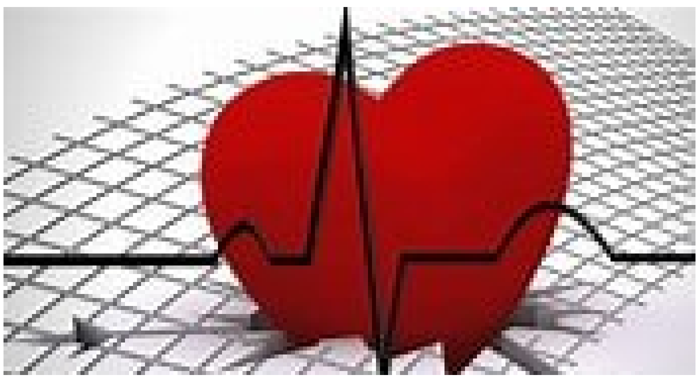
ECG Image Analysis For Arrhythmia Classification Using IBM Watson Studio



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INTRODUCTION

An arrhythmia is a problem with the rate or rhythm of the heartbeat. During an arrhythmia, the heart can beat too fast, too slow, or with an irregular rhythm. Arrhythmia is caused by changes in heart tissue and activity or in the electrical signals that control your heartbeat. These changes can be caused by damage from disease, injury, or genes. Often there are no symptoms, but some people feel an irregular heartbeat. You may feel faint or dizzy or have difficulty breathing. It can also occur suddenly because of exertion or stress, imbalances in the blood, medicines, or problems with electrical signals in the heart.

The most common test used to diagnose an arrhythmia is an electrocardiogram (ECG). Doctor may recommend medicines, placement of a device that can correct an irregular heartbeat, or surgery to repair nerves that are over simulating the heart. If arrhythmia is left untreated, the heart may not be able to pump enough blood to the body.This can damage the heart, the brain, or other organs.Common arrhythmia treatments include healthy lifestyle changes, medicines, surgically implanted devices that control the heartbeat, and other procedures that treat abnormal electrical signals in the heart.

Electrocardiography is the process of producing an electrocardiogram (ECG). It is a graph of voltage versus time of the electrical activity of the heart using electrodes placed on the skin. Some people may not experience active symptoms due to arrhythmia.

However, treatment is still essential for preventing further complications, which may include stroke and heart failure.

OVERVIEW

In this project, we propose an effective electrocardiogram (ECG) arrhythmia classification method using a deep two-dimensional convolution neural network (CNN), in which we classify ECG into 6 categories, one being normal and the other five being different types of arrhythmia. Convolution neural networks (CNNs) can be used to classify electrocardiogram (ECG) beats in the diagnosis of cardiovascular disease, ECG signals are typically processed as one-dimensional signals while CNNs are beer suited to multidimensional pattern or image recognition applications. The results demonstrate that the proposed CNN model is effective for detecting irregular heartbeats or arrhythmia via automatic feature extraction. It is anticipated that the proposed method will be suitable for implementation on portable devices for the health monitoring of cardiovascular disease.

PURPOSE

1. Our Project proposes the design of an efficient system for classification of:

   i. Normal Beats
   ii. Premature Atrial Contraction Beats.
   iii. Premature Ventricular Contraction Beats.
   iv. Left Bundle Branch Block Beats.

v. Right Bundle Branch Block Beats.
vi. Ventricular Fibrillation Beats using CNN.

2. Our aim from the project is to make use of keras to extract the libraries for machine learning .
3. To hyper tune different types of heart rhythm images to machine learning algorithm.
4. To develop a model which can tell us type of Arrhythmia .

LITERATURE SURVEY

Several researchers have proposed and implemented classification of ECG arrhythmia using different approaches of image processing and machine learning.

- DANVILLE, Pa. researchers have found that artificial intelligence can examine electrocardiogram (ECG) test results to identify patients at risk of developing a potentially dangerous type of arrhythmia with an irregular heartbeat or of dying within a year. As a result, there classifier achieved 99.05% average accuracy with 97.85% average sensitivity.

In our project, we used deep learning techniques. Deep Learning is the process of analyzing data from different perspectives and extracting useful knowledge from it.

Different data learning techniques include:

1. Convolution Neural Networks
2. Recurrent Neural Networks (RNNs)
3. Generative Adversarial Network
4. Self-Organizing
5. Boltzmann Machines

Convolution neural network is the most applied deep learning technique, which detects predictions based on image classification. In CNN, train set is used to build the model as the Image data generator class which can classify the data items into its appropriate classes. A test set is used to validate the model.

