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A SECURE WEARABLE PATIENT AUTHENTICATION SYSTEM USING HUMAN BODY COMMUNICATION

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ABSTRACT

Human body communication (HBC) is a short-range wireless communication in the vicinity of, or inside a human body by using the human body as a propagation medium. The diverse HBC propagation signal can be utilized as the biometric trait to authenticate individuals. By means of employing the HBC as both the authentication and the communication approaches, the size of wearable devices will be more miniature. Due to the use of propagation signal between devices, the HBC authentication is suitable for wearable device regardless of the location. Here we use the temperature sensor, heartbeat sensor and ECG sensor to monitor the patient's body temperature, pulse and heart rate connected with human body communication in a securable manner.

Keywords: Body channel transmission, Medical sensing, patient monitoring

INTRODUCTION

This project describes about to build a wireless healthcare monitoring system using HUMAN BODY COMMUNICATION module. Remote monitoring is seen as an effective method of providing immediate care as it allows for continuous as well as emergency transmission of patient information to the doctor or healthcare providers. Remote patient monitoring will not only redefine hospital care but also work, home, and recreational activities. These new technologies enable us to monitor patients on a regular basis, replacing the need to frequently visit the local doctor for a recurring illness. Recent report says chronic diseases are the leading cause of deaths in India. People who have suffered from chronic diseases are monitored their vital signs continuously. Vital signs include the measurement of temperature, pulse rate, blood pressure and blood oxygen saturation. It provides information about a patient's state of health. They can identify the existence of any medical problem, illness and person's body physiological stress. In hospitals both in ICU ward and general ward nurses take care of chronic disease patients.

In home also, we can monitor vital signs of a patients with the help of nurses. These are the normal way of monitoring vital signs. Normally elder people are suffered a lot from chronic disease. They cannot go to hospital regularly and also hospitalization cost also increases. In hospital, the nurse's ratio is low compared to patients. Sometimes nurses have missed to take vital signs data of patients. With the lack of vital sign monitoring, patient undergoes many problems. For checking the vital signs data to be healthy or unhealthy, we need nurse or doctor advice and again cost is increased. Advances in sensor and connectivity technology are allowing devices to collect, record and analyze data. In healthcare, able to collect patient data over long time that can be used to help enable preventive care, allow early diagnosis of diseases. Human Body Communication related healthcare systems are based on the Internet of Things as a network of devices that connect directly with each other to capture and share vital data through a wireless communication and store the data in server. And also it provide facility to access the information through our mobile phone using Bluetooth. HUMAN BODY COMMUNICATION systems are making to reduce costs and improve

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health by increasing the availability and quality of care. In recent years, many e-Health systems developed and they are providing the remote monitoring of the patient.

EMBEDDED SYSTEM:

Embedded systems contain processing cores that are either microcontrollers or digital signal processors. Microcontrollers are generally known as "chip", which may itself be packaged with other microcontrollers in a hybrid system of Application Specific Integrated Circuit (ASIC). In general, input always comes from a detector or sensors in more specific word and meanwhile the output goes to the activator which may start or stop the operation of the machine or the operating system.

An embedded system is combination of computer hardware and software, either fixed incapability or programmable, that is specifically designed for particular kind of application device. Industrial machines, automobiles, medical equipment, vending machines and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with a programming interface, and embedded systems programming id specialized occupation.

