ADVANCED HEART RATE DETECTION USING EMBEDDED SYSTEM

Ravi Gatti
Asst Professor, Dept. Electronics & Communication Engineering,
Sri Venkateshwara College of Engineering,
Bengaluru, India
ravi.ncg@gmail.com

Roopashree H A
UG Student, Dept. Electronics & Communication Engineering,
Sri Venkateshwara College of Engineering,
Bengaluru, India
rupashree1011gmail.com

Pruthvika R
UG Student, Dept. Electronics & Communication Engineering,
Sri Venkateshwara College of Engineering,
Bengaluru, India
pruthvika04@gmail.com

Priyanka K
UG Student, Dept. Electronics & Communication Engineering,
Sri Venkateshwara College of Engineering,
Bengaluru, India
priyankank28@gmail.com

Varun S
UG Student, Dept. Electronics & Communication Engineering,
Sri Venkateshwara College of Engineering,
Bengaluru, India
varunssrinivas05@gmail.com

Abstract— **In current technical innovation in the field of disease detection and prevention, some of the health monitoring systems are made of minimum amount of resources even then, they appear bit complicated when considered with respect to their design complexity. So, to overcome these complexities, the wireless communication system is used and enhanced further to meet the needs of remote monitoring. Remote Patient Monitoring (RPM) technology helps the individual to monitor their health on their own without getting any instructions from medical experts and no need to go for the clinic or hospital. This technology increases the efficiency of such health monitoring services. Most of the health condition monitoring devices that are in use now days are made of offline mode, but the proposed system overcomes all these drawbacks, as it is modeled in such a way that a common man can monitor his health condition by detecting the heart pulse rate and monitoring it in real time. Heart beat is the main important parameter that plays a vital role in monitoring patient's health. Hence, monitoring the heart rate will be more beneficial for human to lead a healthy life. The proposed working module mainly consists of IR sensor that detects and counts the number of pulses over a specified time interval by observing the changes caused in the density of the blood flow and calculates the heart rate per minute and this data is fed to the microcontroller which is processed to digitize the obtained analog signal and this digital count is displayed on the LCD as a final output on its display. The proposed system is advanced in such a way that, just by sensing the change in blood volume through the fingertip this device is capable of detecting the number of pulses and specifying some of the emotional condition of that person as per the data obtained. This monitoring system will be portable and will be available at very low cost with efficient, accurate results in real time and user friendly.**

keywords— IR sensor, RPM technology, Blood Flow, Heart rate ,Pulse.

I. INTRODUCTION

In the field of disease prevention and monitoring of patient's health, some of the technological innovations were enhanced and enabled in the form of monitoring devices. Pulse rate plays a very important role in monitoring a person's health. This pulse rate can be measured with the help of ECG or by sensing the pulses. The pulse can be detected easily by sensing the density of the blood flow through the skin part as the arteries will be connected very close to the skin[1]. So, that the fluctuation in that blood flow can be sensed easily by a sensor that indicates the pulse rate. A heart rate is considered as number of times a person's heart beats per minute. A normal pulse rate depends on an individual's health, age, medication use, and also emotions may have a major impact on it. Awareness and much knowledge regarding the heart rate can help the person in monitoring the health condition, maintaining the body fitness level and it also helps to detect and monitor the developing health problem at the initial stage if that person is undergoing some of the symptoms related to that particular disease. The person's body fitness level can be indicated by considering the heart pulse rate of a person before and after the exercise. The pulse rate can be measured manually only when the person is at rest, to count the number of heart beat per minute. So, measuring the heart rate with the help of an electrical circuit will be much easier, accurate, faster and also time consuming.

In our day-to-day life we come across many electrical and electronics circuits that are designed using a technology called embedded systems, which is a combination of both hardware and the software. Use of this technology helps in reducing the complexity of designing the circuit with very low cost and small size. Implementation of this technology in medical field will be more beneficial and cost effective as embedded system is an electronic device that has the capability of performing multiple tasks regarding the specified application and it can also be programmed and un-programmed to perform particular operations as per the requirement.

