International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 01 | January - 2023 Impact Factor: 7.185 ISSN: 2582-3930

ECG Monitoring Using Deep Learning – A Review

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Abstarct - Electrocardiogram (ECG) is used to detect heart's rhythm and electrical activity. Heart rhythm problems (heart arrhythmias) occur when the electrical signals that coordinate the heart's beats don't work properly and faulty signaling causes the heart to beat too fast, too slow or irregularly. Patients facing arrhythmia have no indications of having an arrhythmia and only a doctor will be able to diagnose arrhythmias in a routine test. Therefore, low cost portable monitoring system plays a important role. The main objective of this project is to design and develop a model for predicting arrhythmia (atrial fibrillation) along with monitoring the ECG signals. To create an arrhythmia prediction model and an ECG monitoring system, Deep Learning algorithms, TensorFlow and Keras library are applied here. The system is being designed with Raspberry pi 3, Arduino UNO, AD8232 single lead ECG sensor, biomedical sensor pad and battery. This system will be helpful for remote ECG monitoring and make easier for doctors to monitor the ECG of their patients outside the hospital.

Key Words: ECG, Deep Learning, arrhythmia.

1. INTRODUCTION

The cardiovascular abnormality is one of the biggest causes of deaths among people of all races around the globe especially in the case of old age people. It is estimated that very soon the highest number of heart disease cases will be from India. There are about 30 million heart patients in India (16 million from rural areas & 14 million from urban) 25% of the heart related deaths, especially heart attack happen to those less than 40.

Prevention of cardiac disease and treatment is the most challenging problem for modern medicine. Arrhythmia occur when the electrical signals that coordinate the heart's beats don't work properly and faulty signalling causes the heart to beat too fast, too slow or irregularly. One of the most common arrhythmias is Atrial fibrillation arrhythmia. In Atrial fibrillation, irregular electrical signal generated at the upper atria.

Electrocardiogram (ECG) is used to detect heart's rhythm and electrical activity. The electrocardiogram is a graphic record of electrocardiography. There are five waves in ECG curve that is P, Q, R, S, T and occasionally U. Vital intervals and sections between waves are used to describe ECG. For diagnostics of various cardiac diseases, the most significant segments of an ECG signal are the QRS complex, ST segment, PR interval, RR interval, PR segment, QT interval. Patients facing arrhythmia have no indications of having an arrhythmia and only a doctor will be able to diagnose arrhythmias in a routine test. Continuous monitoring of patient's heartbeats in daily life is very important to arrhythmia detection as it is difficult to detect arrhythmias in a short time window of the ECG waveform. Quicker the diagnosis, quicker the life of patient can be saved.

The project focuses on creating an arrhythmia prediction model and an ECG monitoring system. To construct an effective model for predicting arrhythmia, Deep Learning algorithms is used here to handle raw information from the ECG signal.

LITERATURE SURVEY

In this section we present the review of various blind sticks made by others.

Paramveer Singh, Ashish Jasuja [1] in their paper have proposed a system to monitor the ECG of the distant patient. The Bio Signals are collected from the body of the patient using ECG sensors and are processed using development boards and then sent to distant cloud named Bluemix, for further analysis by a physician. Hence, in this paper, a low-cost distant patient ECG monitoring system has been implemented.

Mohammad Kachuee, Shayan Fazel, Majid Sarrafzadeh [2] in their paper have proposed a method based on deep convolutional neural networks for classification of heartbeats which is able to classify five different arrythmias in accordance with the AAMI EC57 standard. They have also suggested a method for transferring the knowledge acquired on this task to myocardial infarction (MI) classification task. They have concluded that the method is able to make predictions with average accuracies of 93.4% and 95.9% on arrythmia and MI classification.

Arushi Goyal, Shimony Mittal, Rugved Sawant, Ajat Gidhwani and Jyoti Bagate [3] have developed Portable Heart Attack Detector. Authors in their paper have said that due to increase in issues related to health and as cardiovascular diseases are very common among middle

Fatma Bozyigit, Fatih Erdemir, Murat Sahin, Deniz Kilinc [9] have worked on classification of electrodiagram (ECG) data using Deep Learning methods. The authors in their paper have

aged young adults, they have proposed a model that aims at detecting the occurrence of a heart attack by diagnosig the ECG signal and if any abnormality is detected then the notification along with person's location coordinates are sent to the emergency contacts. They have concluded that the commercial implementation is realistic with minimal changes in design and size of the model.

S.M Ahsanuzzaman, Toufiq Ahmed and Atiqur Rahman [4] in their paper have designed and developed a method for predicting arrythmia along with monitoring the ECG signals. To make this system, long short-term memories neural network, Recurrent neural network, TensorFlow and Keras library are applied. The system is designed with Raspherry Pi 3, Arduino Uno, AD8232 sensor, HC-05 Bluetooth, biomedical sensor pad and battery. They have concluded that this system will make easier for doctors to monitor the ECG of their patients outside the hospitals.

