CARDIAC ARRHYTHMIA DETECTOR USING CNN APPLICATION

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ABSTRACT

In medical practise, an electrocardiogram (ECG) is a crucial indicator tool for assessing cardiovascular arrhythmias. In this study, a machine learning system is used to compare patient ECGs and perform programmed ECG arrhythmia identification. The system was previously tuned based on an overall image informational index. Arrhythmias are more prevalent in those over the age of 60. A convolutional neural network (particularly, Alex Net) is utilised to extract features, and the highlights are then passed via a basic back spread neural network to finish the classification. The fundamental purpose of this research is to provide a simple, effective, and relevant learning strategy for categorising the three types of heart conditions (cardiac defects) so that a diagnosis may be made. The findings showed that when a moving deep learning highlight extractor was combined with a standard back proliferation neural architecture, very elite rates could be achieved. In a comparative analysis, validation accuracy was shown to be 100 percent in Google Net, 94 percent in Squeeze Net, and about 97.33 percent in Alex Net.

Keywords: ECG, Cardiac, pattern recognition, CWT, CNN.

INTRODUCTION

In cardiology, the electrocardiogram (ECG) is a well-known instrument for determining a patient's cardiac condition. In medicine, the ECG is one of the most well-known and commonly used biological signals. The beats per minute (bpm) of the heart can be found by counting the R peaks of the ECG wave over the course of one minute [1].

More importantly, cardiovascular disorders and abnormalities like cardiac arrhythmias, which are the focus of this study's automated detection and classification [2], change the rhythm and shape of the electrocardiogram (ECG). Skilled cardiologists must carefully study the ECG in today's medical practise to determine life-threatening heart arrhythmias [3]. Automatic cardiac arrhythmia classification, on the other hand, might give objective diagnostic findings while also reducing time for cardiologists. These advantages have piqued interest in computer-assisted ECG signal classification and diagnosis in hospitals and health-care settings. Supervised learning is used to figure out the ECG signal [4]. Pattern recognition is used to automatically put a system into one of many different groups. A skilled cardiologist can figure out a number of heart rhythm problems just by looking at the ECG waveforms. In some cases, a powerful ECG analyzer may be more accurate than a cardiologist [5]. However, there are still some ECG waveforms that computers have trouble recognising. On the other hand, using automated analysis of easily accessible ECG waveforms may cut the cardiologist's work load by a lot [6]. The goal of this research is to create a computer-assisted diagnostic system that will help professional cardiologists by making ECG arrhythmia diagnoses that are smart, cost-effective, and save time [7]. The difficulty of detecting ECG arrhythmia patterns is coupled with classic ECG signal processing methods and state-of-the-art deep learning technologies to achieve this goal. Contraction of ventricles and t represents relaxation of ventricles[8].

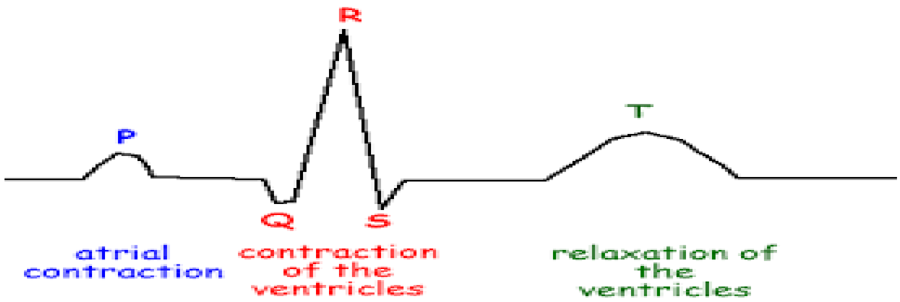

Fig 1: PQRST graph

where p part represents atrial contraction QRS part represents, the remainder of the paper is laid out as follows: In Section 2, current deep learning-based approaches for detecting ECG arrhythmias are briefly addressed. The suggested technique is then detailed in depth in Section 3. Finally, categorization of ECG data, data training and validation, and comparison of the three neural networks are completed [9].

The purpose of this project is to categorise the dataset into different categories of cardiac diseases and then use convolutional neural networks to evaluate the results. The objective is to utilise MATLAB programme. The picture dataset from the hospital is initially digitised by presenting the image and choosing a tiny piece of it (PQRST graph) [10, 11]. The curve is stretched out and stored as a separate picture. Individually, the points on the graph are turned into Excel sheets.

All databases are now manually analysed by looking at the input, and code has been written to pre-process the data using filters before categorising it into three categories: cardiac arrhythmia, congestive heart failure, and normal sinus rhythm [12]. There are 900 photos in all, with 300 of each kind being used for validation.

Pre-processing step:

We employ the continuous wavelet transform with the following settings: The wavelet utilised is called a 'analytic amor. In terms of time and frequency, the wavelet has an identical variance [13]. A continuous wavelet transform (CWT) filter bank is created using the CWT filter bank.