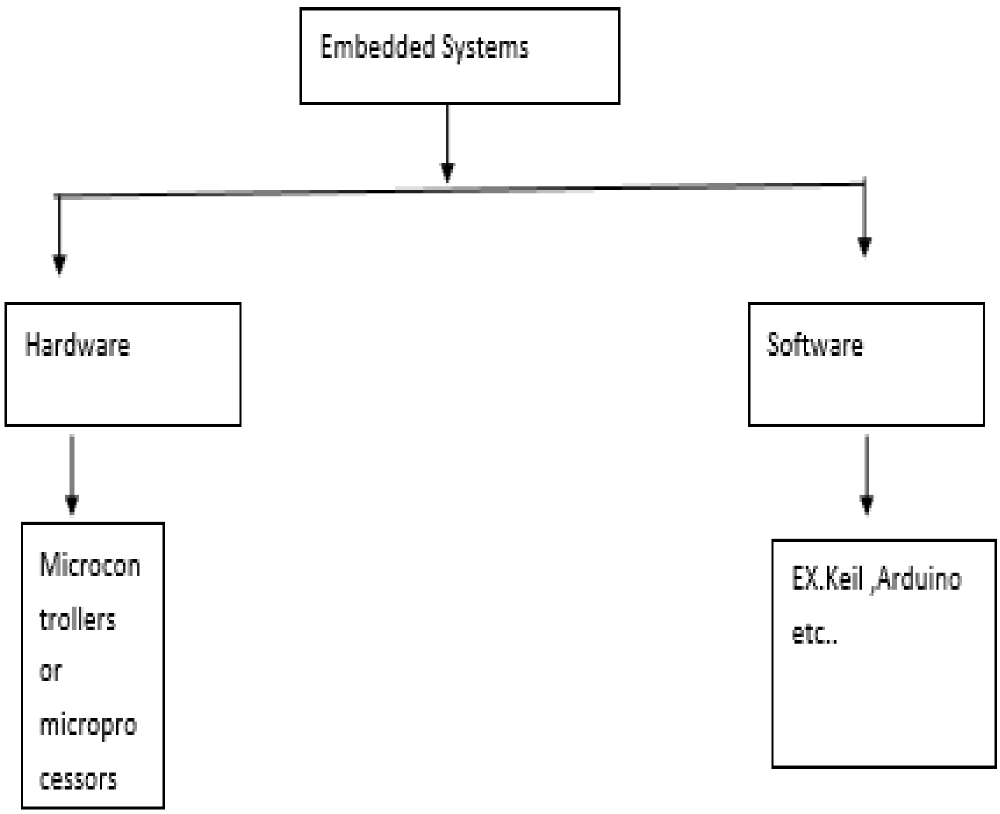

Fig 1 Classification of embedded system

Fig 1 illustrate the Block diagram of Embedded System (ES consists of hardware and software part which again consists of programming language and physical peripherals respectively).

Problem definition

To design a microcontroller (Human Body Communication) based Patient health monitoring system that will check the heart rate, temperature and the humidity of the ambience.

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SYSTEM DESIGN (METHODOLGY)

EXISTING METHOD

The patient's physical parameters & movement status is continuously sent to hospital center through HBC module. The monitoring center receives the information from each patient and transmits it through Arduino microcontroller. The data from patient can be displayed as graph or numeric on monitor if it is necessary. The doctor can diagnose the patient according to continuously recorded data, a sensor electronics module permits the acquisition of different physiological parameters and their online transmission to the handheld portable device connected to the processor. The sensor electronics module constitutes a wireless personal area network. Thus Arduino has low power consumption, low cost , small size, free frequency etc. so that real time monitoring is possible & patient can be treated on time with the system & is helpful in worst condition . Nowadays, a monitor can move with the patient from the operating room to an intensive care unit, to the hospital room, and even into their home. This is paramount in today's world of health care. The most important features in today's patient monitors are mobility, ease of use, and effortless patient data transfer.

PROBLEM STATEMENT

In early decades the situation was like large numbers of patients and limited availability of doctors, large size medical instruments in special care units like ICU'S so that one nurse or doctor is essential to attend each patient in different wards. So the patient could not be continuously monitored so following problem formulation is evolved as follows:- The traditional medical test instruments in large sizes. Patient couldn't be found in time & helped in time. Time consuming patient monitoring Human attention is required for each patient. Limited availability of medical instruments. Continuous monitoring was not possible. Most of the patient died due to lack of experts & machines. The purpose of this study was to find out the needs of medical doctors concerning wireless patient monitoring. The system processes data using plug-in analysis components that can be easily composed into plans using a graphical programming environment.

