Classificaion of Arrhythmia by using deep learning with 2-D ECG spectral Image Represntation

Introduction:

Cardiovascular diseases (CVDs) are the leading cause of human death, with over 17 million people known to lose their lives annually due to CVDs [1]. According to the World Heart Federation, three-fourths of the total CVD deaths are among the middle and low-income segments of the society [2]. A classification model to identify CVDs at their early stage could effectively reduce the mortality rate by providing a timely treatment [3]. One of the common sources of CVDs is cardiac arrhythmia, where heartbeats are known to deviate from their regular beating pattern. A normal heartbeat varies with age, body size, activity, and emotions. In cases where the heartbeat feels too fast or slow, the condition is known as palpitations. An arrhythmia does not necessarily mean that the heart is beating too fast or slow, it indicates that the heart is following an irregular beating pattern. It could mean that the heart is beating too fast—tachycardia (more than 100 beats per minute (bpm)), or slow—bradycardia (less than 60 bpm), skipping a beat, or in extreme cases, cardiac arrest. Some other common types of abnormal heart rhythms include atrial fibrillation atrial flutter, and ventricular fibrillation. These deviations could be classified into various subclasses and represent different types of cardiac arrhythmia. An accurate classification of these types could help in diagnosing and treatment of heart disease patients. Arrhythmia could either mean a slow or fast beating of heart, or patterns that are not attributed to a normal heartbeat. An automated detection of such patterns is of great significance in clinical practice. There are certain known characteristics of cardiac arrhythmia, where the detection requires expert clinical knowledge. The electrocardiogram (ECG) recordings are widely used for diagnosing and predicting cardiac arrhythmia for diagnosing heart diseases. Towards this end, clinical experts might need to look at ECG recordings over a longer period of time for detecting cardiac arrhythmia. The ECG is a one-dimensional (1-D) signal representing a time series,

which can be analyzed using machine learning techniques for automated detection of certain abnormalities. Recently, deep learning techniques have been developed, which provide significant performance in radiological image analysis [4,5]. Convolutional neural networks (CNNs) have recently been shown to work for multi-dimensional (1-D, 2-D, and in certain cases, 3-D) inputs but were initially developed for problems dealing with images represented as two-dimensional inputs [6]. For time series data, 1-D CNNs are proposed but are less versatile when compared to 2-D CNNs. Hence, representing the time series data in a 2-D format could benefit certain machine learning tasks [7,8]. Hence, for ECG signals, a 2-D transformation has to be applied to make the time series suitable for deep learning methods that require 2-D images as input. The short-time Fourier transform (STFT) can convert a 1-D signal into a 2-D spectrogram and encapsulate the time and frequency information within a single matrix. The 2-D spectrogram is similar to hyper-spectral and multi-spectral images (MSI), which have diverse applications in remote sensing and clinical diagnosis, including spectral un-mixing, ground cover classification and matching, mineral exploration, medical image classification, change detection, synthetic material identification, target detection, activity recognition, and surveillance [9–15]. The 2-D matrix of spectrogram coefficients could be useful for extracting robust features for representation of a cardiac ECG signal [16]. This representation could allow the application of CNN architectures (designed to operate on 2-D inputs) for development of automated systems related to CVDs.

Literature Review :

[1] Classification of Arrhythmia by Using Deep Learning with 2- D ECG Spectral Image Representation Author name: Rizwana Naz Asif, Kiran Sultan, SuleimanAli Alsaif, Sagheer Abbas , Muhammad year:2022

Transfer learning methods to ensure accuracy and time management to detect the ECG in a better way in comparison to the previous and machine learning methods and implementation of the proposed method

Advantages: The proposed 2- D CNN model attained better accuracy, sensitivity, and specificity (in eight class classification) than the FFNN model, which classified only four kinds of arrhythmia.The computational resources and the simulation time for training and testing modes also increase and this is the main reason for using a carefully selected CNN model.

Disadvantages : limited data transfer and the speed of the convergence was very slow.

[2] Comparing Feature-Based Classifiers and Convolutional Neural Networks to Detect Arrhythmia from Short Segments of ECG Author name: Fernando Andreotti, Oliver Carr, Marco A. F. Pimentel, Adam Mahdi, Maarten Year:2017

In this study, we classify short segments of ECG into four classes (AF, normal, other rhythms or noise) as part of the Physionet/Computing in Cardiology Challenge 2017. We compare a state-of-the-art feature-based classifier with a convolutional neural network approach. Both methods were trained using the challenge data, supplemented with an additional database derived from Physionet.

