International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9, Issue-7, May 2020

Heart Beat Rate Monitoring using GSM Technology

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Abstract: ***Heart-related problems and parameters are very much important to human beings. With the gradual technological advances, it made easier for the people to capture and monitor changes in their health parameters irrespective of time and location. Atrial fibrillation is one of the most common diseases and at times can be deadly too. Detection and verification of atrial fibrillation can be done by checking the variation in the period of heart rate, if a patient has this disease then the period between each heartbeat will vary. With the increase in the population and the rise of healthcare costs, plenty of people will suffer worldwide due to lack of thorough monitoring of the patients and the inability to pay the bills. This has increased the demand for affordable quality healthcare from remote locations with the periodical inspection by the hygiene officer through GSM technology. Technological advancements in the field of hardware resulted in the depreciation of cost and most importantly reduced the communication gap between the patient and the medical personnel. In this paper, the capability for alarm systems with SMS and MATLAB is implemented as optimization techniques to reduce error and perform real-time monitoring of the patient properly.***

Keywords**: Heart,** ***Heart Beat Rate, Cardiovascular diseases (CVD), MATLAB, GSM.***

I. INTRODUCTION

Heart is one of the most important muscular organ in humans and most animals, it is responsible for pumping blood through the blood vessels of the circulatory system. Blood plays a vital role in providing oxygen and nutrients to the body and also responsible for metabolic waste removal. While pumping the blood the heart beats with a rhythm which is recognized because of the pacemaking cells present in the sinoatrial node. The average heartbeat rate of a resting person is close to 72 beats per minute. The heartbeat rate increases while people exercise but in long-term, the resting heart rate lowers which in turn improves the health of the heart.

Revised Manuscript Received on May 30, 2020.
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The range of conditions which affect your heart is described by heart disease. The most well-known heart diseases include coronary artery disease, arrhythmias (heart rhythm problem), congenital heart defects (diseases by birth) and many more.
In the recent decades, cardiovascular diseases is at number one position for causing the death of people all around the world. 31% of all global deaths as of 2016 is estimated at 17.9 million deaths due to CVDs. Financial problems are the major cause of death of people globally due to CVD.
In older times lifestyle of people was very simple, it included abundant physical labour, stress was very little and their diet was not toxic compared to present times which as a result not many people didn't suffer from heart diseases as they do today.
In modern time the work environment of people is unhealthy, their life is very complex, fast and hard. The stress is high, toxicity in food has increased, as a result of which we find an increase in heart diseases which is linked with other diseases such as diabetes, blood pressure, hypertension, etc. which are basically known as lifestyle diseases.
The symptoms of underlying heart diseases are very subtle and if ignored for a longer period of time could cause severe consequences. But if these abnormalities are detected in early stages then the problems can be taken care of.
As we move forward in life new technologies are introduced, which can be cheaper, faster with a higher level of accuracy. With this people who are financially stable are able to monitor their health remotely, without going to hospitals. But this causes a problem for people who live in remote areas, older people who are unable to visit hospitals frequently which can cause problems in case of emergencies.

II. PREVIOUS WORKS

The literature survey part is mainly dependent on the contributions of significant papers which proved helpful in making a new integrated device for monitoring the heart rate using a fingertip sensor. Arduino is used to provide the warning signal when the heart rate is not within the predefined safety limit and the heartbeat sensor was using infrared pulses in [1], [2]. It has described the monitoring of patients heartbeat and transfer of information to the smartphone using raspberry pi algorithm in [3]. [4] A prototype has been developed to measure the human body temperature, pulse rate, blood pressure (BP) and ECG and glucose level of the patient were measured using different sensors and the data are processed using microcontroller and tracked the patient location in [4], [5]. PPG based heartbeat monitoring, the concept of the Internet of things used for monitoring, and a wireless heartbeat monitoring system using GSM Technology,

