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Deep Learning Based Heart Disease Prediction Using CNN

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ABSTRACT
Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. These are the primary reasons of leading cause of death globally. From small age to old age people are suffering due to this problem and investigation of heart diseases at the age of childhood is of crucial importance. This study explained Prediction of cardiovascular diseases at the early stages in a cardiac patient. So we can monitoring and provide better treatment easily at this stage rather than at the elderly stage. In this study we developed a classification method on ECG image data where the combination of a convolutional neural network and advanced form of CNN that is AlexNet,GG16 MobileNet, are used to diagnose ECG image. The experimental method consisted of detection and classification of the input data was carried out using each model. Then comparative study of four model carried out, best result of model on basis of accuracy and loss value. The experimental results showed that the implemented method demonstrated high classification performance in terms of accuracy, and loss rate of four model respectively.
Keywords—*CNN, ECG, CardiovascularDiseases, VGG, MobileNet, AlexNet*

1. Introduction

Cardiovascular related diseases are one of the primary reasons for worldwide fatality. Congenital heart disease may show symptoms only at the elderly stage and the treatment will become difficult. Hence investigation of heart diseases at the age of childhood is of crucial importance. One easy method in this regard is the automatic diagnosis of heart sound waves (electrocardiogram) using artificial intelligence techniques.[1] This setup helps in testing the heart abnormalities even by a person from the non-medical area. Years back we use the auscultation method for diagnosis of cardiovascular diseases (CVD). After that stethoscope was developed for comfortable auscultation ofpatientsandeveninmodernmedicine,thesameapparatusiswidelyusedinCVDdiagnosis. Auscultation method of CVD diagnosis requires perfect training and experience in identifying heart sound abnormalities. A statistical study reveals the fact that even expert cardiologists have been reported to achieve only 80% accuracy where as the primary health care doctors and medical students normally achieve only 20-40% accuracy.[2] Early detection of cardiac abnormality using electrocardiogram has been proven to be very effective & free from any form of side effect.

Heart Disease prediction is one of the most complicated tasks in medical field. In the modern era, approximately one person dies per minute due to heart disease. Data science plays a crucial role in processing huge amount of data in the field of healthcare. [3] As heart disease prediction is a complex task, there is a need to automate the prediction process to avoid risks associated with it and alert the patient well in advance. The proposed system aims at introducing the chances of heart disease prediction and classifies patient's risk level. Here used major steps as Data collection & cleaning, Feature Extraction, Model Training, Model Evaluation and Model Deployment. Initially the user needs to enter Ecg image data to this system, after that system perform feature extraction and classification based on image data. Finally predict result as Normal or Abnormal or Myocardial

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infarction done by using four model such as CNN , AlexNet, VGG 26 and MobileNetV2. Perform comparative study of these architectures and performance of each network is discussed. Comparative results in terms of accuracy, Loss, and training time between the networks are presented. Section 2 is a study of existing literature. It gives a brief introduction into the basics Architecture of CNN and transfer learning technique. Section3 gives the detailed overview of the implementation. Section4 goes on to summarize the results of the experiment in terms of the accuracy and loss value. Finally, the last section concludes the paper to the implemented system.

2. Experimental Methods or Methodology

The proposed system is a Deep learning based Heart disease prediction system which is easily classify and predict heart condition which is normal or abnormal or myocardial infarction. Early detection of heart condition, we can provide better treatment &better life span. The system is based on four deep learning models and provide result on the basis of accuracy and loss rate. Methodare classified as,

1. Data Collection and Cleaning:- Information gathering and cleaning
2. Data preparation :-Using different model taken
3. Model Training :-Four deep network and python Language
4. Model Evaluation:-Test and evaluate model
5. Model Deployment:- Apply in real world

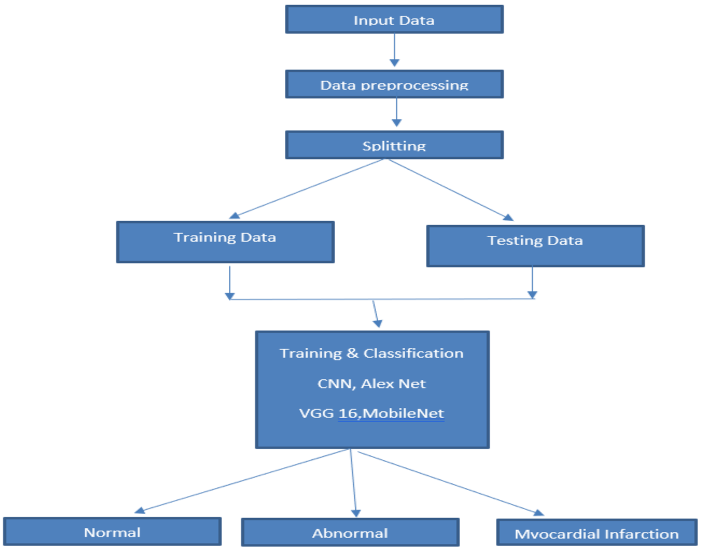

Fig.1. Data flow Model of Proposed System

2.1 Data Collection and Cleaning

ECG dataset can be collected from many different sources such as Physionet ATM, physionet challenge and more. However, the focus of this project is to train the deep learning model classifying normal or abnormal conditions of heart function based on the ECG analysis. At the data cleaning stage, besides removing the ID and URL columns, all the empty, repetitive and problematic rows are also removed from the dataset.