The filters have been adjusted such that the peak magnitudes of all passbands are about identical. The default filter bank was created with a signal of 1024 samples in mind. CWT employs 12 wavelet bandpass filters per octave. Cwt is used to transform a one-dimensional input into a two-dimensional output [14].

The output is categorised and transformed into 227x227 scalogram pictures (2D images) of each kind. The ECG scalogram is shown as a 128-color colour map of type jet. The scalogram pictures are saved in files labelled ARR (heart arrhythmia), CHF (congestive heart failure), and NSR (non-systolic heart failure) (normal sinus rhythm). These pictures will be put into CNN (Alex Net), a deep CNN that has already been trained [15].

METHODOLOGY

The project's primary components include picture dataset digitization and database conversion, deep learning feature extraction, and training and validation utilising several architectures such as Alex Net, Google Net, and Squeeze Net [16]. The MATLAB deep learning toolbox is a framework for developing and deploying deep neural networks containing algorithms, pre-trained models, and applications [17]. The MATLAB GUI is used to present the results to the viewers in a way that is easy to grasp and read.

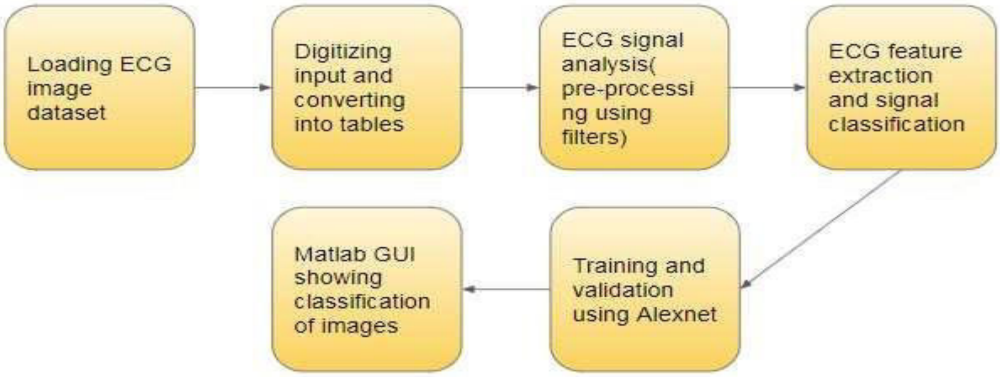

Fig 2: Block diagram showing flow of the project

MATLAB has proven to be a very valuable tool for image processing, identification, and classification. A basic interface was also made with the assistance of MATLAB for better visibility and comprehension.

The digitalization of the photographs is the first stage. This step was important since the input was raw data from the hospital [18]. The Color Threshold software in MATLAB is used to digitise the photos. By thresholding the colour channels based on multiple colour spaces, the Color Threshold software allows you to segment colour pictures. You may make a binary segmentation mask for a colour picture using this programme. The morphological procedures on binary pictures may be performed using the bimorph function.

The digitised picture is the transformed image, and it may be used to diagnose any cardiovascular illness. The 1D input, which is plotted on the transformed picture, is used to generate a 2D output (scalogram). Alex Net will use this 2D output for classification and validation [19].

Deep learning:

Technological breakthroughs and the introduction of artificial intelligence (AI) have ushered in a new era in healthcare. high-end diagnostic technologies to forecast and diagnose various ailments. Deep learning, as a subset of machine learning, has a wide range of applications in the prediction and treatment of deadly diseases, notably cardiovascular disease (CVD) [20].

Artificial neural networks (ANNs) are computer models and nonlinear statistical data modelling tools that imitate the structure and operation of the human biological neuron network. It's a differentiable scoring function that starts with raw picture pixels (the input end) and ends with class scores (the output end). The dataset is sent to the deep convolutional neural networks, which then train, test, and validate the data. The feeding of pictures into a convolution neural network (CNN), the convolution layer for extracting features from the images, the pooling layer, the flatten layer for converting N-dimensional input to 1-dimensional output, and the fully connected layer for classification are all layers of CNN [21].

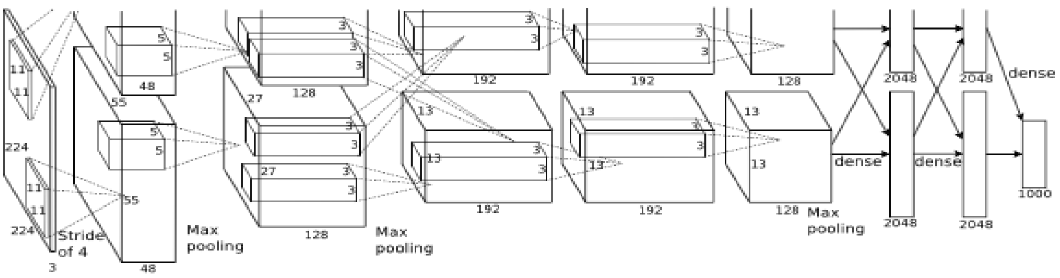

Fig 3: AlexNet Architecture showing layers

Alex Net was trained on ImageNet using photos with dimensions of 227 × 227 x 3 pixels. It contains a total of eight layers with a precision of 97.33 percent. After the assessment of cardiac signals is converted into 227x227-sized scalogram images representing R-T intervals (a total of 750 images for training and 150 for testing), the confusion matrix reveals which

photos were accurately categorised [22].

