ISSN: 2278-4632
Vol-10 Issue-5 No. 3 May 2020

Health Monitoring Wearable Glove

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Abstract: Wearable Technologies are devices which can be worn by the user & simultaneously process and display relevant information on the wearer. Wearable technology has a variety of applications which grows as the field itself expands. The technology that these new devices are employing is innovative to say at the least. Smart technology is certainly something that will be the key to the optimal operating of our future society, especially when it comes to healthcare. In this project, we will build a Health Monitoring Wearable Glove which can be worn and used to display the heart rate of any individual on the display mounted on the glove. The pulse on a person is sensed using a pulse sensor, which sends information to the Lilypad Arduino board & it subsequently processes the information and commands the display module to display the heart rate. A person need not be a professional to check the pulse.

1. INTRODUCTION

Wearable technologies are now an integral part of our daily lives. They live in our wrist, our glasses, track activities and take us into a virtual world. Wearable technology devices are nothing but devices which can be worn by anyone which displays relevant information on the wearer. Wearable technology has a variety of applications which grows as the field itself expands. The wearable technology devices use technologies which are very innovative. Future society will depend mainly on smart technology for optimal operating, especially in the field of healthcare industry[1]. The need of wearable technology in healthcare arises due to the need for monitoring patients over an extensive period of time [5].

1.1. Wearable technology applications

Medical: Wearable Technology plays a very important role in today's Healthcare transformation. In the medical field wearable tech could be used to monitor vital signs, manages diseases, and monitor patients at all time [3].

Security: For security and safety purposes, wearable Tech could be used in a military to provide environment surveillance, remote monitoring and real time data acquisition.

Sports/Fitness: In the field of sports and fitness, devices could be made for physiological monitoring, energy monitoring, sports performance, posture monitoring etc. to provide insight and prevent injuries.

Lifestyle: Wearable Tech are also being used to improve our lifestyles through organising, interactive gaming or decorative displays.

Communication: They can also be used for faster communication during an emergency or area sharing experiences more personally.

1.2. Wearable technology products

Some prominent wearable technologies that we have already used include Fitbit Activity tracker, which monitors our physiological processes and help us track and analyse the data obtained from these processes, VR headsets which transports us to a virtual world. Google Glass which provides functionality that is integrated with the user's current experience of the world and the Athos smart cloth which monitors muscle activity and posture to help us exercise correctly and prevent injuries. Demand is always high for wearable non-invasive devices which do not interfere in the daily routine of the person wearing them [2].

2. LITERATURE SURVEY

Different researchers used different methods and technologies to carry out the process of heart rate monitoring. Some of the important research works are reviewed in this paper.

In this research paper heart-rate signals were collected from finger or ears using IR TX-RX (Infrared Transmitter and Receiver pair) module which was amplified in order to convert them to an observable scale. A low pass filter was used to filter inherent noise. These signals were counted by a microcontroller module (ATmega8L) and displayed on the LCD. Microcontroller is programmed with an algorithm to run the proposed heart rate counting system. The results obtained using this process when compared to those obtained from the manual test involving counting of heart rate was found satisfactory. The proposed system is applicable for family, hospital, community medical treatment,sports healthcare and other medical purposes. Also, fit for the adults and the paediatrics. However, this method in the developed system needs further investigation and need more functionality, which may be useful to consider advance in future research [1].

This paper includes working on a wirelessly display of Heart beat and temperature based on a microcontroller ATmega328 (Lilypad Arduino). Most monitoring systems that are used in today's world works in offline mode but our system has been designed in such a way that a patient can be monitored remotely in real time. This system consists of sensors which measures heartbeat and body temperature of a patient which is controlled by the microcontroller. Both the parameters are displayed in LCD monitor. The transmitted data is wireless and is send through microcontroller. Heartbeat is counted through pulse sensor in Beats per Minute while the temperature sensor measures the temperature and both the data are sent to the microcontroller for transmission to receiving end. Finally, the data are displayed at the receiving end. This system could be made available at a reasonable cost with great effect and accuracy. [2]