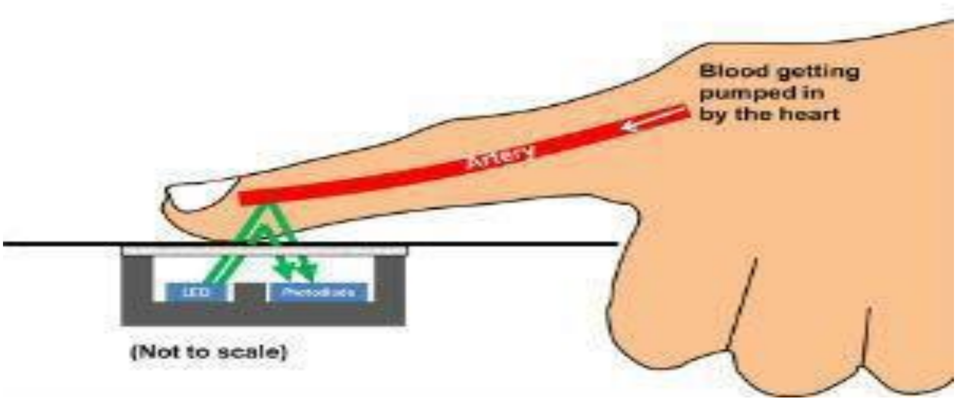

Fig 4 Working of Heart rate sensor

METHODOLOGY

The microprocessor-based system is built for controlling a function or range of functions and is not designed to be programmed by the end user in the same way a PC is defined as an embedded system. An embedded system is designed to perform one particular task albeit with different choices and options.

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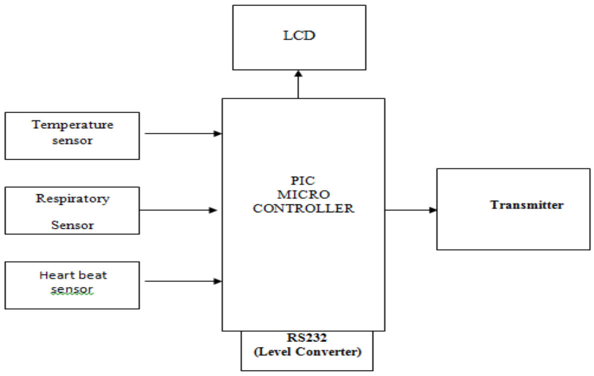

Fig 3 Block Diagram of Patient Monitoring System

HUMAN BODY COMMUNICATION MODULE :

A HUMAN BODY COMMUNICATION modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a HUMAN BODY COMMUNICATION modem looks just like a mobile phone. When a HUMAN BODY COMMUNICATION modem is connected to a computer, this allows the computer to use the HUMAN BODY COMMUNICATION modem to communicate over the mobile network. While these HUMAN BODY COMMUNICATION modems most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages. A HUMAN BODY COMMUNICATION modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides HUMAN BODY COMMUNICATION modem capabilities

Architecture of HUMAN BODY COMMUNICATION Network:

A HBC network is composed of several functional entities, whose functions and interfaces are specified. Figure 1 shows the layout of a generic HUMAN BODY COMMUNICATION network. The HUMAN BODY COMMUNICATION network can be divided into three broad parts. The Mobile Station is carried by the subscriber. The Base Station Subsystem controls the radio link with the Mobile Station. The Network Subsystem, the main part of which is the Mobile services Switching Center (MSC), performs the switching of calls between the mobile users, and between mobile and fixed network users. The MSC also handles the mobility management operations. Not shown are the Operations