In case of hospitals and some of the clinics, the longtime waiting of patients in the waiting list for hospitalization are some of the well-known issues nowadays. Due to the increasing population in today's world, demand for such health care services are also increasing. Patients are facing much problems for their treatment in emergency cases, due to

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lack of on time treatments and they are discharged soon after the diagnosis. So, it's a major issue that a patient's heart condition has to be monitored for a long time to prevent complications. The quality of the health care services needs to be increased by controlling the cost. All these drawbacks could be overcome by designing a device that can be easily handled by a common man to measure the heart rate from time to time and monitor the heart condition and approach the doctors only when required. This saves the time of both the doctors and the patients.

The proposed work consists of display unit which the count of number of heart beats per minute, this device consists of both the hardware and the electronic circuit by the use of microcontroller in it, and it is of small size, portable and beneficial for a common man. So, the objective of this work is to design a low cost heart beat monitoring system which is simple and can be used by each individual to monitor the health condition at any time. This device will be portable, reliable and comfortable and also provides accurate results due to the use of highly sensitive IR sensor.

II. LITERATURE SURVEY

A simple and low cost optimal photo-sensor based heart beat detector with liquid crystal output display was proposed. In this paper, the pulses are measured using the photo-sensor by detecting the changes in blood flow. LED, IR and LCD are some of the sensor used to produce significant output. The heart rate is calculated with help of microcontroller (PIC16FA77A) which also controls the LCD display. The output of this work provided better service for the people, to maintain their health condition. The future work of this research was to enhance communication methods by adding wireless connection, to meet the needs of people, and it is required to be environmental friendly for all the OS of androids [1].

A pulse measurement device to support significant study was proposed. In this work, the author's aim was to design a device that measures the maximum and minimum values of the detected pulse rate of a person. This paper mainly focused on the measurement of the pulse rate and signal analysis of electric pulse for a life span of 20-80 years. The input optical sensor was processed by the use hardware named as ADK R3 and the recorded output data were stored in SD card. Input output parts were controlled by designing an embedded algorithm. Finally, this paper helps in determining the maximum and minimum pulse values. The drawback of this work is that, it is designed only to measure the pulse rate for a limited life span of 20-80 years [2].

Centralize heart beat monitoring and automatic message alert system using WBAN was proposed. In this paper, the multiple heart beat and temperature data are measured and stored. The stored data is processed by a microcontroller, and then it is sent to the centralized unit where the information for multiple sensors would be displayed continuously. This system was applicable only for hospitals or any other clinics. The future work is to expand this system to remote patient's connected to a centralized monitoring system using wireless network [3].

A GSM modem integrated bio-sensor detecting heart beat rate system was proposed to detect using heart attacks. In this work, the heart rate was detected using LDR, LED band and the finger was made to place in it. When the detector activates the LED turns 'ON' with each heartbeat. The obtained signal was processed by microcontroller to detect the pulse rate per minute and was displayed on a LCD screen. This displayed output is sent has an SMS to the medical expert's mobile phone. This helps the doctor to diagnosed the patient and provide easier precaution for them. The future scope was to implement better packaging of the circuitry by using low cost and sensitive sensor to attain better accuracy [4].

The portable system for a vital parameter acquisition using SIX sigma methodologies was developed. In this paper, the author designed a portable device using the six sigma methodology to measure the cardiac activity and transmit these signals to the doctor's mobile to monitor the patient's health condition. This paper mainly focused on a work to design a cost effective device with the help of sensors that are available easily which are capable of acquiring signals. The obtained signals were processed by a microcontroller and with the help of internet of things and Bluetooth module these signals of a patient are displayed on a doctor's mobile application. Finally, a device was developed that could help the patients to monitor their cardiac activity by a quick solution by the doctor and this was time consuming for both the doctor's and the patients. But the drawback is that, only medical expert or a doctor can operate or make use of this device and then treat the patients but cannot be handled by a common man [5].

