ECG Assess Heartbeat rate, Classifying using BPNN while Watching Movie and send Movie Rating through Telegram

Sima Das and Aakashjit Bhattacharya

Abstract The paper has been designed for heartbeat rate classification while watching movies and sending movie ratings using Telegram Bot. The heartbeat of a movie viewer can increase abruptly at any point in the movie, which can harm the health of the person adversely with serious problems like cardiac arrest. To record heart activity in terms of heartbeat rate electrocardiogram is used. The Electrocardiogram is the technique to capture heart-signal provoked by the electric field and captured by a sensor. In this paper, the heartbeat rate is measured while watching a movie and is getting classified using Backpropagation Neural Network, that whether watching the movie will result in a slow, normal, or fast heartbeat rate. Observations are collected and analyzed and from next time when a person starts watching that movie, an alert message is sent using Telegram to notify the type of a movie. So from next time, before watching that movie, a person can get alert about the type of that particular movie based on the previous ratings and can watch or avoid watching the movie based on their discretion as it may affect their heart. The system is designed for weak-hearted, teenagers and be used as a parental guide.

Keywords Electrocardiogram · Machine Learning · Internet of Things · Backpropagation-Neural-Network · Bandpass filter · Telegram Bot

1 Introduction

Movies are used as a means of entertainment all over the world for a long time. It creates an attachment with people massively. In today's world movie is one of the best ways for entertainment and different kinds of people like different genres of movies which impacts the heart and it has the potential to let overcome the human

S. Das (✉) · A. Bhattacharya
Department of Computer Science and Engineering, Maulana Abul Kalam Azad University of Technology, Kolkata, West Bengal, India
e-mail: cstsima3@gmail.com

A. Bhattacharya
e-mail: aakashjit4mtech@gmail.com

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boringness, as well as it connects us to real-life situations that are often ignored by us. Although movies have many advantages, it has many disadvantages too. Sometimes it hurts people's minds. Some movies or some portion of movies have some sexual content and violent scenes that impact our society and at the same time can harm a person's heart as it has happened previously a lot of time in various other movies. We know that emotional regulations and memory formations are related to human sensory functions and involve the olfactory system [1]. Many teenagers are attracted by movies and that adversely affects their studies and changed their behavior also. In the age group of 13–17 years, schoolboys' attitudes have changed and they have become violent after watching violent movies [2]. Some Bollywood movies have changed the attitude of the viewers, with some movies having a negative impact on their life [3]. Normal people's pulse rate increases while watching horror movies [4].

Heartbeat rate is central to the process of heart and its functions are also important because oxygen and blood are circulating to the whole body through heart. For normal people, the heartbeat is slower when they are sleeping or resting, the heartbeat is normal when they doing normal work and heart-beat is faster when they have more pressure like workload, angry, scare, tension, etc. Slow heart rate is good for mammals as it helps to have better longevity [5]. Heart attack can be caused by high blood pressure [6]. Electrocardiogram (ECG) is the process to measure electrical signals through electrodes placed on ventricles of heart, and measured with respect to time that how long it takes to pass through the heart and changes in cardiac muscle. According to electrical signal passes by heart and muscle, it can measure the condition of heart-beat are normal or abnormal. Electrocardiogram signals were captured while watching Fantasia movie during 120 min and R-R interval time series has been used for detrended fluctuation analysis which is collected from subject's fractal scaling related to age [7, 8].

Researchers have invented many techniques for measuring and classifying heart-beats. In [9] Nayak et al, they have shown horror movies to a group of people of the age group of 21–23 years, and have collected ECG data while watching movies, studied by heart rate variability feature, and classified data using the autonomic nervous system (ANS). In [10] Tsai et al. used a wearable ECG sensor to measure tension using Mark Exciting Segment algorithm while watching movies and adventure riding. From [11] Hsu et al., using an ECG sensor for automatic emotion recognition system while playing music. Here these features are extracted by generalized Discriminant Analysis and classifying using least squares support vector machine. In [12] Pandey et al., used a deep convolutional neural network that automatically classifies as a true positive, false positive, false negative, true negative of the electrocardiogram heart-beat on arrhythmia patient's accordingly ANSI-AAMI standards synthetic minority oversampling technique (SMOTE) method used for generating new sample without duplicating.