This research paper shows GSM enabled real time heart rate monitoring system. GSM system is used for communicating the abnormalities in heat rate values. Unusual change in the values of any of these parameters from their set point values will be immediately sensed and local help is sought from the nearby people. If any help is not available, this system sends SMS directly to home, doctor or care taker's mobile phone. Heart rate is the number of heat-beats per unit of time, simply expressed as beats per minute (bpm). An attempt is made to design and develop a system that uses a simulator circuit to diagnose abnormalities in the heart rate which includes Tachycardia and Bradycardia conditions. It is a two directional communication system in which the care taker or Doctor, can also send SMS to know the present parameter status of the person or patient .[3]

In this research paper implementation of heartbeat monitoring and heart attack detection system using Internet of things is shown. These days we saw an increased number of heart diseases & heart attacks. The sensor is interfaced to a microcontroller that allows checking heart rate readings and transmitting them over internet. The user may set the levels of heart beat limit. After setting these limits, the system starts monitoring and as soon as patient heart beat goes above a certain limit, the system sends an alert to the controller which then transmits this over the internet and alerts the doctors as well as concerned users. Also, the system alerts for lower heartbeats. Whenever the user logs on for monitoring, the system also displays the live heart rate of the patient. Thus, concerned patients may monitor heart rate as well get an alert of heart attack to the patient immediately from anywhere and the person can be saved on time. [4]

In this research paper, the design and development of a microcontroller based heartbeat and body temperature monitor using fingertip and temperature sensor is shown. The device involves use of optical technology to detect the flow of blood through the finger and offers the advantage of portability over conventional recording systems. Wireless body area network based remote patient monitoring systems have been presented with numerous problems including efficient data extraction and dynamic tuning of data to

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preserve the quality of data transmission. Evaluation of the device on real signals shows accuracy in heartbeat measurement, even under intense physical activity. This paper presents these challenges as well as solution to these problems by proposing an architecture which allows a network to be formed between the patient and doctor in order to enable remote monitoring of patient by analyzing the data of patient. The device consists of sensors which are used to measure heartbeat as well as body temperature of a patient and it is controlled by a central unit. The readings from these sensors are further processed and sent via GSM module to a remote location where it is displayed on cell phone. The optical heartbeat sensor counts the heartbeat per minute and temperature sensor measures the temperature from the body and both the measured data are sent to a receiving end utilizing wireless technology where the data is displayed in a cell phone for further processing and patient care. This device is shown superior in comparison to traditional systems [5].

In this research paper, it is shown that the heart rate can be measured by monitoring one's pulse using specialized medical devices such as an electrocardiograph (ECG), portable wrist strap watch, or any other commercial heart rate monitors. Despite of its accuracy, somehow it is costly, involve many clinical settings and patient must be attended by medical experts for continuous monitoring. For a patient whom already diagnosed with fatal heart disease, their heart rate condition has to be monitored continuously. This paper proposed an alert system that able to monitor the heart beat rate condition of patient. The heart beat rate is detected using photo plethysmograph (PPG) technique. This signal is processed using PIC16F87 microcontroller to determine the heart beat rate per minute. Then, it sends SMS alert to the mobile phone of medical experts or patient's family members, or their relatives via SMS. This will also alert the family members to quickly attend the patients. [6]

3. METHODOLOGY

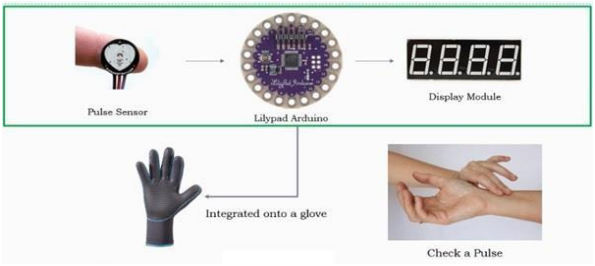

Figure. 1. Project Idea

A pulse sensor is used to detect the pulse of an individual and process the data on the lilypad arduino board and finally display the pulse reading on the display module. This system must be integrated onto glove such that the entire system can work as a standalone pulse measuring device.

