable sensors that measure physiological biomarkers, such as ECG, skin temperature, Blood Pressure, Pulse rate, and moments. The sensors connect to the network though an intermediate data aggregator or concentrator, which is typically a GPRS module. The Data Transmission components of the system are responsible for conveying recordings of the patient from the patient's house (or any remote location) to the data center of the Healthcare Organization (HCO) with assured security and privacy, ideally in near real-time. Typically, the sensory acquisition platform is equipped with a short range radio which is shown in Fig. 1. Components of a remote patient monitoring system that is based on IoT-Cloud architecture.

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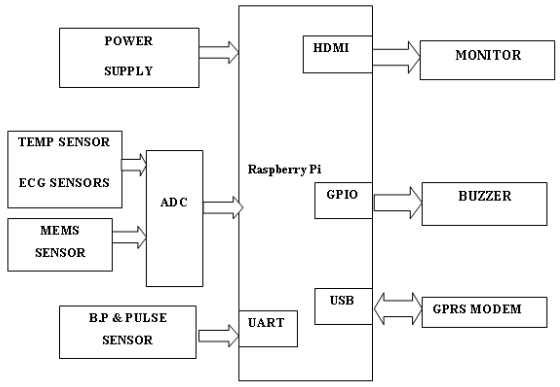

Figure1. Patient Section

Monitor Section:

The output will be displayed in the monitoring section as shown in fig2.

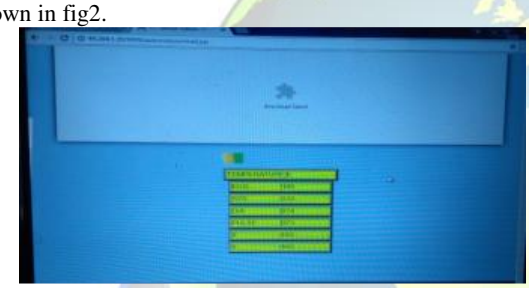

Figure.2.Monitor Section

Working Model:

The block diagram of the project consists of Raspberry Pi3 Model B, sensors, GPRS module, and power supply which is shown in Figure 1.In case of emergency and dangerous situations we have to alert the doctor immediately. For this we are using a Wireless network for doctor to patient communication in the hospital. This way of communication is actually done with GPRS.

Each patient will be given this module and with the help of this module the patient health condition is monitored.

In this raspberry pi3 model B plays a major role of data collection from the sensors and the analyzed data will be passed to the monitoring section by using GPRS communication technology.

In this first we are connecting the sensors to the patient's body. In this Temperature, MEMS, ECG sensors are producing analog outputs but our raspberry Pi reads only digital outputs. So we are using MCP3208 for converting sensors information.ThisMCP3208interface to the Raspberry Pi using 4-wired SPI protocol. For B.P and Pulse sensor data collection we are usingSUNROM Blood pressure sensor model no 4118. It is interfaced to the Pi using UART Protocol. After collecting the data from all the sensors Pi board analyzes the data and send that data to the web server using GPRS module interfaced to the Pi board using USB. In this project for sending the data, first we must connect Raspberry Pi with web server.To establish this connection we are using 'AT' commands.

Modules Used In The Project:

To get effective data regarding patients' health we use the following modules:

A. Raspberry Pi3 Model B:

Raspberry pi3 Model B is a single board computer developed in United Kingdom by raspberry pi foundation. The raspberry pi3 model B is designed on Broadcom BCM2837 processor which include ARM Cortex-A53 based quad core processor which runs on 1200 MHz and has RAM capacity of 1GB.It requires 5V 2A power supply. It has graphic processing unit Dual Core Video Core IV multimedia Co-Processor. It provides Open GL.ES-2.0, accelerated-hardware Open-VG, also it has 1080p30 H.264 high-profile decode Capable of 1Gpixel/s, 1.5Gtexel/s or GFLOPs 24, with texture filtering and DMA infrastructure. It also has four USB connectors, one audio output, camera connector, forty pin GPIO connector, one display serial interface and one High-Definition Multimedia Interface.