A low cost computer based pulse rate monitoring system using microphone pore was proposed. In this paper, the author implemented a low cost device that measures the heart rate of a person from the fingertip with the help of a computer's microphone port. By the use of infrared technology, the optical sensor detects the changes the blood volume. The unwanted components are removed from the noisy signal obtained as an output from the sensor then it is interfaced with the microphone port and processed to measure the pulse rate in real time. This designed device helps a person to have knowledge of heart condition by detecting the heart diseases like sleep arrhythmia. The device is more complex in design [6].

The observations made from all the above mentioned reviews, it is clear that all existing devices that are designed to measure and monitor the heart rate of a patient are limited, as it has to be used only by the medical experts or the doctors in the special health care centers and some clinics, hospitals and also very complex in design. The main drawback is that these devices cannot be handled by a common man itself to know about his heart condition.

So, the proposed system is more advanced, as it is simple in design and portable. A common man can easily handle this device and have knowledge about what is going on in his body

just by observing the heart condition by sensing the pulses. This helps in reducing the time of both the doctors and the patients.

III. SYSTEM OVERVIEW

Some severe disorders such as heart attacks needs simultaneously monitoring methods after diagnosis to prevent further damage that may lead to future complication. Usually monitoring these types of patients occurs in hospitals or health care centers. Heart failures such as heart arrhythmias needs continuous monitoring for a longtime. However, these group of patients are discharged too early from the hospitals, as another patient is in a need of that bed to be hospitalized immediately. As, heart rate is major parameter to monitor person's health, it should be maintained properly to lead a better life. To overcome all these problems a low cost heart beat monitoring system is proposed which is portable and can be used by each individual at home, which will provide more accurate results in measuring the heart rate and helps each and every individual to constantly check and monitor the heart condition to lead a better life.

In this proposed work instead of pressure sensors, IR sensor is used as it has high sensitivity and obtains more stable output. This sensor depends on the fact that speed of the blood is proportional to the heart rate. This is to say that the heart rate changes when people are active. The measured heart rate will be displayed on the LCD which shows the information about, if the person as undergone an exercise by indicating an increasing heart rate, may be some times out of healthy range. The normal heart rate will be recovered, when the person takes a break. People can take care of their health condition by using the heart rate monitoring system.

IV. PROPOSED BLOCK DIAGRAM

The proposed working model includes a photo-sensor that measures the pulse by measuring the changes in the blood flow. Light emitting diode (LED), Infrared sensor (IR), are the best photo-sensors which are used to produce significant heat beat signal that is detected from the human finger.

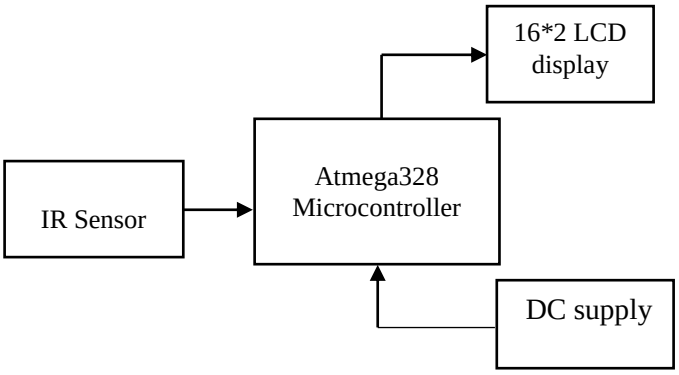

Figure 1: Proposed Implementation Block Diagram.

In this proposed work IR sensor is used in order to sense the heart beat by detecting the changes in the blood flow through the finger with the help of artery that are closely connected to the skin. Every time the heart beats, it is sensed by the IR sensor and the LED turns on. Other than this, this proposed work also includes the use of ATMEGA32 microcontroller which is programmed to count the number of heart pulse over a unit time and control the LCD display which indicates the heart rate. The pulse rate is displayed on the LCD.

