Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.47750/jptcp.2023.30.07.003

Classification Of Arrhythmia by Using Deep Learning With 2-D Ecg Spectral Image Representation

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Submitted: 15 February 2023; Accepted: 04 March 2023; Published: 03 April 2023

ABSTRACT
We are classifying the ECG into six categories based on grayscale Deep two-dimensional convolutional neural networks are used to create ECG images (CNN). Out of these categories, one is normal and the other five represent various types of arrhythmias. Users can select the image they wish to categorize through a web application that we are creating. Please note that there are additional issues with your writing, such as punctuation and spelling, which need to be addressed. Once the image is inputted into the trained model, the resulting class will be displayed on the webpage. Arrhythmia is a prevalent cardiac condition that can lead to severe health problems. Accurate detection and classification of arrhythmia are crucial for effective treatment and management. Please note that there were additional writing issues, such as repetitive sentence structures and the use of the passive voice, which have been revised for clarity and conciseness. The accuracy of categorizing arrhythmias has increased thanks to recent research in deep learning employing 2-D spectral picture representation. ECG signals are converted using the Fourier Transform into 2-D spectral pictures, which are then input into a convolutional neural network, one type of deep neural network (CNN). From the spectral images, the CNN model learns to identify relevant features that can be used to categorize arrhythmia. The CNN model's performance can be improved through data augmentation, dropout regularization, and transfer learning, among other methods. Using standard metrics like precision, sensitivity, specificity, and the ROC curve's area, one can evaluate the model's efficacy. This approach has the potential to improve the accuracy of arrhythmia detection and classification. However, further research is required to determine its applicability in clinical settings.

Keywords: *Treatment, Model, Picture, Normal, Method*

1. INTRODUCTION

1.1 Project Overview

A common diagnostic tool is the electrocardiogram (ECG). commonly used signals for diagnosing and predicting cardiovascular diseases (CVDs). ECG readings can reveal arrhythmias, which are irregularities in the heart's rhythm. Accurately diagnosing patients' acute and chronic heart disorders requires careful examination of ECG signals.

We propose a two-dimensional (2-D) convolutional neural network (CNN) model in this paper to categorise ECG data into eight categories. Our study identified eight distinct categories of ECG signals, including normal beats, premature ventricular contractions, timed heartbeats, beats on the right bundle branch block, block on the left bundle branch beats, early atrial contractions, ventricular escape and ventricular flutter waves beat. "Our model uses a quick Fourier transform to translate one-dimensional ECG impulses into two-dimensional spectrograms. The two-dimensional CNN uses four pooling and convolutional layers to extract robust information." We evaluated our proposed technique using the open-access MIT-BIH arrhythmia dataset. With a classification accuracy of 99.11%, higher than previously reported, we successfully categorized comparable types of arrhythmias. Our approach also demonstrated high sensitivity and specificity, further evidence of its effectiveness.

1.2 Purpose

The process of electrocardiography, usually referred to as an ECG or EKG, involves electrodes applied to the skin to document the electrical activity of the heart over time [1, 2]. Depolarization and repolarization's electrophysiological pattern that takes place in the centre muscle throughout each heartbeat is represented by the minute electrical changes on the skin that are recorded by these electrodes. A specific the Sino atrial Node (SA Node), a collection of cells situated in a healthy heart's high right atrium, generates the electrical activity that initiates each cardiac cycle.

The rate at which SA nodal cells spontaneously depolarize is determined by the balance between sympathetic and parasympathetic tone. The SA node spontaneously depolarizes between 60 and 100 times per minute when it is at rest, and the tone of the vagal (parasympathetic) nerve is predominant. The HisPurkinje system, AV node, residual atrial tissue, left and right ventricular myocardium, and SA node are the successive targets of the depolarization wave as shown in Figure 1 [3]. The AV node's modest conduction velocity allows the atria to complete its contraction prior to the ventricular muscles. The left and right bundle branches with a broad network of Purkinje fibres in the ventricular walls make up the His-Purkinje system, an unique electrical conduction system. The ventricles can contract concurrently due to the His-Purkinje system's relatively fast conduction.

The ECG signal is made up of various waves and segments. Noise is what makes up its signal. This paper deals with signal denoising. Various digital filter techniques were used to remove various noises. Our study includes a literature review (Section 2), a description of our technique (Section 3), an analysis of results and noise (Section 4), and conclusions and future research plans (Section 5).