which could potentially be an integral part of a suite of personal healthcare appliances in [6], [7], [8]. To measure the parameters like the temperature of the body, beat rate of heart, sweat rate and transfer it to the computer so that health condition of a patient can be analysed remotely and resend the information to the doctor through the GSM technology in [9]. To prevent the death rate of heart patient disease by periodically monitoring the patient's heart by a biosensors through the recent trends in wireless using GSM technologies in [10], [11]. To monitoring heartbeat and body temperature using fingertip and temperature sensor of the patient by optical heartbeat by using different sensors and also used to track the location of the patient through GSM technology in[12], [13]. The three major factors affecting performance as individual variants, environmental variants, and sensor variants had taken through biometric identification and verification and had processed through it using IoT in [14]. To monitor the heartbeat and heart attack of the different age groups have different ranges for maximum and minimum values of heart rate by hardware system consisting of a Node MCU and pulse sensor through IoT based system in [15]. An efficient cost-effective continuous heartbeat monitoring system using Raspberry Pi3 model B with IoT (Internet of things) due to transfer data over the internet without the aid of human or human and computer interaction in [16]. A remote sensing parameter of the human body which consists of pulse and temperature had tracked regularly of the health status of a patient through web-based technology in [17]. A heart rate sensor had detected the variations in the heart rate by using PPG (Photo Plethysmography) and for ATMEGA328PU Microcontroller with PPG techniques and GSM modem used to store the data in the cloud in [18]. A portable prototype bracelet and chest straps to wrist wearable's, provided various heartbeat sensors and currently emerging sensor devices were implemented using pulse rate sensor, Arduino UNO, Raspberry Pi 3 and Thing Speak cloud had provided quick service to the patient if the doctor was faraway or in case monitored by the guardian in [19] [20]. Using different sensors for knowing the real-time condition of the health of the patients and IOT (Raspberry pi kit) technology, Arduino microcontroller and IoT module patient could be track and monitored by the health officer in [21], [22]. By using GSM network and Very Large Scale Integration (VLSI) technology patient monitoring systems measure physiological characteristics, the heartbeat and temperature of the patient were measured by using sensors as an analog data and converted into digital data which was stored in AT89S52 microcontroller device at regular intervals of time described in [23], [24]. A screen physical parameter like heartbeat, temperature, ECG, BP regularly system comprises of an IR base heartbeat sensor, Arduino Uno and sends the deliberate information straightforwardly to a specialist through Web application to avoid a financial case of the patient in [25], [26]. Articulating all researchers past work about health monitoring through GSM Technology that they had not used the optimizing technology to perform the proper monitoring of the patient by health officer at a remote area.

III. PROCEDURE

The goal of our model is to minimize the use of hardware, reduce the cost and most importantly omitting the communication gap between the patient and the medical personnel. So for the first step

Step-1: The name, ID number, age/date of birth, mobile number, types of diseases and area of the patient are to be fetched and stored in the doctor's database.
Step-2: Then different parameters of the patient are to be taken that are initial blood pressure, weight of the patient and the timing.
Step-3: Next step is for the patient to take a 10-second video of his finger (left/right) in front of a light source as the input. It is required that the video is to be taken in a dark environment.
Step-4: The next step is to process the input and get the required data. The light passing through the finger flickers. This flickering is because when blood pumps through the veins the light passing through the finger dims down. This dipping of light represents the heartbeats.
Step-5: Now, the video's number of frames and the number of samples are calculated and the video is converted from RGB to grey. The greyscaled video is stored in the form of a 2-D matrix and the total number of rows representing the total number of frames. So, the values stored in the matrix denotes the white value. Hence the lower white values represent each heartbeat.
Step-6: Then in the next step all the column values are added and stored in a single column. This results in an N x 1 matrix which has the white values of each frame.
Step-7: Now with the matrix, the signal is plotted. Since the lower values signifies the heartbeats. So, when plotted the lower points represents the heartbeats.
Step-8: Now that we have the signal we need to filter it as in the higher white light parts noise is very high and it could interfere with heart rate calculation.
Step-9: A threshold is calculated which will be required to filter and rectify the signal. For filtering, the parts of the signal which are above the calculated threshold are filtered.
Step-10: For this, the signal is filtered using the 1-D median filter. Here, the noise is reduced by taking mean values.
Step-11: Since we now have the filtered signal, the next step is to rectify the signal. Here, by using the threshold value the signal is converted to square wave.
Step-12: To get the heartbeat rate the square wave is converted to impulses and total impulses are counted to get the heartbeat rate.
Step-13: After the diagnosis of the report by the doctor, a text message will go to the respective patient regarding the continuation of the medications.