EXISTING PROBLEM

According to the World Health Organization (WHO), cardiovascular diseases (CVDs) are the number one cause of deaths today. Over 17.7 million people died from CVDs in the year 2017 all over the world which is about 31% of all deaths.

It is important to periodically monitor the heart rhythms to manage and prevent the CVDs. An Electrocardiogram (ECG) is a non-invasive medical tool that displays the rhythm and status of the heart. Therefore, automatic detection of irregular heart rhythms from ECG signals is a significant task in cardiology.

PROPOSED SOLUTION(CNN Architecture)

The proposed CNN architecture mainly consists of the following layers:

i. Two convolution layers

ii. Two max-pooling layers

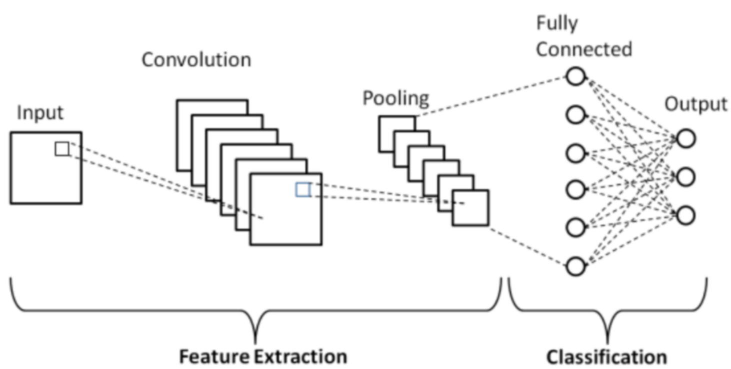
iii. One fully-connected output layer with six softmax units.

iv. One flattening layer.

The network begins with a convolution layer with 32 feature maps with the convolution kernel 3x3 which takes the image with input size of 64 × 64 pixels.

The second convolution layer consists of 32 feature maps with the convolution kernel of 3 × 3 whose activation function is "relu".

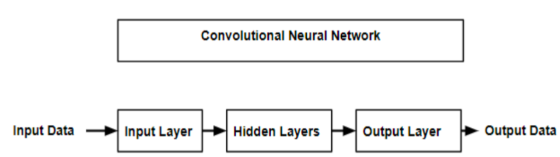
The kernel size for max pooling layers are 2 × 2.
The flattening layer flattens the dimension of the image.
Each convolution layer in our CNN model is followed by a rectified linear unit (ReLU) layer to produce the outputs. We have created an UI using the Flask for the ECG Arrhythmia Classification prediction,this UI will allow the users to predict the case status very easily and the User interface is user-friendly.

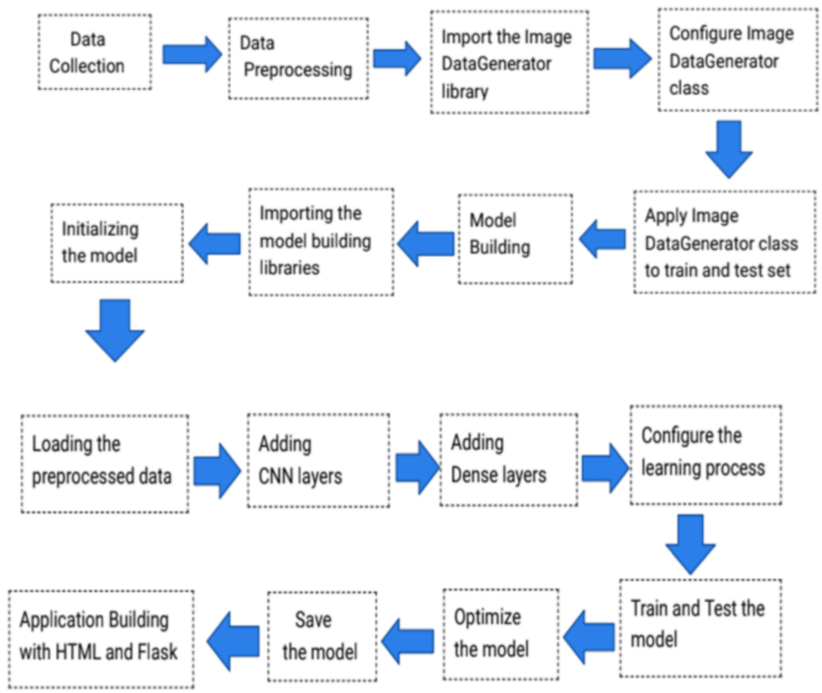


THEORITICAL ANALYSIS

Image quality and accuracy are the core factors of this research, image quality assessment as well as improvement depending on the enhancement stage where low pre-processing techniques are used . The proposed technique is efficient for segmentation principles to be a region of interest foundation for feature extraction obtaining.