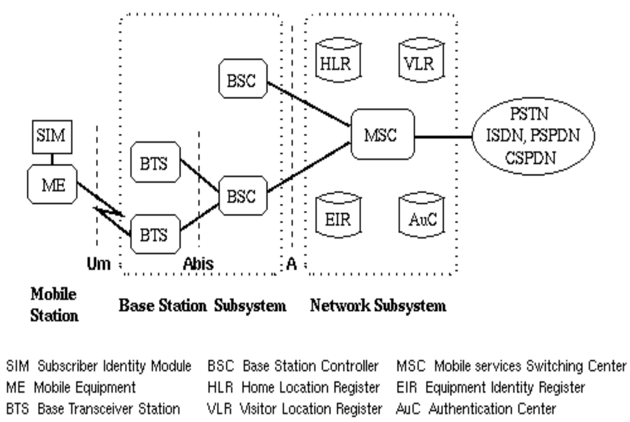

Fig 5 General architecture of a HUMAN BODY COMMUNICATION network

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PROPOSED SYSTEM

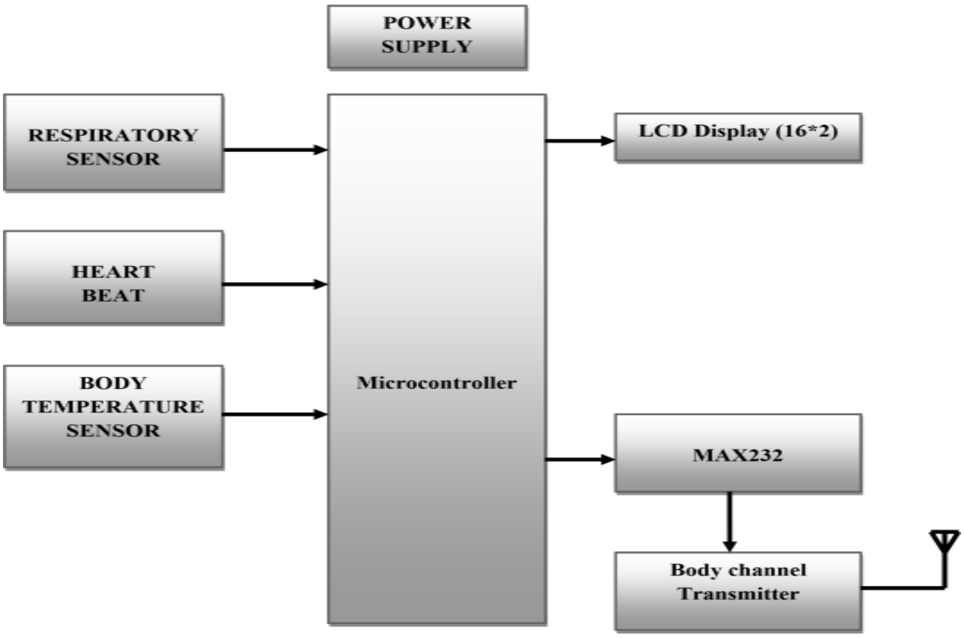

Fig. 6 Block diagram of proposed system

DS18B20 TEMPERATURE SENSOR:

1) 64-bit layered ROM.
2) temperature sensor.
3) nonvolatile temperature alarm triggers TH and TL.
4) a configuration register.

The device derives its power from the 1-Wire communication line by storing energy on an internal capacitor during periods of time when the signal line is high and continues to operate off this power source during the low times of the 1-Wire line until it returns high to replenish the parasite (capacitor) supply.

As an alternative, the DS18B20 may also be powered from an external 3 volt - 5.5 volt supply. Communication to the DS18B20 is via a 1-Wire port. With the 1-Wire port, the memory and control functions will not be available before the ROM function protocol has been established. The master must first provide one of five ROM function commands: 1) Read ROM, 2) Match ROM, 3) Search ROM, 4) Skip ROM, or 5) Alarm Search.

These commands operate on the 64-bit layered ROM portion of each device and can single out a specific device if many are present on the 1-Wire line as well as indicate to the bus master how many and what types of devices are present. After a ROM function sequence has been successfully executed, the memory and control functions are accessible and the master may then provide any one of the six memory and control function commands.

The scratchpad also contains a configuration byte to set the desired resolution of the temperature to digital conversion. Writing TH, TL, and the configuration byte is done using a memory function command. Read access to these registers is through the scratchpad. All data is read and written least significant bit first.