Details of the above mentioned block diagram as shown in figure 1 is as follows:

A. IR SENSOR

The sensor consists of IR light emitting diode and a photo diode that are placed side by side and the fingertip is placed closer towards the IR sensor in order to sense the pulse. As soon as the finger is placed towards the sensor, it gets activated and transmits an IR light from the higher LED to the tip of the finger, then a part of that light is reflected from the blood which depends on the density of the blood volume inside the finger. This reflected light is absorbed by the photodiode and the pulses are detected. So, whenever the heart beats, the pulses will be detected by the photodiode by observing the changes in the flow of reflected IR light from the finger and this output signal obtained from the photodiode is amplified by passing it through the low pass filter which is cascaded. These pulses are fed to an LED. So, whenever the heart beats, LED glows and the pulses are recorded by the microcontroller.

B. MICROCONTROLLER

Arduino UNO board is used to read sensors and control signals such as motor and light. It is an open source microcontroller board that allows the user to upload programs and then interact with things in the real world. ATMEGA 328 microcontroller is the used in this work that runs at 8MHz. The output signal from sensor is sent to the microcontroller which is processed to measure the pulse by converting the obtained analog signal to a digitized form and generates a control signal to control the LCD. The pulse rate is calculated using a timer then the digitized output from the microcontroller is sent to the LCD.

C. LCD Display

It is the electronic visual display that uses the light modulating properties of liquid crystals. The digitized output obtained from the microcontroller is displayed on the LCD screen.

In this work IR sensor detects the pulse from the blood. As the heart pumps the blood in the body, which is considered as a heartbeat the blood contraction in the body changes. These changes are used to make a pulse electrically. Finally, the detected pulses are counted by the timer in the microcontroller over a unit time and the digitized output are displayed on the LCD also the heart condition of that person will be displayed .

V. METHODOLOGY

The methodology of this proposed deals with the flow of proposed method implementation. Which basically explains the what are the initialization parameter value which must be maintained for the calibration of the prototype model.

The proposed model is a combination of both the hardware and the software. The circuit is designed by interfacing the Arduino board with the LCD and the IR sensor which is capable of providing control signals to control the LCD. When the finger is placed on the sensor, it senses the number pulses over a unit time. The LED turns on when the pulses are detected, which then activates the timer of the microcontroller to start the count? By considering only, the high frequency contents over the number of detected pulses it measures the heart rate and displays the final count on the LCD monitor in digital form along with the display of some of the emotional conditions related to the obtained output data of that person. As this would help the person to have some knowledge regarding health condition by observing the changes in pulse rate.

This work includes the following steps as shown in figure 2:

Step 1: Initialization of both microcontroller and the LCD is done, then the project title is made to be displayed on the LCD monitor.

Step 2: IR sensor is initialized to detect the pulses by observing the fluctuations of the blood flow by undergoing the density of the blood. It gets activated whenever it detects the pulse. The output signal is obtained in the form of an analog signal or a voltage signal.

Step 3: As soon as the IR sensor senses the pulse, LED turns on indicating that the heart pulse is detected. This output is fed as an input to the microcontroller.

Step 4: Microcontroller is processed to perform the required operation with the help of an Arduino IDE software program. The timer gets activated and starts the count and measures the respective pulse rate.

Step 5: Finally, after counting the pulse rate, the timer stops and the measured data are displayed on the LCD monitor. With respect to the displayed pulse rate the heart condition of a person will also be displayed on the monitor such as whether a person is emotional or not. Some of the conditioned will be viewed as per the threshold strategy as it signifies exact condition of a person.

In this way, the overall procedure will be repeat from step 3 until the pulse is detected and the sensor senses the pulse and LED gets turned on. Then the corresponding output is processed and the obtained data is displayed on the LCD. The emotional condition of that person with respect to the measured heart rate will be displayed on the LCD as a person is depressed or emotional, excited. This process repeats.