	CONFUSION MATRIX			
arr	338	6	2	97.70%
chf	12	334	2	96%
nsr	0	10	346	96.20%
	96.60%	95.40%	95.90%	97%
	arr	chf	nsr	

Fig 4: Confusion matrix showing the number of images classified correctly under arr,chf and nsr

Google Net:

We can retrain it since it is a pre-trained version of the network. It is mostly used to classify images. A filter may be considered at each layer of the network design. The validation accuracy was obtained with a perfect score of 100. Squeeze net: With ten convolutional layers, it has a validation accuracy of 94%. The accuracy was compared using Google Net and Squeeze Net. However, AlexNet was the primary architecture utilized [23].

On the basis of the input, a GUI was created that displays the relevant categorization. The input was a scalogram picture created using cwt (continuous wavelet transform), and Alex net was used to categorize the images since it has been trained on over a million photos and can classify them into over 1000 categories [24]. For development, simple buttons and graphics are utilized. The user may choose a scalogram picture from the directory when the "insert the input ECG image" button is selected. When the user clicks the "predict" button, he will learn what sort of heart condition he has [25].

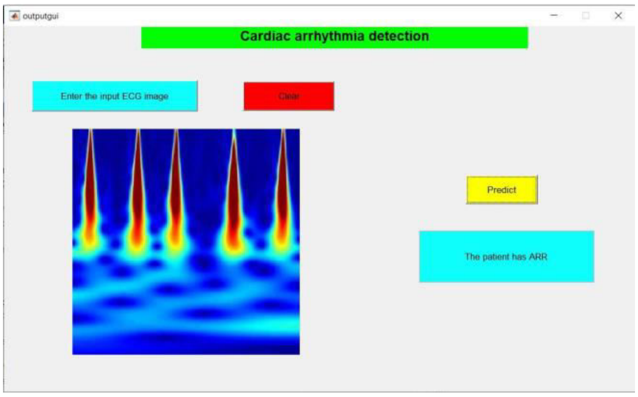

Fig 5: GUI showing the classification of images

IV RESULTS

The findings of networks that used features from the sixth and seventh deep complete convolutional layers of Alex Net demonstrated that the deeper layers of a deep convolutional neural network trained on a large quantity of annotated data may be transferred and used to identify ECG arrhythmias. The validation accuracy of the proposed system was 97.33 percent, indicating that combining a transferred deep learning feature extractor with a simple back propagation neural network is an effective method for autonomously diagnosing cardiac arrhythmia. Transferring a deep CNN that has already been trained takes away the need for a lot of knowledge and processing power when building a deep convolutional neural network from scratch. Alex Net’s results show that a big, deep, convolutional neural network may be able to break records on a hard dataset with only supervised learning. Now that there are many deep learning frameworks, it's easy to put AlexNet to use.

V CONCLUSION

ECG data from the hospital is digitized, pre-processed, and turned into scalogram pictures for classification in this research. Deep learning is used to extract features, and data is trained and validated. Heart defects were used to categorise the overall pictures. The validation accuracy is evaluated in all three instances: 97.33 percent in Alex Net, 94 percent in Squeeze Net, and 100 percent in Google Net. We looked at how many photos were labelled incorrectly using the confusion matrix. Because people in our country are affected by cardiovascular disease, this research began.

The number of diseases is steadily increasing. Arrhythmias are more common in those over 60. It's partly due to a more experienced heart's mileage. Individuals in rural areas are unable to diagnose their illnesses due to the lack of offices. The purpose of the work is to determine what kind of cardiac ailment a patient is suffering from so that he may recognise it early if it exists. When the project is developed, it will be able to detect new concerns with patients who have cardiac problems. An app may be developed so that a patient can learn more about the illness he is suffering from while sitting at home.

For something similar, a simple interface is used. It's possible that it may be made available in far-flung areas where practically everything is restricted. We may also include a variety of other sorts of cardiac arrhythmias in the development of this project. The hardware component may also be added to it for estimating other elements such as pulse, pulse rate, and oximeter, transforming it into a comprehensive medical services framework. The message may also be transmitted directly to the patients' cell phone by using the GSM module. It may also be shown on an LCD screen.

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