BLOCK DIAGRAM





Hardware Requirements

RAM : 4GB and above

OS: Windows 7 and above with 64bit

Hard disk: Minimum 100GB

SOFTWARE DESIGNING

1. Jupyter notebook Environment
2. Spyder IDE
3. Deep Learning Algorithm(CNN)
4. HTML
5. Flask App

We developed this project using Python programming language which is an interpreted and high level programming language and uses the Deep Learning algorithms. For coding we have used the Jupyter Notebook environment of the Anaconda distributions and the Spyder, it is an integrated scientific programming environment in python language. For creating an user interface for the prediction we have used Flask. It is a micro web framework written in Python. A scripting language named HTML is used to create a webpage by creating the templates to use in the functions of the Flask and HTML.

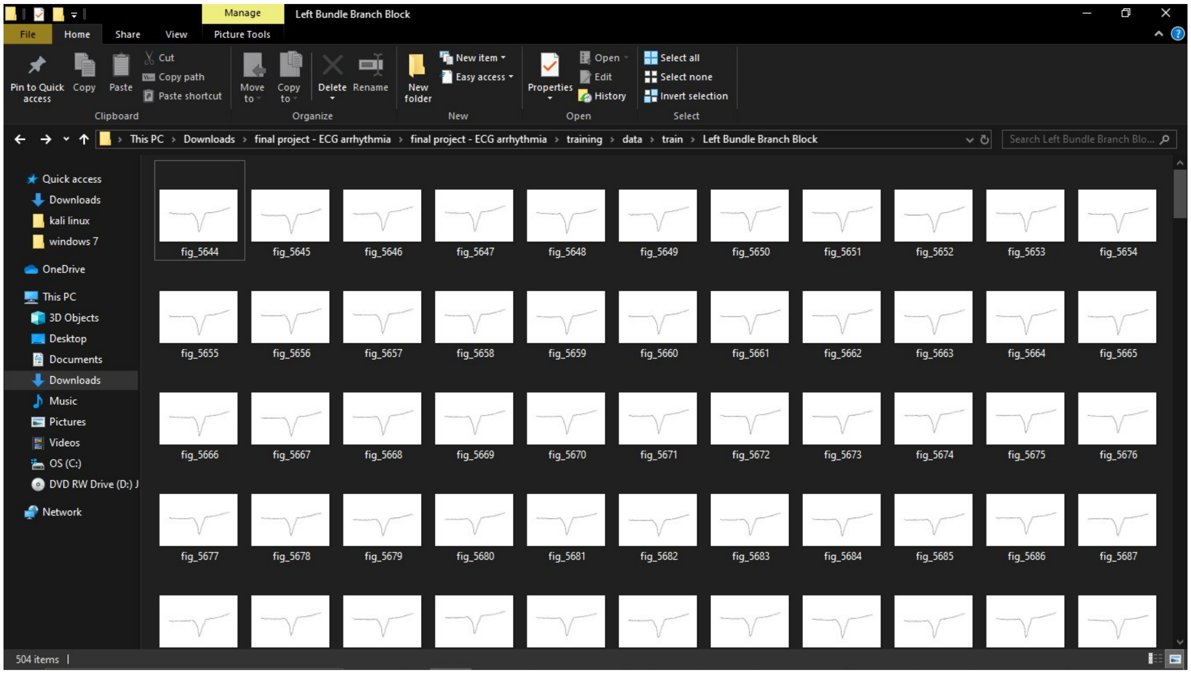
EXPERIMENTAL INVESTIGATION

Our dataset consists of two folders named train and test. In train and test sets we have six classes each named as Normal,Premature Atrial Contraction ,Premature Ventricular Contraction , Left Bundle Branch Block,Right Bundle Branch Block ,Ventricular Fibrillation. A total of 15,341 images in the train set and 6,825 images in the test set are collected.