2.2 Data preparation

Data preparation is a stage where the data is being prepared and transformed into a contextwhichthemachinecanunderstandandtherefore,feedingintothemachinelearning model to be trained. In this project, the input images were prepared using different pre-processing steps: 1)

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resizing images to 224 × 224 × 3, 2) augmenting the resized images using augmentation methods such as rotate, flip, and skewing, 3) normalizing all images (original and augmented images), and 4) converting the images of RGB to gray scale and into arrays for using them as input for the next stage of the model. For training the deep learning model, the dataset must be split. The dataset images are randomly split into two parts (trainandvalidation) 75% and 25% for training and validation, respectively, to insure the variety of the images.

2.3 Model Training

This study targets not only to accurately detect heart diseases with the help of CNN and advanced CNN neural network model. Here advanced form of CNN such as AlexNet ,VGG 16,MobileNetv2 are used and its result are discussed.

3.3 Model Evaluation

Aftertrainingtheneuralnetworkmodels,itwillbetestedontheunseentestdataset. The metrics that will be used to evaluate these models are accuracy and validation loss. Accuracy metric to determine how accurate the models can be used to classify normal or abnormal case of heart. The training loss indicates how well the model is fitting the training data, while the validation loss indicates how well the model fits new data.

2.4 Model Deployment

The model deployment meant to be deployed in actual real-world. Here performs heart diseases detection conducted as a social service under different groups. This way easily detects heart abnormality and at earliest stage get the good treatment.

Model 1 :- CNN Architecture

Model 1 implemented with 11 layer CNN architecture. In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of Artificial Neural Network(ANN), most commonly applied to analyze visual imagery.[7] Mainly CNN model consist of three layers Convolution layer .

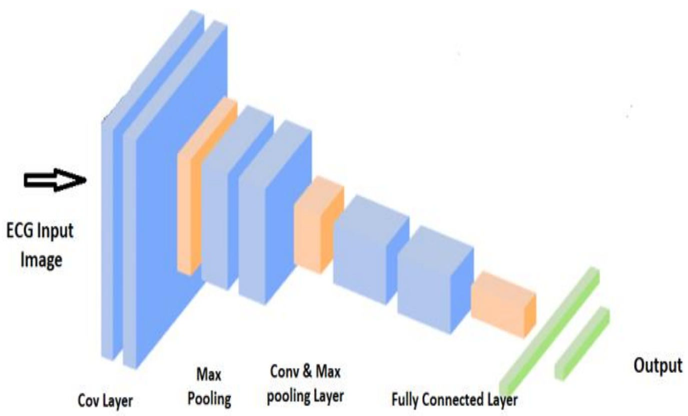

Fig .2. Layer CNN Architecture

The first layer, used to extract the various features from the input images and the mathematical operation of convolution is performed b/w the input image and a filter of a particular size M x M. The second layer is pooling layer. Its primary aim of this layer is to decrease the size of the convolved feature map to reduce the computational costs .The final layer is and fully connected layer. These layers are termed as output layer and form the last few layers of a CNN Architecture. The activation function softmax is used here to make result accurately. [8]Architecture of CNN are shown in fig 2.

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Model 2 :- AlexNet Architecture

Model 2 is implemented with one of the advanced form of CNN such as Alexnet. [9]AlexNet architecture consists of 5 convolutional layers, 3max-pooling layers, 2 normalization layers, 2 fully connected layers, and 1 softmax layer. Each convolutional layer consists of convolutional filters and an online aractivation function ReLU. The pooling layers are used to perform max pooling. Input size is fixed due to the presence of fully connected layers. The input size is mentioned at most of the places as 224x224x3 but due to some padding which happens it works out to be 227x227x3.AlexNet overall has 60 million parameters.

Model 3 :- VGG 16 Architecture

Model 3 is implemented with another advanced form of CNN model such as VGG 16.VGGNet-16 consists of 16 convolutional layers and is very appealing because of its very uniform Architecture.Similar toAlexNet, it has only 3x3 convolutions, but lots of filters. The input to any of the network configurations is considered to be a fixed size 224x224 image with three channels R,G, and B. The only pre-processing done is normalizing the RGB values for every pixel. This is achieved by subtracting the mean value from every pixel. Image is passed through the first stack of 2 convolution layers of the very small receptive size of 3 x 3, followed by ReLU activations. Each of these two layers contains 64 filters.