Rishabh Singhla, Prince Singh, Rosy Madaan, Supriya Panda [5] in their paper have created and trained a neural network model which predicts digit from hand-written images with high degree of accuracy. TensorFlow syntax with Keras as its front-end has been used for this purpose. The model incorporates neural networks very efficiently and has given an accuracy of 94% and above for every possible prediction and thus they have concluded that deep learning is effective to automatically detect objects.

Arka Prava Roy, Sandipan Chatterjee, Prasenjit Maji , Hemanta Kumar Mondal [6] in their paper deal with the analysis of the signal for the classification of critical and noncritical data using different learning-based algorithms for smart Internet of Things (IoT) based health-care monitoring application using Wireless Body Area Network (WBAN) and how to minimize the misclassified critical data. PARAMETERS NORMAL RANGE RR interval 0.6-1 s PR interval 0.12-0.2 s ST interval 0.08-0.12 These features are identified using a heat map and according to that feature, mapping is to be done. This paper presents an approach for helping IOT and WBAN based ECG monitoring systems for identifying the critical signals using machine learning and transmit them while running on low power levels.

Atiqur Rahman, Junayeed Absar Samim, Zaber Al Hasan [7] in their paper have developed a system to detect atrial fibrillation arrhythmia and syncope due to arrhythmia. This system uses the Recurrent Neural Network with long shortterm memory algorithm for detecting atrial fibrillation.

Shushmita Roy Tithi, Afifa Aktar, Fahimul Aleem Amhitabha Chakraborthy [8] in their paper distinguished between normal and abnormal ECG by means of machine learning. Applied 6 algorithms separately. Also predicting, which algorithm is best for a particular diseases. But the availability of dataset relating ECG is rare. Therefore, they used the data set found in UCI Machine Learning Repository database to complete this Different types: logic regression, SVM, decision tree, etc.

stated that classification is widely used techniques in healthcare, especially concerning diagnosing cardiac disorders i.e., Arrhythmia. ECG is an important diagnostic tool for analysing cardiac tissues and structures. Hence, they concluded that according experimental results CNN.

Sr No.	Paper - Topic	Year	Technologies Used / Algorithms Implemented
1	"IoT Based Low-Cost Distant Patient ECG Monitoring System"	2017	Technologies Used - Raspberry pi Model 2, Arduino, IoT, Cloud, AD8232 ECG Sensor,
2	"ECG Heartbeat Classification: A Deep Transferable Representation"	2018	Algorithms Implemented - Support Vector Machine (SVM), Random Forest (RF), Convolutional Neural Networks (CNN).
3	"Portable Heart Attack Detector"	2017	Technologies Used - Raspberry pi 3, Arduino UNO, AD8232 ECG sensor, GSM Module, GPS Module
4	"Low Cost, Portable ECG Monitoring and Alarming System Based on Deep Learning"	2020	Technologies Used - Raspberry pi 3, Arduino UNO, AD8232 ECG sensor. Algorithms Implemented - Recurrent Neural Network (RNN), Long short-term memory (LSTM).
5	"Image Classification Using Tensor Flow"	2021	Algorithms Implemented – Deeper Neural Networks.
6	"Classification of ECG Signals for IoT-based Smart Healthcare Applications using WBAN"	2020	Technologies Used – IoT. Algorithms Implemented - Decision Tree (DT), Logistic Regression (LR), Support Vector Machine (SVM), Gaussian Naïve (GN), Random Forest (RF), KNN, MLP.
7	"Remote ECG Monitoring and Syncope Detection System Using Deep Learning"	2020	Technologies Used – Arduino Mega, Raspberry Pi 3. Algorithms Implemented - Recurrent Neural Network (RNN), Long short-term memory (LSTM).
8	"ECG data analysis and heart disease prediction using machine learning algorithms"	2020	Algorithms Implemented - Logistic Regression (LR), Decision Tree (DT), Nearest Neighbor (NN), Naïve Bayes (NB), Support Vector Machine (SVM), Artificial Neural Network (ANN).
9	"Classification of electrocardiogram (ECG) data using deep learning methods"	2021	Algorithms Implemented - Recurrent Neural Network (RNN), Long short-term memory (LSTM), Gated Recurrent Units (GRU), Convolutional Neural Networks (CNN).

3. CONCLUSION

This paper is a comprehensive survey for ECG monitoring using Deep Learning. The different techniques recently implemented and completed experiments and studies in the domain got reviewed and analysed. To this end, we found that there are improvements which can be made in the hardware as well as the software.

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