Advantages: The featurebased classifier obtained an F 1 score of 72.0% on the training set (5- fold crossvalidation), and 79% on the hidden test set. Similarly, the convolutional neural network scored 72.1%on the augmented database and 83% on the test set and the latter method resulted on a final score of 79% at the competition.

Disadvantages: They are computationally expensive and require large datasets .Inconsistent noise classification and annotating the normal segments

[3] ECG Classification for Detecting ECG ArrhythmiaEmpowered with Deep Learning App roache Author name: Rizwana Naz,Kiran Sultan,Suleiman Ali Alsaif year:2022

Transfer learning methods to ensure accuracy and time management to detect the ECG in a better way in comparison to the previous and machine learning methods and to implementation of the proposed method.

Advantages: There are a lot of problems like loss of data, data size limitations, redundancy Deep learning is already in practice to do a variety of tasks in pattern and image recognition and motivated the medical research to work in this state of the art. Blood Pressure (BP) estimation can be evaluated by the ECG signals

Disadvantages: The quality of morphological features extraction in the ECG greatly a & ects the recognition and classification rate of ECG signals Detection of irregular heartbeats from ECG signals is a significant task for the automatic diagnosis of cardiovascular diseases

[4] A Review on Cardiac Abnormalities Classificationusing Electrocardiogram with Machine Learning and Deep Learning Classification Techniques. Author name: Muhammad Adnan Khan,Amir Mosavi,Shashank Yadav,Upendra Kumar. year:2020

This survey is focusing on the latest research papers in which machine learning and deep learning classification techniques are applied in different manners.

Advantages: They found highest accuracy rate 99.3% by using k-NN classification by feeding genetic algorithm features.They recorded ECG signals in two differentsituationstechnique on the WEKA software for clas sification and they utilized MIT-BIH arrhythmia database. During classification they found accuracy rate of 88.49%.

Disadvantages: The adoption of featureds specifically switched theextraction features manually and this approach couly help in examining cardiac patient efficiently by the doctors. Training and testing sets, they transformed one dimensional ECG signals to two- dimensional image and classified the ECG data into five classes with 99.21% average accuracy.

[5] Arrhythmia Classification Techniques Using Deep Neural Network Author name: Ali Haider Khan,Muzammil Hussain,Muhammad Kamran Malik year:2021

The Cardiac disorder and arrhymia detection, analysis of electrocardiogram (ECG) Signals has become the focus of numerous reserches. 2D Graph Fourier transforn (GFT) was developed

Advantages: All the classes of ECG Arrhythmia and give the accuracy against training set and validation dataset and tables shows the percentage Accuracy of different transfer learning approaches for the proposed CAA-TL modeland discovered that all three different transfer learningap-proaches performed well.

Disadvantages: E most ECG databases are not specific to their clinical context. E description of the patient population in which these ECGs were obtained is lacking. important in interpreting the methodology and clinical utility in context.

[6] Classification of Arrhythmia in Heartbeat Detection Using Deep Learning Comput Intell Neurosci. Author name: Wusat Ullah, Imran Siddique, Rana Muhammad Zulqarnain, Mohammad Mahtab Alam, Irfan Ahmad, and Usman Ahmad Raza Year 2021

Aims to apply deep learning techniques dataset to classify arrhythmia. By using two kinds of the dataset . One dataset is the MIT-BIH arrhythmia database and the second database is PTB Diagnostic ECG Database.

Advantages: The result achieved by using these three techniques shows the accuracy of 99.12% for the CNN model, 99.3% for CNN + LSTM, and 99.29% for CNN + LSTM + Atten tion Model.

Disadvantages: Challenges in designing and adjusting CNN models, the high computational cost of neural networks and requires a large dataset for successful training.

References:

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2. Classification of Arrhythmia in Heartbeat Detection Using Deep Learning Comput Intell Neurosci. 2021; 2021: 2195922.

3. Comparing Feature-Based Classifiers and Convolutional Neural Networks to Detect Arrhythmia from Short Segments of ECG Fernando Andreotti, Oliver Carr, Marco A. F. Pimentel, Adam Mahdi, Maarten De Vos Institute of Biomedical Engineering, University of Oxford, Oxford, United Kingdom.

4. A Review on Cardiac Abnormalities Classification using Electrocardiogram with Machine Learning and Deep Learning Classification Techniques December 2020 INTERNATIONAL JOURNAL OF COMPUTER SCIENCES AND ENGINEERING 8(12):74-84 DOI:10.26438/ijcse/v8i12.7484.

5. Comparing Feature Based Classifiers and Convolutional Neural Networks to Detect Arrhythmia from Short Segments of ECG September 2017 DOI:10.22489/CinC.2017.360-239 Conference: 2017 Computing in Cardiology Conference.