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Features of DS18B20:

- Unique 1-Wire® Interface Requires Only One Port Pin for Communication ƒ
- Each Device has a Unique 64-Bit Serial Code Stored in an On-Board ROM
- Multidrop Capability Simplifies Distributed Temperature-Sensing Applications ƒ
- Requires No External Components ƒ
- Can Be Powered from Data Line; Power Supply Range is 3.0V to 5.5V ƒ
- Measures Temperatures from -55°C to +125°C (-67°F to +257°F) ƒ
- ±0.5°C Accuracy from -10°C to +85°C ƒ
- Thermometer Resolution is User Selectable from 9 to 12 Bits ƒ
- Converts Temperature to 12-Bit Digital Word in 750ms (Max) ƒ
- User-Definable Nonvolatile (NV) Alarm Settings ƒ
- Alarm Search Command Identifies and Addresses Devices Whose Temperature is Outside Programmed Limits (Temperature Alarm Condition) ƒ

PULSE SENSOR

Pulse Sensor is a well-designed plug-and- play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart rate data into their projects. The sensor clips onto a fingertip or earlobe and plugs right into Arduino. It also includes an open-source monitoring app that graphs your pulse in real time.
The Pulse Sensor that we make is essentially a photoplethysmograph, which is a well known medical device used for non-invasive heart rate monitoring. Sometimes, photoplethysmographs measure blood-oxygen levels (SpO2), sometimes they don't. The heart pulse signal that comes out of a photoplethysmograph is an analog fluctuation in voltage, and it has a predictable wave shape as shown in figure 4.10. Our latest hardware version, Pulse Sensor Amped, amplifies the raw signal of the previous Pulse Sensor, and normalizes the pulse wave around V/2 (midpoint in voltage). Our goal is to find successive moments of instantaneous heart beat and measure the time between, called the Inter Beat Interval (IBI). By following the predictable shape and pattern of the PPG wave, we are able to do just that.

Now, we're not heart researchers, but we play them on this blog. We're basing this page on Other People's Research that seem reasonable to us (references below). When the heart pumps blood through the body, with every beat there is a pulse wave (kind of like a shock wave) that travels along all arteries to the very extremities of capillary tissue where the Pulse Sensor is attached. Actual blood circulates in the body much slower than the pulse wave travels. Let's follow events as they progress from point 'T' on the PPG below. A rapid upward rise in signal value occurs as the pulse wave passes under the sensor, then the signal falls back down toward the normal point. Sometimes, the dicroic notch (downward spike) is more pronounced than others, but generally the signal settles down to background noise before the next pulse wave washes through. Since the wave is repeating and predictable, we could choose almost any recognizable feature as a reference point, say the peak, and measure the heart rate by doing math on the time between each peak.

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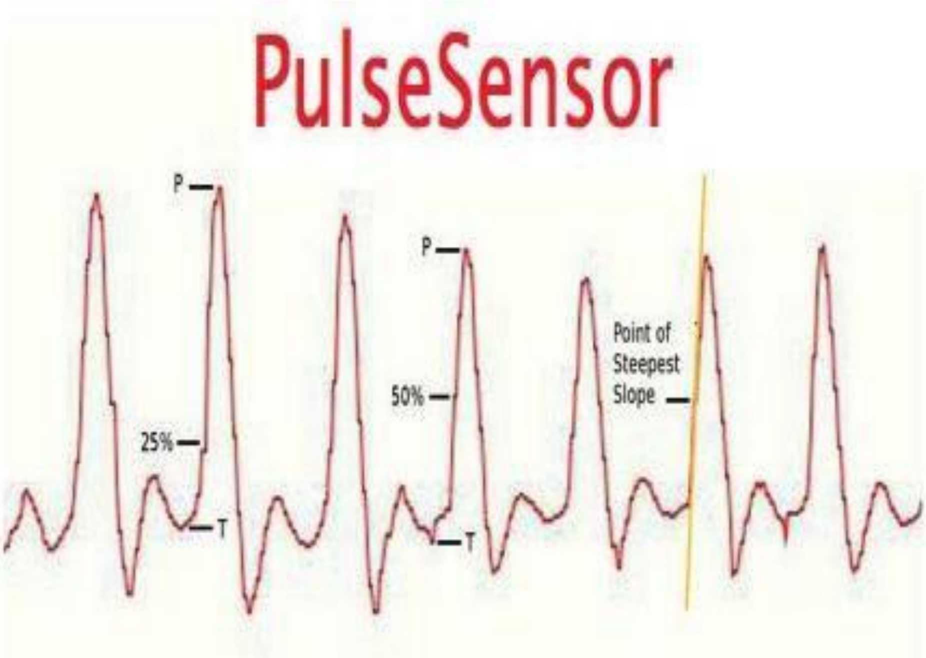