Figure.3.Raspberry Pi 3 Model B Board

B. B.P and Pulse Sensor:

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For the measurement of pulse rate and BP values we use Sunrom's Sensor which will give sensors data in UART TTL logic mode. To get the data from sensor module, interface to the UART of the controller. Blood Pressure & Pulse sensor is used to measure the B.P and pulse rate of the patient. It shows systolic, diastolic and pulse readings. Compact design fits over your wrist like a watch. Easy to use wrist style eliminates pumping.

Figure.4.B.P and Pulse Sensor

C. ECG:

The ECG sensor measures electrical potentials produced by the heart (Electro□cardiogram). These small voltages are measured at the skin of the wrists and elbow through electrodes. The ECG sensor can also be used to measure the electrical potentials generated by muscle cells, when there is contraction and relaxation (Electromyogram). For safety reasons the sensor uses an optical coupler to avoid any direct electrical contact between the person whose ECG is measured and the measurement interface or computer. The ECG sensor is delivered together with a package of 100 electrode patches.

Figure.5.ECG Sensor

D.Thermistor:

A thermistor is a type of resistor whose resistance varies significantly with temperature, more than in standard resistors. The word is a portmanteau of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting over current protectors, and self-regulating heating elements. Thermistors differ from resistance temperature detectors (RTD) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is alsodifferent; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range, typically −90 °C to 130 °C.

Figure.6.Temperature sensor

E.MEMS:

Micro electro mechanical systems (MEMS) are small integrated devices or systems that combine electrical and mechanical components. Their size range from the sub micrometer (or sub micron) level to the millimeter level and there can be any number, from a few to millions, in a particular system. MEMS extend the fabrication techniques developed for the integrated circuit industry to add mechanical elements such as beams, gears, diaphragms, and springs to devices. These systems can sense, control and activate mechanical processes on the micro scale and function individually or in arrays to generate effects on the macro scale. The micro fabrication technology enables fabrication of large arrays of devices, which individually perform simple tasks, but in combination can accomplish complicated functions.

Figure.7. MEMS

MEMS are not only used for any one

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application or device, or they are not defined by a single fabrication process or limited to a few materials. They are a fabrication approach that conveys the advantages of miniaturization, multiple components and microelectronics to the design and construction of integrated electromechanical systems. MEMS are not only about miniaturization of mechanical systems but they are also a new pattern for designing mechanical devices and systems.

In this application we are using ADXL335 sensor is used for collecting the Human movements the pin configuration showed in fig 8, In this we are giving 5V Dc for operating and we get the 3-axis analog output range of 3.3v that will be given to ADC for further operations.

Figure.8. ADXL335

F.MCP3208

The Raspberry Pi computer does not read analog inputs. It's a digital computer. So we need analog to digital converter circuit in our application,soMCP3208 is used in this project.It is a successive approximation of 12-bit Analog to-Digital (A/D) Converters with on-board sample and hold circuitary. It converts analog values into digital and that output will be given in communication format.Communication with the device is accomplished using a 4-wire SPI compatible interface.

Figure.9. MCP3208

V. SOFTWARE DESCRIPTION

In order to use Raspberry Pi, we need to install an Operating System (OS) in toan SD card. An Operating System is the set of basic programs and utilities that allow your computer to run; Examples include Windows on a PC or OSX on a Mac. These instructions will guide you through installing a recovery program on your SD card that will allow you to easily install different OS's and to recover your card if you break it.

1. Insert an SD card that is 4GB or greater in size into your computer
2. Format the SD card so that the Pi can read it.

QT Creator:

Qt Creator provides a cross-platform, complete integrated development environment (IDE) for application developers to create applications for multiple desktop, embedded, and mobile device platforms, such as Android and iOS. It is available for Linux, MAC OS and Windows operating systems. *Qt Creator* is the integrated development environment (IDE) of choice for Qt. It provides good support for developing for embedded systems, including cross-compiling, deploying to a target system, debugging and profiling.