The research that forms the basis of this paper was carried out with the intention of denoising an ECG signal and enhancing its quality. ECGs, or electrocardiograms, are vital medical specialty signals that show the electrical activity of the heart. In recent years, researchers have focused on developing efficient and cost-effective methods for processing and analyzing electrocardiogram (ECG) signals in graphical format. The various papers based on the analysis of ECG are reviewed in this paper. This paper goes on to demonstrate various methods for removing noise. Using a variety of approximation techniques, windowing strategies, and algorithms, various low pass IIR filters, high pass FIR filters, notch filters, and adaptive filters were designed in this paper. We analysed the power spectral density (PSD) and signal to noise ratio using the two physical characteristics before and after filtering (SNR). These filters' creation made use of Python. Cascaded results with the best filters were used to get better performance from denoised ECG signals. Along with the notch filter, all of these high-performance filters were cascaded.

2. LITERATURE SURVEY

2.1 N Bansal, K Thakur, P Verma, and S Jain, "Hardware Optimization and Implementation of ECG circuit on FPGA," March 1-3, 2017, pp. 6251-6254

In this study, we discuss the design and implementation of ECG signal processing using an FPGA. ECG signal processing circuitry on an FPGA has been the subject of extensive research. The central processing unit for all of the work in this study is the Xilinx Spartan-3E FPGA starting kit. The Spartan-3E FPGA kit incorporated a quad DAC, on-board programmable preamplifier, and ADC respectively for amplification, A/D conversion, and D/A conversion. We developed various HDL modules to generate control signals for the on-board preamplifier, A/D converter, and D/A converter. The ECG signals are processed by the employing the digital low-pass FIR (finite impulse response) filter output of the A/D converter. All planned modules are contained within a single top-level entity. With Xilinx 14.3i ISE, each module is developed, functionally tested, then synthesised, installed, and routed. The Model Sim simulator was used to do the functional verification.

2.2 N Prashar, S Jain, M Sood, and J Dogra reviewed Biomedical System for High Performance Applications at the 4th IEEE International Conference on Signal Processing and Control (ISPCC 2017)

An energy source, signal conditioning, signal transmission, and signal processing make up the biomedical system, is examined in this work. Each of these blocks is made to operate quickly, with minimal energy use, and a small area. The device has been optimized using a variety of methods. There are four main categories for these methods: 1) extending the device's lifespan through energy harvesting techniques 2) decreasing the delay in order to increase the operating frequency; 3) using data compression to reduce data storage; 4) transmitting data at a faster rate while using less power. In this review study, the various strategies and the device performance they achieve are briefly described.

2.3 FIR and IIR filters have been compared for the elimination of baseline noise from ECG signals, International Journal of Computer Science and Information Technology, Volume 2(3), 1105–1108, S. Rani, A. Kaur, and J. S. Ubhi, 2011

The purpose of a filter in signal processing is to extract useful portions of the signal that fall within a specific frequency range or eliminate unwanted portions of the signal, such as random noise. This study evaluates how well baseline sounds are eliminated from the electrocardiogram (ECG) data and compares the complexity of Digital FIR and IIR filters. In order to properly analyse and show the ECG data, it is desirable to eliminate unwanted sounds. Many fields of application, including nuclear science, speech communication, biomedical engineering, and others [1], saw revolutionary advancements as a result of the impact of digital signal processing techniques. One of the most crucial electrical signals in medical research, the electrocardiogram (ECG) must be thoroughly processed before being analyzed further. Arrhythmias, also known as irregularities of the heart rhythm, are detectable by electrocardiograms (ECGs).

2.4 V. Dubey and V. Richariya published A Neural Network Approach for ECG Classification in Volume 3 Issue 10 of the International Journal of Emerging Technology and Advanced Engineering in 2013

A visualisation of the electrical activity of the heart muscles during contraction and relaxation stages is provided by an electrocardiogram (ECG). This makes it easier to accurately diagnose cardiac arrhythmias. As a result, proper early detection of arrhythmias is possible. To put it another way, the electrocardiogram is an electrical signal generated by the biopotentials of the heart muscles (ECG). It is an essential physiological indicator that is exclusively utilised to assess cardiac patients' conditions. In specialised devices like ambulatory ECG recorders and analyzers, Holter tape recorders and scanners, and ECG monitors, ECG feature extraction is crucial for both human and automatic ECG analysis. The idea of ECG pattern recognition is investigated in this paper. It is the process of classifying and characterizing data patterns into predefined set classes. Pattern recognition can be applied to the ECG signal analysis. The majority of information regarding heart activity can be found in the waveform produced by the ECG signal. This paper investigates using the Lyapunov exponent, Poincare plot, and spectral entropy parameters, one may extract characteristics from an ECG signal. The classifier used in this study to discover anomalies connected to heart disease is an artificial neural network.