Fig 7 Pulse sensor output signal

Some heart researchers say it's when the signal gets to 25% of the amplitude, some say when it's 50% of the amplitude, and some say it's the point when the slope is steepest during the upward rise event. This version 1.1 of Pulse Sensor code is designed to measure the IBI by timing between moments when the signal crosses 50% of the wave amplitude during that fast upward rise. First off, it's important to have a regular sample rate with high enough resolution to get reliable measurement of the timing between each beat. To do this, we set up Timer2, an 8 bit hardware timer on the ATmega328 (UNO), so that it throws an interrupt every other millisecond. That gives us a sample rate of 500Hz and beat-to-beat timing resolution of 2mS (note2). This will disable PWM output on pin 3 and 11. Also, it will disable the tone() command. This code works with Arduino UNO or Arduino PRO or Arduino Pro Mini 5V or any Arduino running with an ATmega328 and 16MHz clock.

The Pulse Sensor Kit includes:

- 1) A 24-inch Color-Coded Cable, with (male) header connectors. You'll find this makes it easy to embed the sensor into your project, and connect to an Arduino. No soldering is required.
- 2) An Ear Clip, perfectly sized to the sensor. We searched many places to find just the right clip. It can be hot glued to the back of the sensor and easily worn on the earlobe.
- 3) 2 Velcro Dots. These are 'hook' side and are also perfectly sized to the sensor. You'll find these Velcro dots very useful if you want to make a Velcro (or fabric) strap to wrap around a finger tip. 4) Velcro strap to wrap the Pulse Sensor around your finger.
- 4) 3 Transparent Stickers. These are used on the front of the Pulse Sensor to protect it from oily fingers and sweaty earlobes.
- 5) The Pulse Sensor has 3 holes around the outside edge which make it easy to sew it into almost anything.

Taking your pulse is as simple as holding a finger to your neck or wrist and timing the beats with your watch. But if you want to record the data or use it to trigger events, you need to turn that mechanical pulsing action into an electrical signal. This pulse sensor fits over a fingertip and uses the amount of infrared light reflected by the blood circulating inside to do just that.

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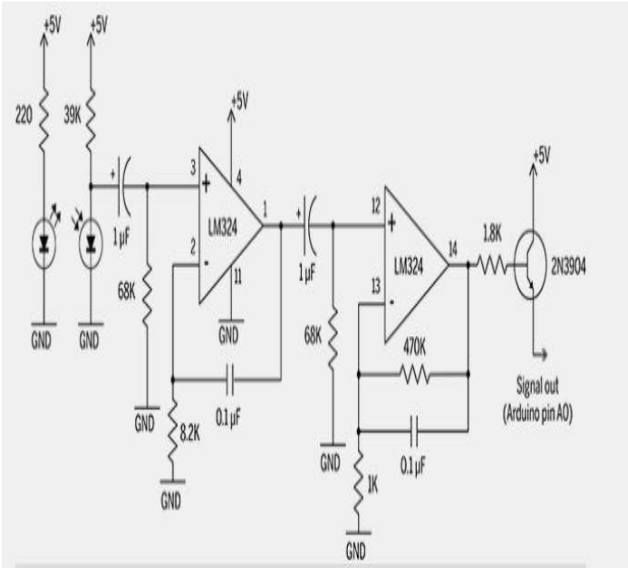

Fig 8 Schematic with symbolic op-amp representation.

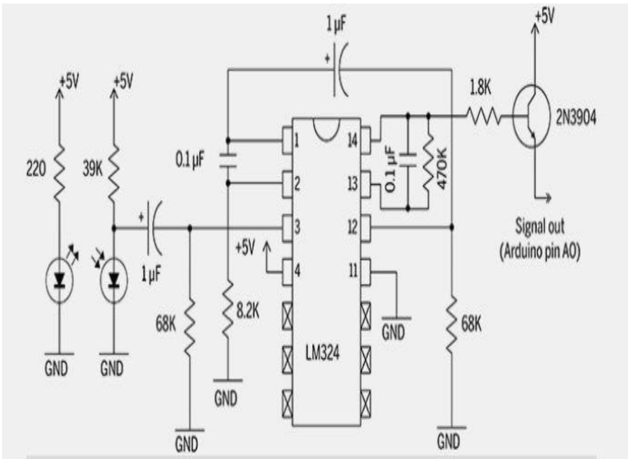

Fig 9 Schematic with symbolic LM324 representation.