IV. OUR PROPOSED METHODOLOGY

Fig. 1 shows a snapshot of a frame of the video input given to the system.

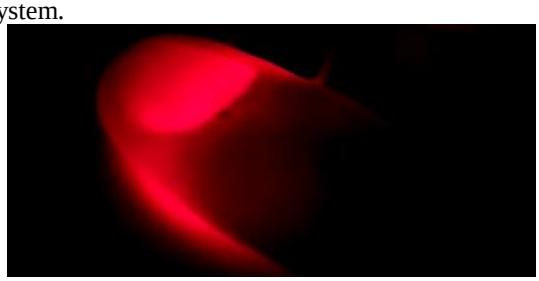

Fig. 4.1 Fingertip Data

After that the video is converted to greyscale using rgb2gray() method in matlab, Fig.2 shows a snapshot after the change.

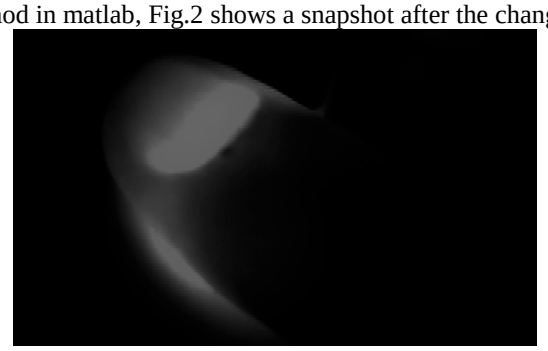

Fig. 4.2. Grey Scaled frame of the finger data

After the conversion the data is stored in 2-D matrix, as shown in Fig. 3 the lower values represents the heartbeats.

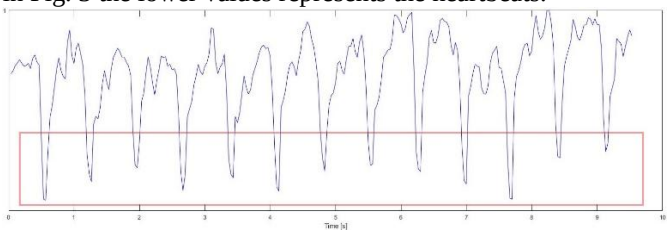

Fig. 4.3. Plot of the white light values

In pseudo code – 1 the signal is filtered with respect to the threshold to remove the unwanted noise which and the filtered signal is shown in Fig. 4.

```
-While counter is less than number of frames
-If signal value at counter is greater than threshold
-Filter the signal
-End if
-End of loop
```

Pseudo Code - 1

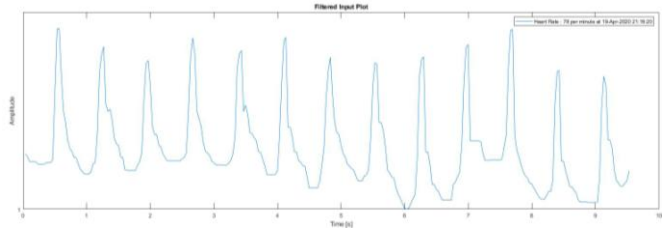

Fig. 4.4. Filtered signal

The threshold is used here to rectify the signal. The signal is converted to square wave signal using pseudo code – 2. The resulting signal is shown in Fig. 5.

```
-While counter is less than number of frames
-If signal value at counter is less than or equal to threshold
-Make the value of signal 1
-Else
-Make the value of signal 0
-End if
-End of loop
```