Internet of Things (IoT) being quite challenging [13] and innovative [14] is evolving at a quite high pace and is expanding into many aspects of human society [15]. It has been said in [16], that IoT has been defined as the next logical stage of the internet along with its extension in the physical world. It is playing a crucial role in many aspects of our daily life [17] and this trend will increase in the upcoming years

[18]. Over the years IoT has evolved and has got its application in the domain of health and fitness monitoring [19], and in combination with Machine Learning/Deep Learning, it is used to create and implement intelligent systems [20]. So, we have used it to implement our proposed system. IoT has played an integral part in our proposed system because, without the concept IoT, the monitoring and alerting system could not be implemented in such a user-friendly manner in our work. Telegram is a Cloud-based service and we have used its Bot APIs for the messaging and alerting service. It is a quite popular app and ranks 8th in the list of instant messaging apps as of July 2019 and supports end-to-end encryption [21]. In various countries where there is a restriction of the social media platforms, Telegram has become a leading social networking platform in those countries.

In this paper, we have discussed the measurement of heartbeat rate during watching movies. The proposed system designed helps guardians to choose which movies are suitable for their children and how long they can watch the movies without a negative impact on their hearts. The proposed system is designed for teenagers as well as old persons and weak-hearted people to show the rating and know before viewing the movie. We have proposed an Internet of Things based alert system using Telegram Bot that is alerting people about the rating of the movie, as a result, they have received an alerting message using Telegram Bot. This is because some parents are busy with their work at the office. So, to observe their children from office who have logged into see the movies using parent's mobile numbers, these techniques used to be a parietal guide for movie rating. So in this paper, we measure heartbeat rate and classified as slow, normal, and fast rate of heartbeat and also rating movie about pressure on the heart to alert people which type movie it is that's why they make their decision for watching a movie.

The rest of the paper organized as the following order—Sect. 2 introduced proposed method for the current paper, Sect. 3 shows the experimental result, and Sect. 4 is the last section which is represented in the conclusion and future work.

2 Proposed Method

Our proposed system (from Fig. 1) collects data from the heart using ECG sensor, and clean data using filtering using bandpass filter and artifact remove process using PAN Tompkins algorithm, after preprocessing, feature selection and extraction are done based on age, R-R interval and heartbeat rate of the subject and then it classifies heartbeat rate as slow, normal or fast using back-propagation-neural-network (BPNN) after classified result store in the cloud and warns other viewers who are watching a movie later and The possible heartbeat rate from previous observations will be sent to the registered Telegram Account.