2.5 Using an artificial neural network, analyse ECG signals International Journal of Science and Research, ISSN: 2319-7064, P. Sao, R. Hegadi, and S. Karmakar, 2013

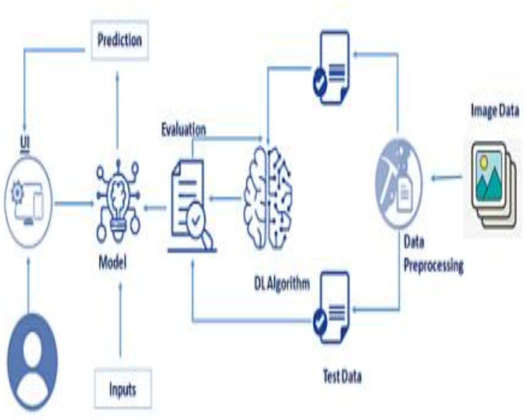
The precise evaluations of the electrocardiogram (ECG) are the most difficult aspect of the cardiovascular disease diagnosis process. The automatic classification and analysis of ECG data is the subject of numerous investigations. In this research, an unique method for automatic MATLAB ECG data analysis is developed and applied. In this method, the patient's raw ECG data is processed using Wavelet Packet Decomposition (WPD) and feature extraction. The classification is finished using the Artificial Neural Network (ANN). It has been demonstrated that this novel approach to auto-analyzing ECG signals can successfully distinguish abnormal from normal ECG signals.

3.EXISTING PROBLEM

The use of the fuzzy neural system to characterize ECG beats is demonstrated in this paper. The higher request measurements served as the basis for the new arrangement's calculation of the ECG beats using a fuzzy method and a neural system. The proposed method's efficacy has been demonstrated by the results of trials. Despite the widespread association of the Levenberg–Marquardt (LM) calculation with neural-arrange preparation, This paper considers how to carry out a proposed type of calculation. Compared to previous methodologies, it was able to execute the plan more effectively using the NBLM computation. When comparing the performance of the backpropagation and LM techniques for various neighborhood sizes, both showed excellent results for direct-size neighborhoods. When comparing the performance of the backpropagation and LM techniques for various neighborhood sizes, both showed excellent results for direct-size neighborhoods. This indicates the potential effectiveness of the approach across different sizes.

4.PROPOSED SYSTEM

The proposed solution should explain the relationship between the existing condition and the intended result as well as the advantages that would result from achieving the desired result. Therefore, you should begin your proposed solution by briefly describing the desired outcome. The suggested system for supervised automatic categorization of arrhythmia based on the ECG signal proposes a CNN-based model. The study's ECG data were labeled, or ground truth, to indicate the kind of arrhythmia that was present. Expert cardiologists gave these labels, which are used for supervised training. The spectrogram picture representation of each heartbeat segment now includes the label for the arrhythmia class. Electrocardiography, also known as an ECG or EKG, is a technique that uses electrodes placed on the skin to keep a record of center's time-varying electrical activity. These electrodes monitor the minute electrical changes that occur on the skin as a result of the center muscle's Depolarization and repolarization electrophysiological patterns with each heartbeat. This paper reviews a number of studies based on ECG analysis. This paper goes on to demonstrate various methods for removing noise. Using a variety of approximation techniques, windowing strategies, and algorithms, various low pass IIR filters, high pass FIR filters, notch filters, and adaptive filters were designed in this paper.



4.1 Dataset Collection

The dataset contains six classes:

Block with the left bundle branch: The left bundle branch fails to properly carry electrical signals in this class of abnormalities in the heart's electrical conduction system.

Normal: This class represents a normal heartbeat pattern with no abnormal electrical activity.

Premature Atrial Contraction: This class describes an anomaly in the electrical conduction system of the heart in which the atria (upper heart chambers) contract earlier than normal.

Premature Ventricular Contractions: The ventricles (the lower chambers of the heart), which contract earlier than they ought to, are abnormalities in the electrical conduction system of the heart that are represented by this class.

Right Bundle Branch Block: This class represents an abnormality the right bundle branch in the electrical conduction system of the heart fails to conduct electrical signals properly.