Here are the key steps:

1. Install Qt Creator.
2. Get a Linux image running on the target system.
3. Set up the tool chain/SDK.
4. Build a cross-compiled Qt and configure it.

In this methodology, QT Creator is used for writing and executing CPP program code.Initiallyall the header files ,ports ,variables and the input devices such as ADC(temp, ECG, MEMS),BP sensor has to be declared. The data can be collected from those sensors and it can be send to the server using GPRS module. It can be viewed from anywhere with the help of internet. If the data is not displayed in the server, again data collection step has to be repeated. This is how the flow of code execution takes place.

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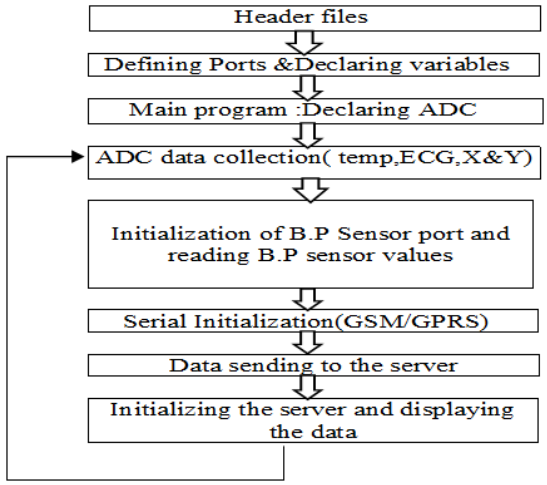

Figure.10.Program Flow

VI. RESULTS

Figure.11. Hardware setup

Figure.12. Code running

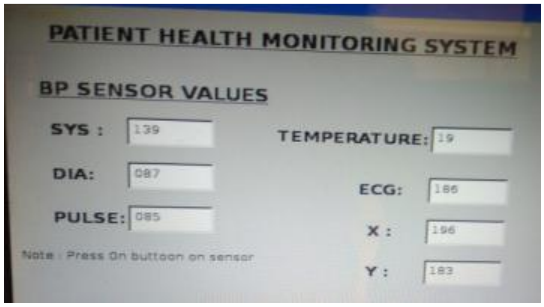

Figure.13. Patient Data collection

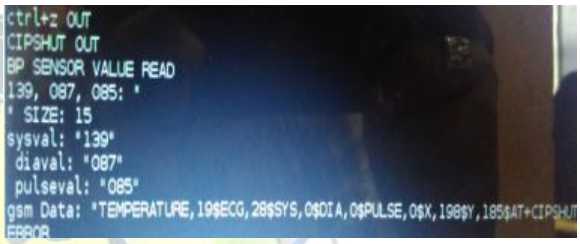

Figure.14. Patient Data Sending

The figure 10 shows that how the code runs by collecting datafrom the ADC(Temp,ECG and MEMS) and BP sensors.The collected data is displayed in a Patient health monitoring page as shown in figure13.This is how the data will be transmitted to the server through internet.

VII. CONCLUSIONS

This paper illustrates an approach of how to design and implement an Raspberry Pi based Health monitoring system, which is simple, stable, very easy to use at home for the elderly persons in a community and also very convenient to all of the community residents. The system has a good scalability. The residents can access the community server to check themselves' health information without others software but a computer with IE. Doctors can review a patient's former health information via internet too when they diagnose the patient. As a result, this system would have a wide use in future.

VIII. FUTUREENHANCEMENTS

Research & development is an endless process. There is always chance to improve any system.

From the above designed methodology it can be concluded that we are able to transmit the data which is sensed from patient to the server PC by using

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wireless transmission technology. We extend this data transmission by using GPRS technology. And also we add extra sensors like blood glucose level sensors, EEG sensors for better monitoring of patient condition.

Expanding the project can be done along with the proposed methodology to allow two way communications between doctors and patients will be beneficiary in many cases where patient needs to communicate directly to the doctor. This will allow doctors to send messages to the patients, and thus make the consultation and service provision more transparent and effective.

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