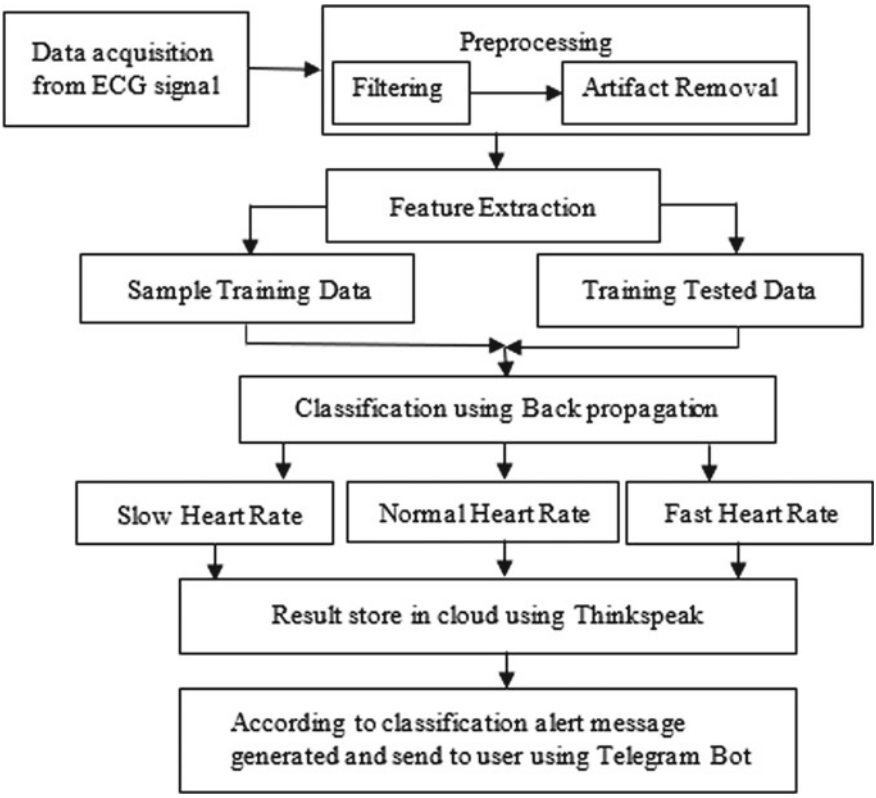


Fig. 1 Heart rate monitoring, classifying using BPNN and send movie rating through Telegram Bot while watching movie and storing result in ThingSpeak Cloud Platform

2.1 Preprocessing

Raw dataset is not feasible for analysis that's why there is a need to clean data and that process is called pre-processing. In machine learning, for accurate results data needs to pre-processed properly. It is the first step of machine learning to process data in a formatted way that is suitable for the machine. Filtering and artifact fact removing are the types of data preprocessing to eliminate electrical interference, Electromyography (EMG) noise.

1. Filtering—Filtering (from Fig. 2) is the first step of pre-processing. Different kinds of noises like muscle noise and power line interference are removed by a bandpass filter with a range of 5–15 Hz.
2. Artifact Removal—After applying a bandpass filter PAN-Tompkin algorithm is applied for identified Artifact from the ECG database as shown in Fig. 3. In this algorithm we have implemented the following steps in the following order—at first derivation, then squaring, after that average and threshold, the last step is

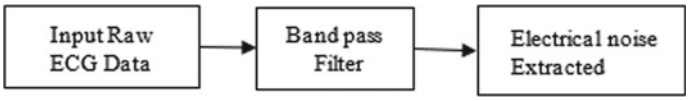


Fig. 2 Filtered electrical noise from raw ECG dataset

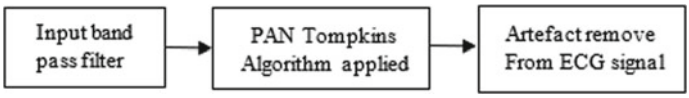


Fig. 3 Artifact remove from ECG signal

peak detection and QRS detection. By applying these algorithm artifacts like a power line, baseline wondering are removed and datasets are more cleaned and formatted.

2.2 Feature Extraction

Feature selection and extraction plays a vital role in machine learning. In this work, features are selected for classification based on:

1. Age—For this experiment 20 participates are present at the age between 21–34 and 68–85 age group.
2. R-R interval—R-R interval is discussed below. To feature selection, we used Discrete Wavelet Transform that selected Q, R, S all features of heart-beat. In QRS there have time delay denoted as RR and others are RR_0 is the interval between previous beat and predecessor, RR_1 is the interval between current and previous beat and RR_2 is the interval between current and subsequent beat

$$R1 = \frac{RR_0}{RR_2} \tag{1}$$

$$R2 = \frac{RR_2}{RR_1} \tag{2}$$

$$R3 = \frac{RR_n}{RR_1} \tag{3}$$

where, RRn = mean (RR_0, RR_1, RR_2) and $R1$ used for Ratio1 (as shown in Eq. 1), $R2$ used for Ratio2 (as shown in Eq. 2), and $R3$ denotes Ratio3 (as shown in Eq. 3).