Pseudo Code - 2

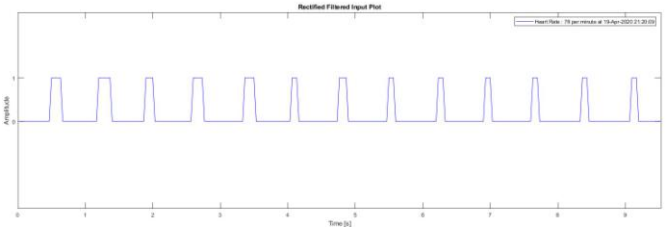

Fig. 4.5. Rectified Signal (in form of square wave)

Finally to get the heartbeat rate the signal is converted into impulses with each high impulse representing each heartbeat and is shown in Fig – 6.

```
-While counter is less than number of frames
-If signal value at counter is not equal to previous value
-Create an impulse at alternate counter
-Increment alternate counter
-Make previous value to current value
-Else
-Make previous value to current value
-End if
-End of loop
```

Pseudo Code - 3

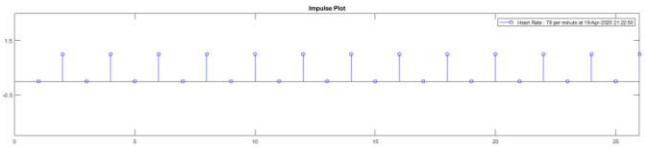

Fig. 4.6. Impulse Signal

Here the impulses represents the heart beats in the span of 10 seconds. The heart rate is calculated by counting the impulses which in case of our system is done by taking half of the alternate counter as in the pseudo code - 3. Then the count is multiplied by 6 for beats per minute.

The next step is to check for abnormalities in the calculated heart beat rate. If the heart beat rate is found to be less than or greater than the range of a normal person, an alert is sent using GSM module to the family and the medical personnel to attend the patient.

V. RESULT AND ANALYSIS

After giving the required input the model successfully calculated the heartbeat rate which is displayed with the graphs along with the time.

The program then swiftly processes the first 10 seconds of the video input, analyzing heartbeat for faster processing. It then processes the dipping of light and plots a graph. To reduce noise from the previously generated signal it filters (filtering parts of the signal that are above threshold) and rectifies the graph to generate an impulse signal. This helps in counting BPM and finally, a signal is generated with the measured heart rate with date and time when the report is generated. We have further taken heartrate data for consecutive 5 days during morning and evening hours for comparing and detecting any significant abnormal changes. This also indicates the patient's resting heart rate and heart rate after any activity carried out by the patient. From the above tabulation, we get a perspective of the varying heart rate for both morning and evening hours with the state of the patient during the measurement of heart rate.