A. HARDWARE COMPONENTS

1. IR sensor.
2. Arduino UNO.
3. LCD display.

B. SOFTWARE COMPONENTS

1. Arduino IDE.

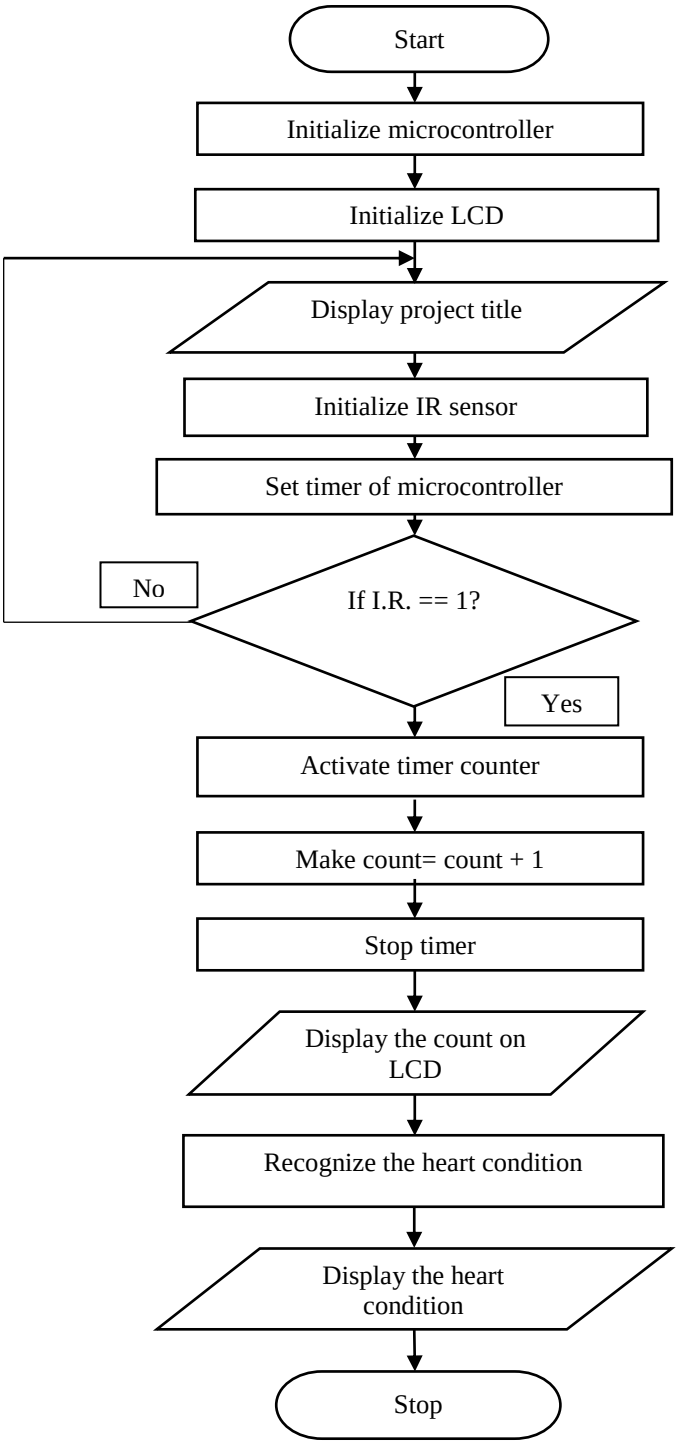

Figure 2: Flowchart of a proposed work.

VI. RESULTS AND DISCUSSION

Heart rate is an important parameter of human health that has to be monitored perfectly. Usually, doctors make use of heart rate monitor such as ECG to check and measure heart rate of the patient. In this work, we have designed a simple and an advanced version of heart beat monitoring system that can easily be use by a common man to measure his heat rate per minute and monitor his health condition. Here we made use of highly sensitive IR sensor, which senses the pulses through the skin by placing the finger towards the sensor which is further processed using the microcontroller and finally the measured heart rate is displayed on the LCD. Since, the measured heart rate will be displayed on LCD in the digital form, it can be easily understood by a common man.