The two op-amps output a clean but weak signal which is amplified by the transistor before output. The complete pulse sensor is a three-wire device that runs on 5V and outputs signal on the white wire.

VIBRATION SENSOR

The vibration sensor has two electrical contacts that do not touch each other in idle condition. When any movement or vibration occurs, the sensor's contacts close and touch each other. When the movement or vibration stops, the sensor's contacts return back to their original positions, away from each other. The closed contacts during vibration trigger the circuit connected to it.

Principle:

Usually at any angle switch is ON state, by the vibration or movement, the rollers of the conduction current in the switch will produce a movement or vibration, causing the current through the disconnect or the rise of the resistance and trigger circuit. The characteristics of this switch is usually general in the conduction state briefly disconnected resistant to vibration, so it's high sensitivity settings by IC, customers according to their sensitivity requirements for adjustments.

The vibration sensor has a small spring mechanism that makes the contacts touch each other when vibration occurs above a certain threshold level. Two pins coming out of the sensor are insulated by

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a resistance of more than 10-mega-ohm. During vibration the spring inside the sensor vibrates and makes a momentary short-circuit between the two terminals. Terminals of the vibration sensor have no polarity but one pin is thick. It is connected to Vcc through a resistor and the thin pin is connected to the circuit to be triggered. The sensor's maximum working voltage is 12V DC but it works even at three volts. When using it in a circuit, it consumes less than 5mA current and offers around 10-mega-ohm contact resistance in open state and less than 5-ohm in contact state. It is highly reliable and its response time is less than 2ms. It works more than 500,000 times without breakdown.

Circuit and working:

Circuit diagram of the vibration sensor is shown in Fig.4.19. It is built around NE7555 timer (IC1), npn transistor BC547 (T1), piezo buzzer (PZ1) and a few other components.

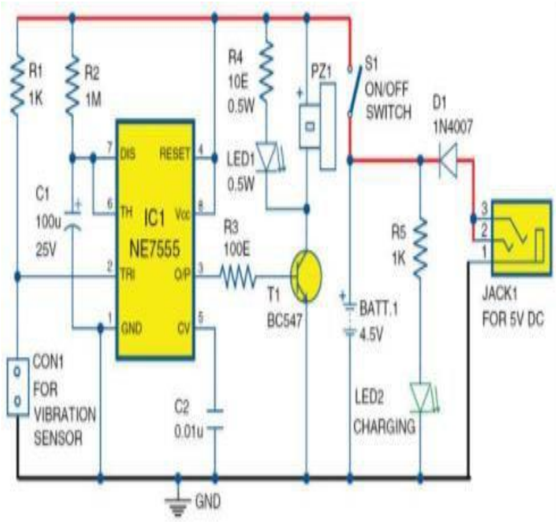

Fig 10 Circuit diagram of Vibration sensor

The circuit is simple. NE7555 timer is configured in monostable mode to activate the buzzer and the white LED for around two minutes when the sensor detects vibration. The vibration sensor is directly connected between trigger pin 2 and ground pin 1 of IC1. NE7555 is the CMOS version of NE555 timer and works off three volts.

The sensor is biased by resistor R1, which also keeps trigger pin 2 of IC1 in high state during standby. When the sensor senses a small vibration, its contacts close and takes pin 2 of timer to ground level. This triggers the timer and its output goes high for around two minutes based on the values of timing components R2 and C1. When output of the timer turns high, transistor T1 conducts to drive the 0.5W white LED and the buzzer. The circuit is powered by a 4.5-volt rechargeable battery pack generally used in cordless phones.

Sensor Details SW-420:

Single-roller type full induction trigger switch. When no vibration or tilt, the product is ON conduction state, and in the steady state, when a vibration or tilt, the switch will be rendered instantly disconnect the conductive resistance increases, generating a current pulse signal, thereby triggering circuit. These products are completely sealed package, waterproof, dustproof.