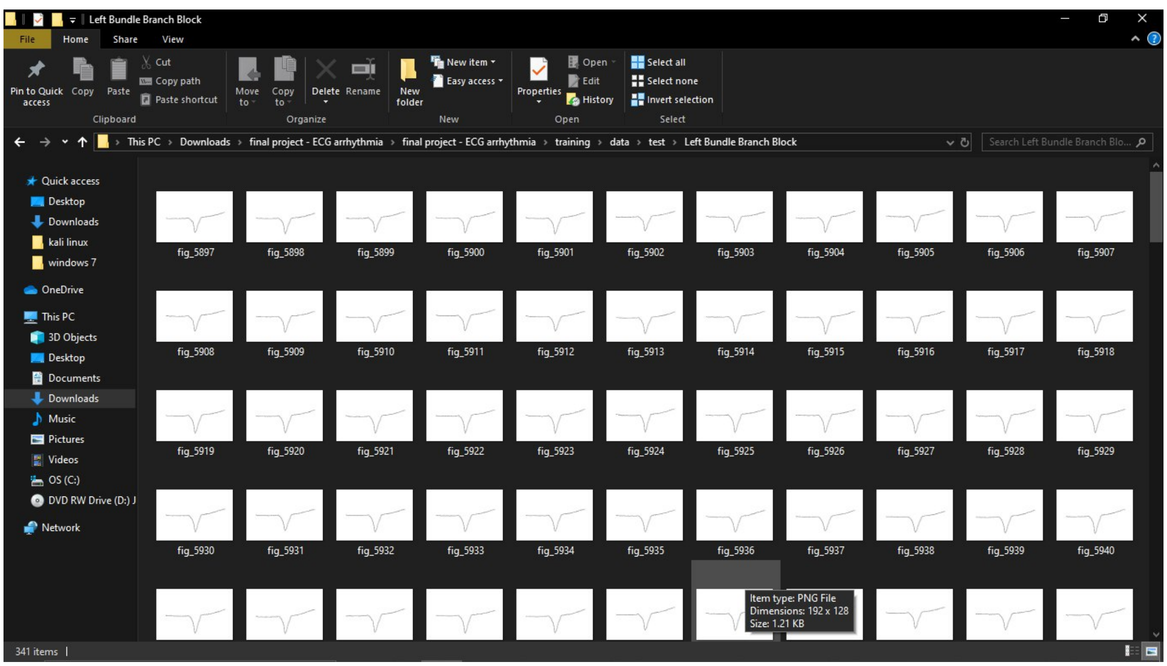
During the training process, the dataset of input images (divided into training and validaon sets) is repeatedly submitted to the network to capture the structure of the images that is salient for the task. Initially, the weights for each artificial neuron are randomly choosen. Then, they are adjusted at each iteration, targeting minimiztion of the loss function. The performance of the trained model is then evaluated using an independent test dataset. This is also aimed at assessing whether an "overfitting" has occurred.

The sample of sets is given below:

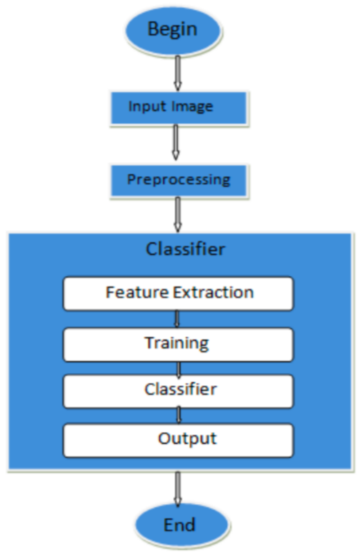
Train Set:

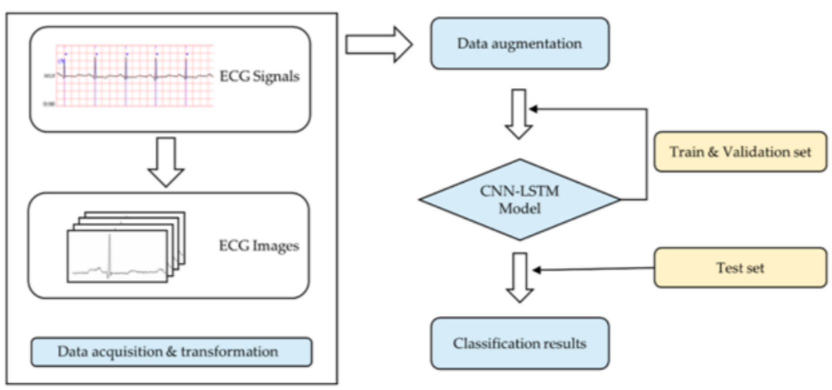


Test Set:



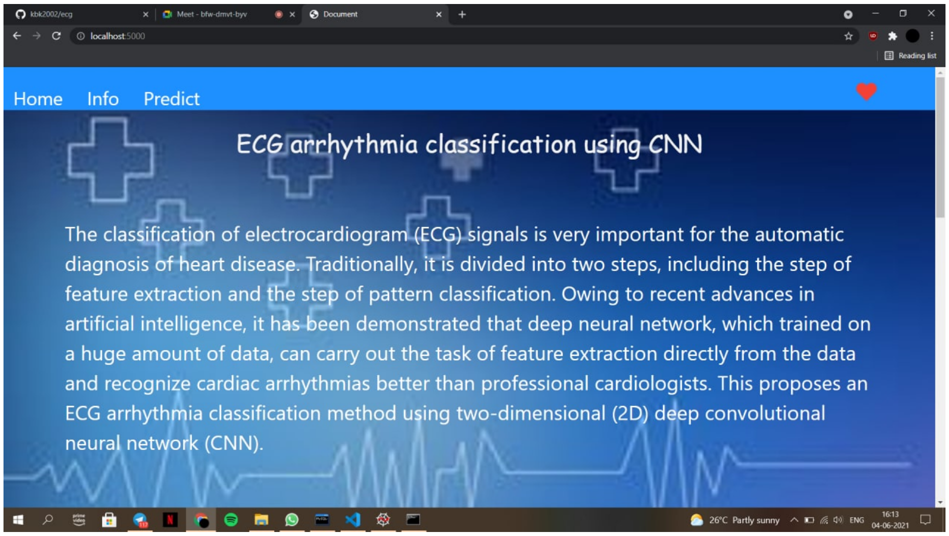
FLOW CHART

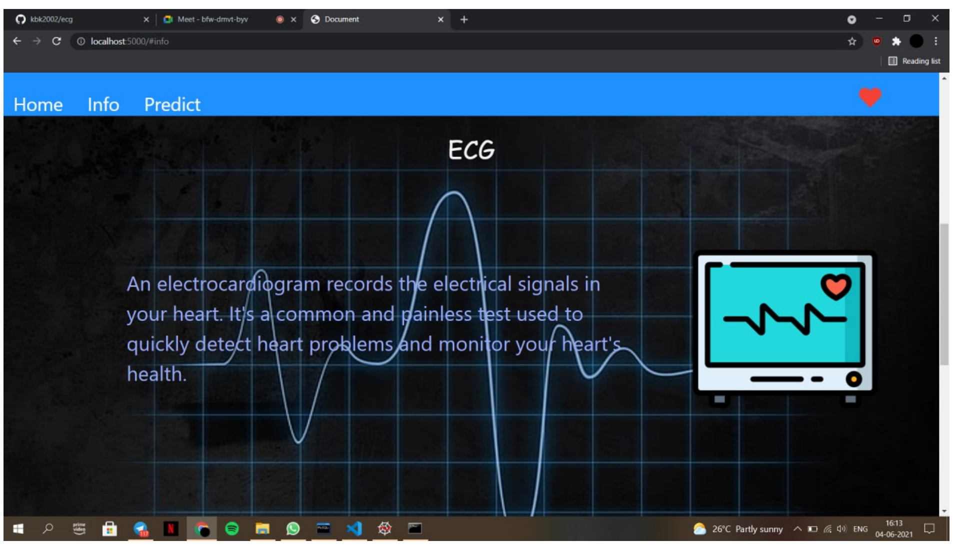


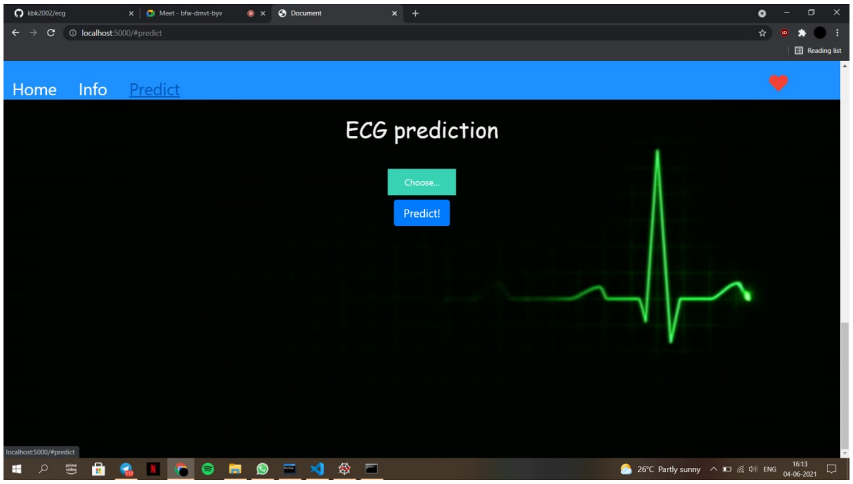


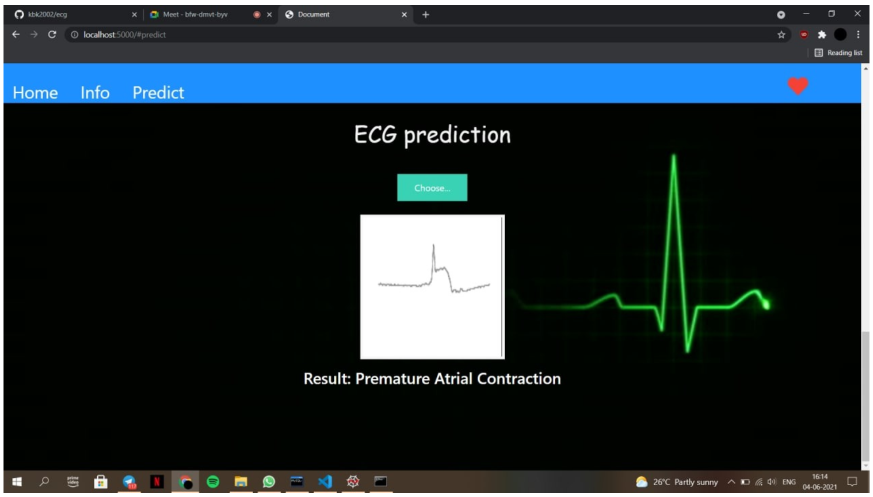
RESULT

In this way, we can recognize and classify the disease and analyze the condition of the patient.Here, CNN is used to predict the outcome based on the image analysis by giving an object detection code. With the avaliability of a robust dataset our model has achieved good accuracy of 95%. Firstly we have saved our model and checked the predictions. After getting correct predictions we have integrated our model with a web application using flask and html. Thus, we can finally deploy our model using IBM Watson Studio and make it available for end user.









ADVANTAGES AND DISADVANTAGES

Advantages:

1. It is considered as the best ml technique for image classification due to high speed and accuracy.
2. Image pre-processing required is much less compared to other algorithms.
3. It is used over feed forward neural networks as it can be trained better in case of complex images to have higher accuracies.
4. It reduces images to a form which is easier to process without losing features which are critical for a good prediction by applying relevant

filters and reusability of weights .

Disadvantages:

1. Needs a clear image for prediction.
2. It may not be robust in predicting unclear images.
3. It requires a large training data.
4. While CNN have already existed for a long time, their success was limited due to the size of considered network.

APPLICATIONS

1. Can also be used for prediction of different diseases in a short time.
2. Not only in disease prediction but also to predict anything via images this can be used.