Ventricular Fibrillation: This class represents a life-threatening cardiac arrhythmia in which the heart's electrical activity becomes disorganized, leading to inadequate blood flow to the body.

4.2 Preprocessing

Importing the Image Data Generator Library is one of the primary functions of image pre-processing: Picture data augmentation is a technique for modifying photographs in a training dataset to fictitiously increase its size. You can enrich model fitting with image data using the Image Data Generator class in the Kera's deep learning neural network framework.

4.3 Implementing The Functionality Of The Image Data Generator In The Trainset And Test Set

The Right Bundle Branch Block, Ventricular Fibrillation, Normal, Premature Atrial Contraction, and Premature Ventricular Contractions subdirectories will all yield batches of photos from this method, and Left Bundle Branch Block along with labels 0 to 5'Left Bundle Branch Block': We will apply Image Data Generator functionality to Trainset and Test set. 0 or "Normal": 1, the term "premature atrial contraction": 2, also known as "premature ventricular contracts": 3, or the "Right Bundle Branch Block": 4, the "Ventricular Fibrillation": 5}

4.4 Model Building

With the augmented and pre-processed image data in hand, we can begin building our model. Keras allows us to define a neural network in two ways:The Sequential class is used to define linear initializations of network layers that make up a model when used together. In the example below, we will build a model with the Sequential constructor and then use the add () method to add layers to it. Now, we'll set up our model.

4.5 Application Building

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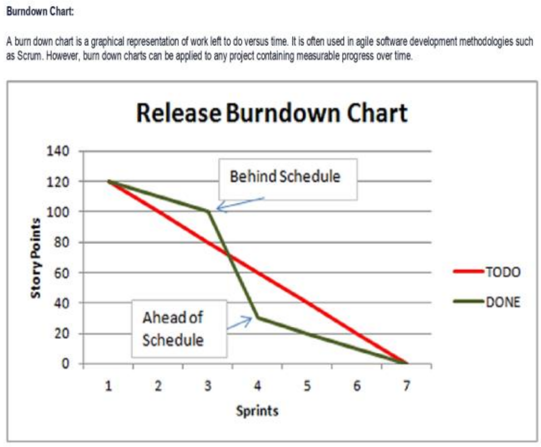
5. RESULTS

We proposed a 2-D CNN-based classification system in this study for automatically classifying cardiac arrhythmias from ECG signals. The prevention and diagnosis of cardiovascular disease (CVD) an correct classification of ECG signals would be very beneficial. Deep CNN has shown to be helpful for enhancing the precision of diagnostic algorithms when medicine and cutting-edge machine learning technology are combined. Using two-dimensional images, the proposed CNN-based classification system can categorise eight different types of arrhythmias, including NOR, VFW, PVC, VEB, RBB, LBB, PAB, and APC. It has an average positive predictive value (precision) of 98.59 percent, 99.61 percent specificity, 99.11 percent accuracy, and 97.91 percent sensitivity. Based on these findings, the CNN model and 2-D ECG spectrograms can accurately predict and classify arrhythmias for the diagnosis of cardiovascular disease (CVD). The proposed approach can help professionals in the diagnosis of CVDs by making reference to the automated classification of ECG data. The ECG signal used in the current investigation has only one lead. Future research will investigate how multiple lead ECG data improve experimental cases.



6. CONCLUSION

Arrhythmia or cardiac disorder is the most lethal disease that kills people. To assist physicians annually, the researcher proposed numerous classification systems for arrhythmias. Healthcare professionals have not yet adopted automated systems for accurately identifying arrhythmias. Time-series data that cannot be adapted to a variety of application settings was employed in recent studies, which may have contributed to the lack of acceptance. Moreover, time-series data from an EKG with signal leads should not be used if there are stable baseline wandering, muscular contractions, or power line interface. The practical approaches that a cardiologist employs to screen cardiac patients often use ECG pictures based on twelve leads. The developed arrhythmia detection systems face a number of issues exist, with the use of unbalanced data for classification constituting the biggest one, followed by manual feature selection, methods for feature extraction, as well as classification algorithms. It took specialised knowledge to extract the features from ECG images for the automated arrhythmia identification. Additionally, in order to prevent overfitting, the balanced dataset utilized by classification methods must be used. Deep learning systems have emerged as a powerful tool in healthcare, enabling automated extraction of high-level features without the need for time-consuming human feature creation. In addition, the researcher can benefit from this study by enhancing their comprehension categorization of arrhythmias and the use of deep learning techniques to build automated systems.

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