A pulse is basically a pressure wave that travel across all the arteries. Every time Heart beats, arteries carry oxygenated blood from the heart to the extremities of our bodies. Pulses can be felt in the places where an artery can be pressed against the bone. One such artery is the radial artery below the wrist. Pulse oximetry is a technique used to measure the blood oxygen content and blood volume in the skin. Such devices are calledpulse oximeters. These devices work based on the amount of light absorbed or reflected by blood which varies based on the volume of the blood or the oxygen content in the blood. Devices which sense the amount of light that has passed through the blood are transmissive type oximeters and those that sense the amount of light that is reflected from the blood are reflective type. The output graph of the acquired pulse is called a Plethysmogrpah. The pulse sensor that we used in this project is a reflective type pulse oximeter.

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Figure. 2. Reflexive Pulse Oximeter

3.1.Pulse Glove – Block Diagram

The system has a Sensor module, Control module and a Display module for its effective functioning.

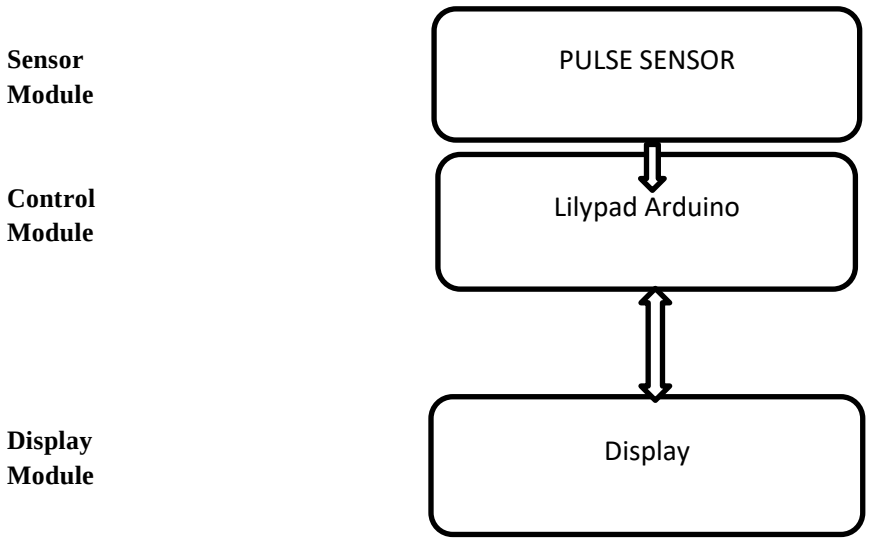

Figure. 3. Block Diagram

3.1.1. Sensor Module

A pulse sensor will be used for detecting the pulse of a patient. This sensor will be stitched to a glove for easy handling. The sensor module senses the pulse and sends the information to the Control module.

3.1.2. Control Module

Information from the sensor will be received by a Lilypad Arduino board. The information is then processed and appropriate command to the Display module is sent.

3.1.3. Display Module

This section will comprise of a display unit which display the pulse rate.

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4. HARDWARE AND SOFTWARE

This project uses software as well as hardware for its implementation.

4.1. Hardware Used

- Arduino Lilypad
- FTDI Board
- Pulse sensor
- TM 1637 Display
- Pin Connectors
- Battery connector and holder
- AA batteries

Arduino is an Open source electronics platform based on easy to use hardware and software. It is a combination of microcontroller based arduino boards, arduino programming language and the arduino software for development and compilation. Arduino has evolved from being just an embedded environment to helping build advanced products for internet of things applications, wearables, 3D printing etc. Also, being an open source platform the hardware design schematics, PCB files and the code for the software are freely available. This gives users the flexibility to adapt and develop the design for their own projects. Arduino is used in thousands of different projects, thanks to its simple and accessible user experience. Some of the other reasons why people are going for arduino are because they are inexpensive, it works cross-platform, simplicity and clear programming environment, open source and extensible software and hardware.