3. Used to analyze visual imagery.
4. Decoding facial recognition.

CONCLUSION

Our project mainly focused on the advancement of predictive image analysis to achieve good accuracy in predicting valid disease outcomes using Deep learning methods. The analysis of the results signify that the integration of data augmentation images along with different feature detectors and Imagedatagenerator class to transform the original data into new data using random translations.

A decision support system for classification of ECG Arrhythmia helps and assists a physician in making optimum, accurate and timely decision, and reduce the overall cost of the treatment. The proposed system greatly reduces the cost of the treatment.

FUTURE SCOPE

The future work will focus on exploring more of the dataset values and yielding more interesting outcomes. This study can help in making more effective and reliable disease prediction and diagnostic system which will contribute towards developing better healthcare system.In further study, we will try to conduct experiments on larger data sets or try to tune the model so as to achieve the state -of-art performance of the model and a great UI support system making it a complete web application model.

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3. Fatma Murat, Ozal Yildirim, Muhammed Talo, Ulas Baran Baloglu, Yakup Demir, U. Rajendra Acharya, "Applicaon of deep learning techniques for heartbeats detecon using ECG signals-analysis and review", Computers in Biology and Medicine, pp. 103726, 2020.Google Scholar.

APPENDIX

Source codes:

1.https://1drv.ms/w/s!AhKwl_zekX1WiUeb_HuIgLTPAcyN?e=jOiuW1

2.https://1drv.ms/w/s!AhKwl_zekX1WiUlrlECrQLxx6baJ?e=aMu6CP