3. Heart Beat Rate—Heartbeat rate is also an important feature. Given formula in Eq. 4, calculates the heartbeat rate.

$$\text{HBR} = \frac{60}{R - R \text{ Interval}} \tag{4}$$

2.3 Classification

After feature extraction, selected features are used for heartbeat rate classification. Figure 4 describe the method of classification, it is done by backpropagation neural network (BPNN). BPNN is a statistical technique used in machine learning and many biological neural networks. It is iterative gradient descent algorithm that input cleaned and formatted data to the hidden layer and finds propagation error then weight updated, when the error of propagation is in the backward direction it changes it layer by updating weight value. This algorithm designed for minimizing mean square error which occurs on the desired output and actual output.

$$\text{CE} = \frac{1}{2} \sum_{J=1}^{M} (D_J - A_J)^2 \tag{5}$$

where CE is used for detecting the cumulative error, A_J is the desired output and D_J is the actual output of the J Eq. 5.

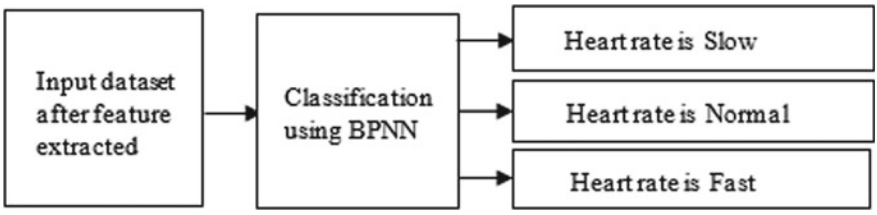


Fig. 4 Classification using backpropagation neural network

Table 1 Training data of R-R interval and heartbeat rate

Classification	R-R Interval	Conditions of heart beat rate (BPM)
Slow	1 for male 0 for female	Heart rate <60
Normal	1 for male 0 for female	Heart rate ≥60 && heart rate ≤100
Fast	1 for male 0 for female	Heart rate >100

2.4 Rating

In this experiment, we have measured the heartbeat rates while watching a movie Fantasia and that is classified into three groups slow, normal, and fast heartbeat rate that depends upon movie scenes. Concerning time movie is separated into different frames and we are measuring the heartbeat of participants of each separated frame then classifying this frame and mark as any one type of heartbeat rate among three. Then apply the formula which is given below in Eq. 6.

$$\text{Movie\_Rating} = \frac{F_1 \times \text{slow} + F_2 \times \text{normal} + F_3 \times \text{fast}}{F_1 + F_2 + F_3} \tag{6}$$

F_1 denotes how many times the heartbeat rate is slow, F_2 denotes how many times the heartbeat rate is normal and F_3 denotes how many times the heartbeat rate is fast while watching Fantasia movie.

IF Movie_Rating >= 0 && Movie_Rating <= 1
THEN "As per our past studies, Heart Beat Rate Slow for this movie"
ELSE IF Movie_Rating >= 1.1 && Movie_Rating <= 2
THEN "As per our past studies, Heart Beat Rate Normal for this movie"
ELSE IF Movie_Rating >= 2.1
THEN "As per our past studies, Heart Beat Rate Fast for this movie"

From the above condition, we can get the result of movie ratings according to the heartbeat rate, and the rating is sent through Telegram to the user and is used as parental controls for the user before watching a particular movie.

2.5 Telegram Bot

In our experiment, we have sent the message using Telegram Bot and the Movie Rating calculated is transmitted to the cloud to help future viewers of that particular movie and send them the collective average rating of the movie from different past viewers. Other messaging apps can also be used if required and if there is the support of APIs for those messaging apps. We have used the Telegram Messenger because the APIs are free of cost and this provides a cross-platform and cross-device support.

3 Experimental Results

3.1 ECG Recording and Data Collection

The ECG signals were collected underwent 120 min continue resting and watching movie "Fantasia" and the blood pressure signals are digitalized at 250 Hz. From