Future Technology Devices International, also known as FTDI, is a Scottish privately held semiconductor device company, specializing in Universal Serial Bus (USB) technology. To allow support for legacy devices with modern computers, FTDI develops, manufactures and supports devices and their related software drivers for converting RS-232 to USB signals. FTDI provides application-specific integrated circuit (ASIC) design services. They also provide consultancy services for product design, specifically in the realm of electronic devices.

TM1637 used in this work is a chip for driving 7- segment displays. Several modules used in this chip form a 4 digit numerical display module. There are seven LEDs arranged in the shape of numeric 8, each called a segment and hence the name. Each of these seven segment LEDs are represented by a character for reference. In some displays, there will be an additional LED for decimal point indication.Table

Truth table for 7-segment display

Segments Input							7 Segment Display
a	b	c	d	e	f	g	
1	1	1	1	1	1	0	0
0	1	1	0	0	0	0	1
1	1	0	1	1	0	1	2
1	1	1	1	0	0	1	3
0	1	1	0	0	1	1	4
1	0	1	1	0	1	1	5
1	0	1	1	1	1	1	6
1	1	1	0	0	0	0	7
1	1	1	1	1	1	1	8
1	1	1	1	0	0	1	9

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There are two types of 7-segment displays namely Common Cathode and Common Anode type. In the common cathode display, all the cathode connections of the LED segments are joined together to ground. The individual segments are illuminated by "HIGH" signal. In the common anode display, all the anode connections of the LED segments are joined together to VCC. This is the most commonly used display module. In this project, we use Common Anode type display.Shown below is the common anode type display and its pin description.

4.2. Software Used

The Arduino Software (IDE) runs on Windows, Macintosh OSX and Linux Operating Systems. But most microcontroller system software requirements are limited to Windows only. The Arduino Software is provided as an open source tool for the beginners and students to write and upload the program onto the microcontroller. Programming of the Uno board is denoted by "Sketches". Each sketch contains variable declaration, initialization and control code. The setup function contains the Initialization variables and Loop function contains the Control code. The program/sketch is saved in .ino format and the various sketch operations like opening, verifying, saving etc. can be done from the tool menu. We should select the suitable board and serial port number from the tools menu. Upload button is used to upload the code to microcontroller.

5.SETUP

5.1. Project Schematics

As we know there are three primary components in the health monitoring glove. The pulse sensor, the lilypad arduino and the TM 1637 display Module

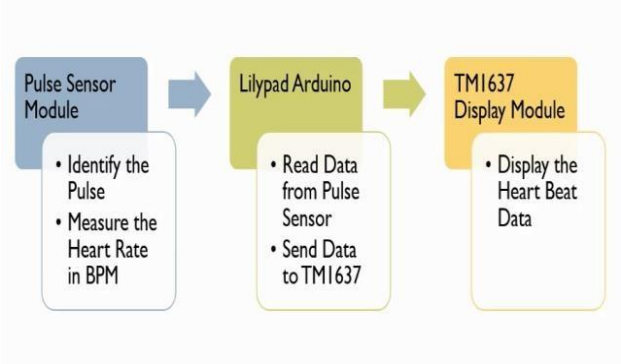

Figure. 4. Project schematics

The pulse sensor module is necessary to detect the pulse and measure the rate of the post in Beats Per Minute. The Lilypad Arduino read the data from the pulse sensor at regular intervals and sends the same [4]to the TM 1637 display module. Finally TM 1637 display module receives the data in digital format and displays it using the four seven segment display. In addition to the above primary components there are also the power supply, a glove and conductive thread that form the wearable.

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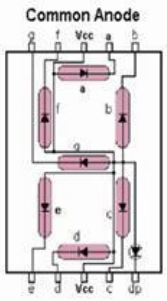

Pin Name	Description
a, b, c, d, e, f, g	LEDs to Display numeric
Vcc	Pin to connect Common Anode
DP	Decimal Point LED

5.2. Connection Schematics

Below table shows how the three components are interfaced with each other.