The convolution stride is fixed at 1 pixel, and the padding is 1 pixel. This configuration preserves the spatial resolution, and the size of the output activation map is the same as the input image dimensions. The activation maps are then passed through spatial max pooling over a 2 x 2-pixel window, with a stride of 2 pixels. This halves the size of the activations. Thus the size of the activations at the end of the first stack is112x 112 x64.

Theactivationsthenflowthroughasimilarsecondstack,butwith128filtersasagainst 64 in the first one. Consequently, the size after the second stack becomes 56 x 56 x 128. This is followed by the third stack with three convolutional layers and a max pool layer. Theno. of filters applied here are 256, making the output size of the stack 28x28x256. This is followed by two stacks of three convolutional layers, with each containing 512 filters. The output at the end of both these stacks will be 7x7x512. The stacks of convolutional layers are followed by three fully connected layers with a flattening layer in- between. The first two have 4,096 neurons each, and the last fully connected layer serves as the output layer and has 1,000 neurons corresponding to the 1,000 possible classesfor the ImageNet dataset. The output layer is followed by the Softmax activation layer used for categoricalclassification.

Model 4 :- Mobile NetV2 Architecture

MobileNetV2 is a convolutional neural network architecture that seeks to perform well on mobile devices. It is based on an inverted residual structure where the residual connections are between the bottleneck layers. The intermediate expansion layer uses lightweight depth wise convolutions to filter features as a source of non-linearity.As a whole, the architecture of MobileNetV2 contains the initial fully convolution layer with 32 filters, followed by 19 residual bottleneck layers. Architecture are shown below.

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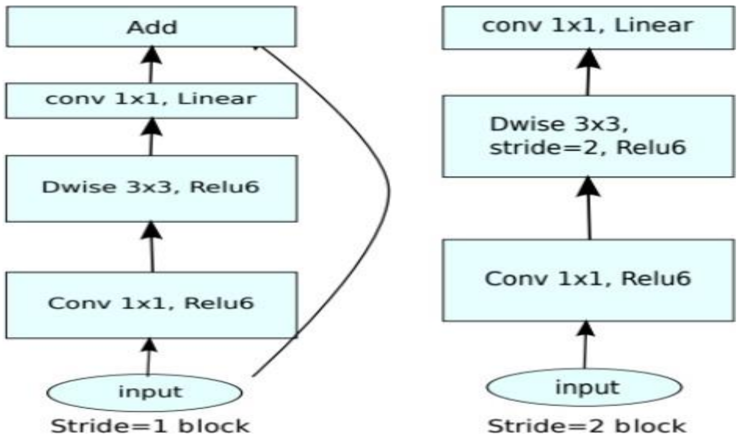

Fig. 3. MobileNetV2 Architecture

3. Results and Discussion

Experimental result of four model implementation show very effective result in terms of accuracy and loss value. Table 4.1showstheoverallperformancesforall4modelsand its accuracy and validation lossrate.

Model Name	Accuracy%	Loss%
CNN	94	0.68
AlexNet	81	0.74
VGG 16	87	0.70
MobileNet	96	0.11

Table 4 Performance Metrics of 4 model

In Deep Learning, the performance evaluation metrics are used to calculate the performance of your trained machine learning models. This helps in finding how better your deep learning model can perform on a dataset that it has never seen before. The 5.1 and figure5.2 shows graphical representation of both accuracy and loss rate of 4 model trained. The metrics that will be used to evaluate these models are accuracy, loss and computational time. The reason of using accuracy metric in this project is to determine how accurate the models can be used to detect heart condition normal or abnormal or myocardial infarction.

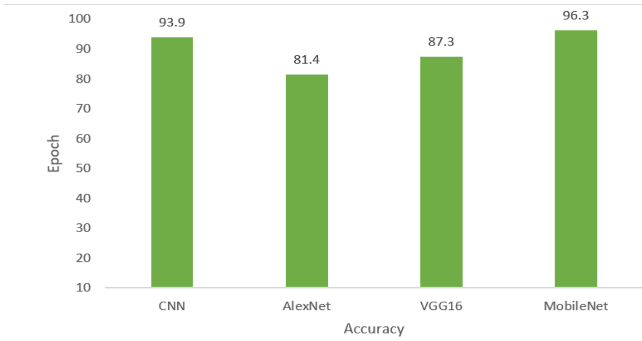

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Fig. 4. Accuracy of four model

Fig .5. Validation loss of four model

CONCLUSION

Diagnosis/ prediction of cardiovascular diseases at the early stages in a cardiac patient is of great importance because monitoring and treatment will be easy at this stage rather thanattheelderlystage.Electrocardiogramhasbeenthemostprominentdiagnostictechnique for cardiac disease detection. It helps cardiologist to obtain the waveform of heart electricalpotentialactivates,whichenablesthemindetectingseveralheartproblems,such as arrhythmia, which is the major reason of death. In the proposed approach different types CNNmodel with ECG images from physionet ATM database processed, and to perform a comparative study of all this model are evaluated. From this 4-model comparison, got consistently accurate results with MobileNet architecture of accuracy 96 % which ensures that, it is reliable and robust.

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