	YOUNG SUBJECTS					OLD SUBJECTS				
	Y1	Y2	Y3	Y4	Y5	O1	O2	O3	O4	O5
HEART BEAT ECG READINGS	0.736	1.152	0.9	1.284	0.916	0.992	0.964	0.8	1.236	1.016
	0.744	0.952	0.864	1.2	0.944	0.98	0.936	0.828	1.24	0.996
	0.752	1.012	0.82	1.152	0.976	0.988	0.96	0.832	1.244	0.996
	0.756	1.016	0.816	1.232	0.996	1	0.944	0.844	1.264	1.004
	0.72	0.904	0.84	1.044	0.988	0.972	0.968	0.868	1.264	1.016
	0.756	0.856	0.852	1.316	0.972	0.964	0.968	0.88	1.296	1.02
	0.78	0.888	0.888	1.188	0.96	0.98	0.964	0.884	1.256	1.028
	0.768	0.928	0.996	1.116	0.956	0.984	0.976	0.892	1.276	1.04
	0.712	0.896	1.02	1.4	0.948	1	0.98	0.884	1.256	1.044
	0.724	0.872	0.952	1.12	0.952	1.004	0.976	0.864	1.252	1.04
	0.748	0.828	0.944	1.128	0.952	0.992	0.98	0.864	1.26	1.044
	0.76	0.856	0.964	1.356	0.956	0.98	0.984	0.864	1.236	1.04
	0.728	0.892	0.952	1.1	0.912	0.98	1	0.884	1.208	1.048
	0.756	0.828	0.912	1.264	0.888	1.004	0.992	0.908	1.204	1.044
	0.764	0.772	0.916	1.304	0.836	1.016	0.992	0.948	1.208	1.044
	0.74	0.792	0.952	1.3	0.892	0.98	1	0.988	1.228	1.048
	0.748	0.888	0.928	1.196	0.98	0.972	0.996	1.008	1.232	1.056
	0.78	0.812	0.88	1.32	1.004	0.976	0.992	1.028	1.236	1.052
	0.816	0.904	0.876	1.376	1.004	0.936	1.008	1.064	1.26	1.056
	0.748	1.096	0.916	1.296	1.008	0.916	1.012	1.04	1.252	1.056

Fig. 5 Dataset collection using ECG while watching movie

Fig. 5, we can see a sample of ECG dataset during watching movie Y1, Y2, Y3, Y4, Y5 are young and O1, O2, O3, O4, O5 are old individual's heartbeat rate. ECG dataset has been collected for this experiment while watching "Fantasia" movie of 20 participants at the age of 21–34 years and 68–85 years old healthy subjects from a free website "https://physionet.org/content/fantasia/1.0.0/".

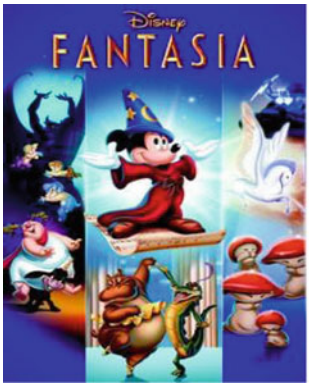
3.2 Measuring Heartbeat Rate

The duration of data collection for the "Fantasia" movie is 120 min and we used 100 data per frame and the movie has several epochs. By measuring each frame and using BPNN we can be classifying the data as slow, normal, and fast heartbeat rate. By applying Eq. 6, we got the answer of movie rating is 1.5 that is in between the range of 1.1–2 that's mean the movie is a normal rating movie according to heartbeat rate which is given in Table 2.

4 Conclusion and Future Work

Fantasia movie from Walt Disney is a quite innovative and revolutionary animated classic, that combines the masterpiece of Western classical music along with colorful imaginative visuals, with Leopold Stokowski and the Philadelphia Orchestra. It is quite impressive, free-flowing, abstract, and often with surrealistic pieces. In "The

Table 2 Screenshot of sending movie rating using Telegram Bot

Screenshot of the Fantasia Movie	Screenshot of sending movie rating using Telegram Bot
	

Sorcerer's Apprentice" we find Mickey Mouse has been shown an aspiring magician who has overstepped all his limits. The movie is quite significant, critical, and is having commercial successes. Through this movie a lot of types of emotions have been reflected from the viewer that's why we have chosen this movie for the experiment to measure heartbeat rate of the viewer using ECG to measure heartbeat rate of the participates while watching the movie and classifying heartbeat rate using back-propagation neural network to find which type of heartbeat occurs in which scene and give a message using Telegram to inform heartbeat is which category- slow, normal or fast. Movie rating technique used for rating the movie which is a parental guide for teenagers and a weakhearted person.

In the future, we are planning to extend this work with brain cognitive load detection while watching the movie.

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