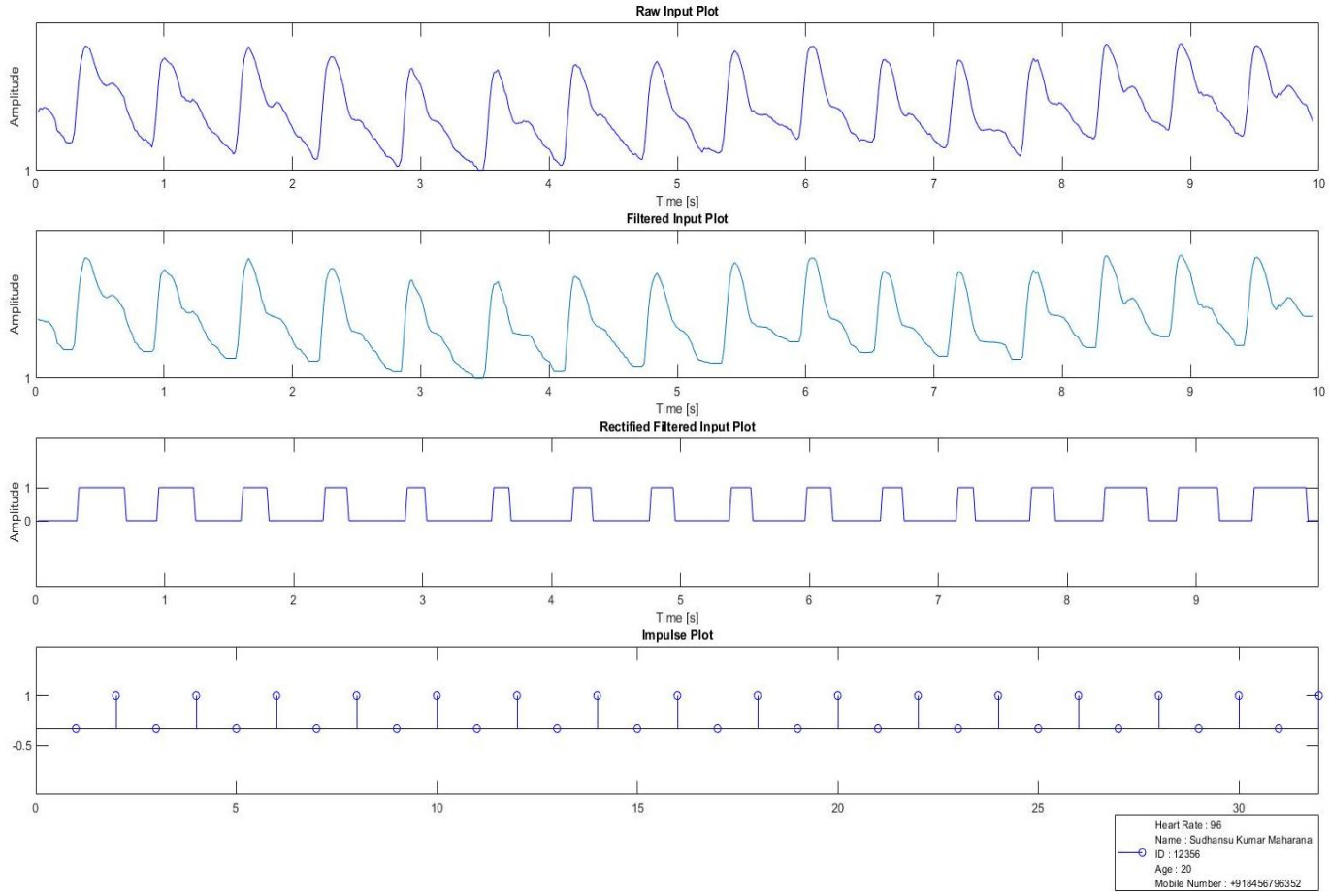

Fig. 5.1. Final Plot with Heart Beat Rate and Time

This data collected in table – 1 is of a person in his early 20's. Different conditions state different details of the person's state when he took the fingertip video. Resting conditions states that the person was on resting condition and have not moved from his place for at least past 10 mins. Moderate activity states that the person has been doing some mild activity which includes walking or standing. Strenuous activity states that the person was doing some rigorous work which may include jogging, running etc. The average maximum heartrate of a person in his early 20's is 200 and resting heart rate ranges from 60 to 100 bpm for a normal healthy person. So the above data shows that the person is normal and will lead a healthy life.

Table 1 Observations for concurrent days

Days	Morning		Evening	
	Heartbeat Rate	Condition	Heartbeat Rate	Condition
Day 1	78	Resting	84	Moderate Activity
Day 2	78	Resting	90	Moderate Activity
Day 3	84	Moderate Activity	102	After strenuous activity
Day 4	72	Resting	84	Moderate Activity
Day 5	78	Resting	96	After strenuous activity

VI. CONCLUSION AND FUTURE SCOPE

Taking care of your health should be of the utmost importance and with the work habits nowadays it is easily neglected. Taking care of yourself and your loved ones while still working is a laborious task. Having to go to the doctors now and then could be tedious but also in the contrary could reduce the risk of critical cases. Another difficulty could be for the people living in the rural areas as the medical establishment could be far away. But as technology is developing, almost everything can be done from home. So this model is made to eliminate the communication gap between patients and medical personnel. If any abnormalities are found beforehand critical situations could be avoided. Our purposed model intends to reduce the cost of monitoring patients regardless of location. This model is capable of using
GSM module which in cases of emergency will send alert to family members and medical personnel. In future, more parameters of a patient's body could be taken into consideration to further improve the result of our model.

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