SOFTWARE TOOL-ARDUINO IDE

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You

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can tell your board what to do by sending a set of instructions to the microcontroller on the board.

As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8- bit boards to products for Human Body Communication applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

Hardware Specifications:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended):7-12V
- Input Voltage (limits): 6- 20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 Ma
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328)
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)

Arduino Installation:

Step 1:
First you must have your Arduino board (you can choose your favorite board) and a USB cable.
Step 2: Download Arduino IDE Software. Step 3: Power up your board.
Step 4: Launch Arduino IDE Step 5: Open your first project.
Step 6: Select your Arduino board. Step 7: Select your serial port.
Step 8: Upload the program to your board.

PROJECT OUTLOOK AND OUTPUTS WORKING

Pulse sensor is connected to Finger tip or Ear lobe as pulse can be detected easily from there. The pulse sensor emits and detects the light rays into the ear or finger and calculates the pulse rate. The output analog pulse rate is connected to the A0 analog input pin of the NODE MCU. The input connected to the NODE MCU is converted into digital form.

- The Temperature sensor is attached to the body part of the patient and the temperature sensor senses the body temperature and converts into digital form. The temperature sensor is connected to the D3the digital input pin of the NODE MCU.
- The Vibration sensor has two separated contacts if patient's body vibrates then sensor short circuits and gives digital high output. If not remains as low output. The vibration sensor output is connected to the D5 pin of NODE MCU.
- NODE MCU connected to internet with built in HBC module updates the sensor output values to the RECEIVER server.
- IFTTT Doctor based service is assigned with particular range of sensor output parameters. The IFTTT is programmed such that if the sensor output values exceed the given range then An alert is sent to pre-assigned Email.

OUTPUTS

- Temperature sensor output
- Pulse sensor output
- Respiratory sensor output

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ADVANTAGES

- HUMAN BODY COMMUNICATION Monitoring proves really helpful when we need to monitor & record and keep track of changes in the health parameters of the patient over the period of time. So with the HUMAN BODY COMMUNICATION health monitoring, we can have the database of these changes in the health parameters. Doctors can take the reference of these changes or the history of the patient while suggesting the treatment or the medicines to the patient.
- Hospital stays are minimized due to Remote Patient Monitoring.
- Hospital visits for normal routine checkups are minimized.
- Patient health parameter data is stored over the Doctor. So it is more beneficial than maintaining the records on printed papers kept in the files. Or even the digital records which are kept in a particular computer or laptop or memory device like pen- drive. Because there are chances that these devices can get corrupt and data might be lost. Whereas, in case of HUMAN BODY COMMUNICATION, the Doctor storage is more reliable and does have minimal chances of data loss.

APPLICATIONS

➢ HUMAN BODY COMMUNICATION Healthcare is the most demanding field in the medical area. This project is for, elderly person in our home. Also for the senior citizen living alone or living with 1 or 2 members. This project really proves helpful when family members need to go out for some emergency work.

➢ Disable patients who find it really difficult to go to doctors on daily basis or for those patients who need continuous monitoring from the doctor.

CONCLUSION

Monitoring your beloved ones becomes a difficult task in the modern day life. Keeping track of the health status of the patient at home is a difficult task. Specially old age patients should be periodically monitored and their loved ones need to be informed about their health status from time to time while at work. So, a system with an innovative system that automated this task with ease. This system puts forward a smart patient health monitoring system that uses sensors to track patient health and uses internet to inform their loved ones in case of any issues. Our system uses temperature as well as heartbeat sensing to keep track of patient health. The sensors are connected to a mcu to track the status which is in turn interfaced to a HBC module connection in order to transmit alerts.

FUTURESCOPE

A GPS module in HUMAN BODY COMMUNICATION patient monitoring can be added. This GPS module will find out the position or the location of the patient using the longitude and latitude received. Then it will send this location to the Doctor that is the HUMAN BODY COMMUNICATION using the HBC module. Then doctors can find out the position of the patient in case they have to take some preventive action.

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