Normal Heart rate of an adult of 18 and above should be around 60 – 120 beats per minute. In the same way, it varies for different age groups. So, when people check their heart beat with this proposed model they can easily monitor their heart condition. If the heart rate is below or above the normal rate, then it signifies that there are chances of getting some of the diseases related to heart, so they can approach the doctors for further treatment and get the precautions.

The following are some of the tests performed to check the working condition of the designed device.

A. Testing the working condition of the proposed model.

1. Initially the model is tested without placing the finger or any obstacle towards the sensor to check the perfectness of it.
2. When the finger is not placed towards the senor, LED remains off, indicating that the sensor has not detected the pulse. So, the GUI (graphical user interface) graph remains empty and only the title will be displayed on the LCD monitor as shown in the figure 3 below.
3. This indicates that the proposed model is ready to undergo the test to calculate the heart pulse.

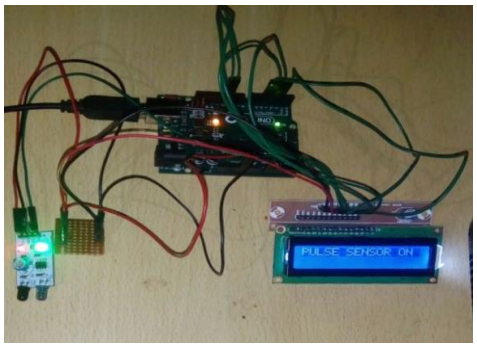

Figure 3: Tested view of the module.

B. Testing to detect the heart pulse.

1. Initially, the testing is performed by placing the finger towards the IR sensor. The finger has to be placed very close to the sensor to get more accuracy.
2. IR sensor detects the pulse by observing the fluctuations caused in the blood flow. As soon as the pulse is detected the LED turns on. This detected pulse rate is viewed on the GUI and also displayed on the LCD monitor as shown in the figure 5 & 6 below.

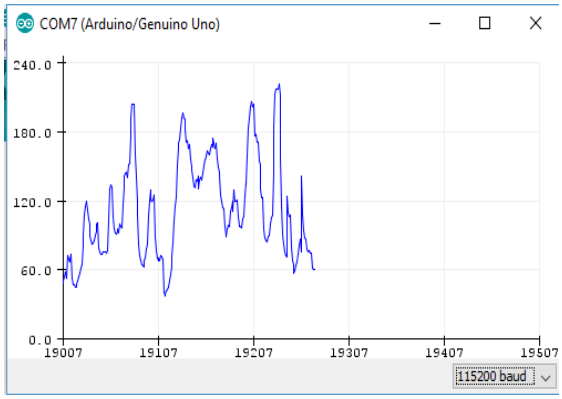

Figure 4: Tested GUI view of a detected heart pulses by the IR sensor.

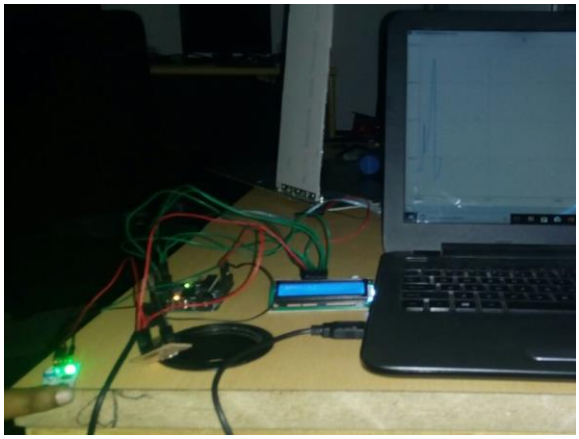

Figure 5: Tested view of module when the heart pulses are detected.

C. Final output of the proposed model.

1. The detected pulses obtained by the sensor are voltage signals. Later on, this pulses are sent to the LED. The LED turns on and the signal is sent to the microcontroller.
2. The microcontroller is processed by the Arduino IDE software which considers only the high frequency components of the detected pulses per minute as per the program are generated.
3. These pulses are digitized and fed to the LCD monitor.
4. LCD monitor displays the final count of a heart rate per minute in digitized form as shown in the figure 6 below.