Table 2. Connection Schematics

Component 1	Pin	Pin Description		Pin	Pin Description	Component 2
Pulse Sensor	+	5V Positive		+	5V Positive	Lilypad Arduino
	-	Ground		-	Ground	
	S	Signal Pin		A0	Analog Pin	
TM1637 Display Module	VCC	5V Positive		+	5V Positive	Lilypad Arduino
	GND	Ground		-	Ground	
	DIO	Data Input/Output		9	Digital Pin	
	CLK	Clock Signal		10	Digital Pin	

Pulse sensor has 3 pins. The + ve and –ve pins are connected to the +ve and GND pins of the Arduino Lilypad respectively. Signal Pin which transmits the data read by the pulse senor is interfaced with the Analog pin A0 of the Lilypad.

5.2. Programming Logic

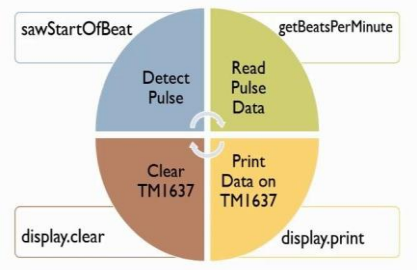

Figure. 5. Programming Logic

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Pulse sensor first detects the pulse based on the threshold value set for it. Sensor measures the change in volume of blood through any organ of the body which causes a change in light intensity through that organ[]. This is accomplished by the sawStartOfBeat function. Once the pulse is detected, the data is read in Beats Per Minute using the getBeatsPerMinute function. This data in then printed on the TM 1637 display module using the display.print function. Finally, once the data is displayed, the display is cleared soon after so as to make it ready for the next set of data. This cycle is repeated every set of seconds or whenever a pulse is detected, whichever takes longer. Some of the functions used in the code are:

- sawStartOfBeat()

Returns true if a new heartbeat pulse has been detected. Type = boolean.

- getBeatsPerMinute()

Returns the latest beats-per-minute. Type = int.

- display.print()

To print data in TM 1637 display module

- display.clear()

To clear the TM 1637 display module

The various components are mounted in a hand glove for easy usage. By just holding the hands in such a way that the pulse sensor touches his/her artery, we will get a display of the pulse rate of the person. A person need not be a professional to check the pulse.

6. RESULT AND DISCUSSION

Wearable glove using pulse sensor is used to detect the pulse rate of a human being, and is used for health monitoring. When a finger is attached to a pulse sensor it detects the pulse and gives pulse reading in display section. The pulse detection is shown in the below figure.

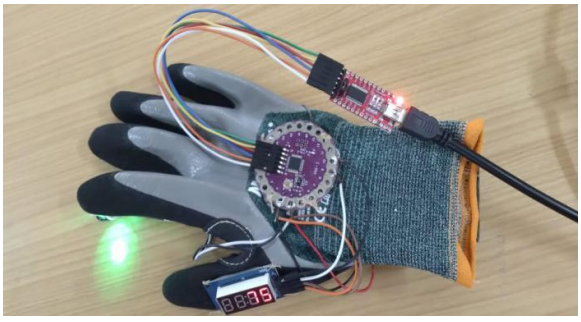

Figure 6 :Wearable glove showing heart beat in BPM

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7. CONCLUSION

The wearable sensors make the detection of physiological signals relevant to the motion visual pattern of the elders-sly patients at home. The In-Network data aggregation implemented in our system is used to increase the energy efficiency of wireless sensor nodes at the same time avoid packet losses and high storage capacity servers in compared to other monitoring systems without aggregation technique. These sensor nodes are programmed to awaken the node whenever abnormal signals are detected and transmit the data to the server and then return to the sleep mode. When an abnormality is detected in the sensor node, it automatically turns on and transmits the signal to the central server and simultaneously alerts the caretaker near the patients. The analysis is done using the software mote view, a built-in library for data acquisition, processing, analysis, and display.

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