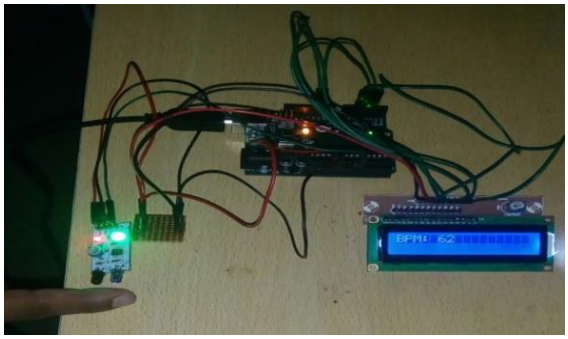

Figure 6: Final output of the proposed module.

VII. CONCLUSION

The proposed working model functioned smoothly and the overall observation was made and the objectives were achieved successfully. Apart from all this, the proposed work provides better service for the people to lead a healthy life by monitoring their heart condition from time to time on their own without the need of consulting the medical experts to check their heart rate. Through this work, the device is made simple to use, portable, safety and applicable to all levels of users and very useful for a common man, especially for elders. The device is advanced compared to the currently available industrial product as it is capable of recognizing the heart condition of a person such as emotions just by measuring the heart rate by sensing the pulses. It is portable, as it can be used at home and carried anywhere by individual. It is user friendly and available at low cost. In the future, this work is looking forward to include more advanced by designing it to send it as an SMS alert to the doctors when serious issues regarding the patient's health were recognized by this device. This proposed working model is more accurate due to the use of IR sensor as it provides more stable output, low cost and simple in design when compared to commercial devices that are currently available in the market.

REFERENCES

1. N.M.Z Hashim, N.A. Ali, A. Salleh, A.S. Jaafar, N.A.Z. Abdin, "Development of optimal photosensor based heart pulse detector", University Technical Malaysia Melaka, Hang Tuah Jaya, 76100, Page no. 1-7. Durian Tunggal Melaka, Malaysia 2013.
2. Thadsanee Thongkanuang , " heart rate measurement and electrical pulse signal analysis for subject span of 20-80 years", electronics research institute (ERI), page no. 1-9, 2015.
3. Kala Venugopal, Amit Kumar, "Centralized heart rate monitoring and automated message alert system using WBAN", International journal of scientific and research publications, page no. 1-4, 2013.
4. Anand Giri, Aparna Dubey, "Performance improvement of health monitoring system using wireless technologies", International Journal for research in applied science and engineering technology (IJRASET), page no. 88-92, 2014.
5. Bhargavi Haripriya. A, Sowndharyaul . "Development of Portable Vital Parameter Acquisition System Using SIX SIGMA Methodology"
6. Mohammad Abu Raiham Miah, Apratim Roy, "A Low Cost Computer Based Heart Rate Monitoring Sytem Using Fingertip and Microphone Port", International Conference on Informatics, Electronics and Vision (ICIEV), 2013.
7. T.S. Arulananth, B. Shilpa, "Fingertip Based Heart Beat Monitoring System Using Embedded System", IEEE conference, 2017.
8. Bandana Mallick, Ajith Kumar Patro, "Heart Rate Monitoring System using Fingertip through Arduino and Processing software", International Journal of Science, Engineering and Technology Research (IJSERT), page no. 84-89, 2016.
9. Liena Elrayah Abdelkhair Khairelseed, "Microcontroller Based Heart Rate Monitor using Fingertip Sensor", university of Khartoum, 2011.
10. Gulati M, Shaw I.J, Black HR, Merz CN, "Heart Rate Response to Exercise Stress Testing in Asymptomatic Women", June 2010.
11. M.M.A. Hashem, Rushdie Shams, Md. Abdul Kadar, "Design and development of a heart rate monitoring device using fingertip", International Conference on Computer and Communication Engineering (ICCCE2101) Kuala Lampur, Malaysia, 2010.