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Automatic Echocardiogram Analysis Using Deep Learning

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ABSTRACT: The most common cause of heart disease is narrowing or blockage of the coronary arteries, the blood vessels that supply blood to the heart itself. Early sign of heart disease will help you to choose the best treatment based on doctor recommendations to you. In an echocardiogram of heart, these echoes are turned into moving picture of your heart. Echocardiogram is a common test using sound wave map out shape and size of heart. This paper has focused on echocardiography where the decision is to detect the defect in the four chambers of heart quick. This work proposes to study Convolutional Neural Networks in medical science. It focuses on echocardiography. The term echocardiography means that the internal structure of a patient's heart is studied through the images. The ultrasound waves create these images. The abnormalities in these images are found through echo. This work proposes to study Convolutional Neural Networks in medical science. It focuses on echocardiography. 2D echocardiogram is the test in which pictures of heart and various parts of heart are taken with the help of probe. The motive of this work is to decrease the overhead of the cardiologist. This approach will result in pointing the abnormality in the heart. Since, cardiologist and less experienced surgeons may take a while to figure out the defect or may miss the defect in the heart, this is a powerful approach which can detect even a little defect in heart which human eye tends to ignore.

Keywords: Convolutional neural network, Deep learning, Quality assessment, Echocardiography, Apical four-chamber, Machine Learning, Artificial Intelligence and Image Processing, etc.

1. INTRODUCTION

In Heart failure is one of the primary causes of death worldwide, giving more value to the early detection of cardiac problems? Echocardiography is the most common diagnostic test used in management and follow-up of patients with suspected or known heart problems. It can provide the doctor with helpful information, including the size and shape of the heart, pumping capacity, and extent of tissue damages. Echocardiograms are obtained from various planes or acoustic windows, called echo views, which visualize different heart structures. The standard echo views are categorized into four groups, parasternal, apical, suprasternal notch, and sub costal. To acquire a good quality echo of a certain view, the transducer should be positioned so that its beam sections through certain cardiac structures. Echo acquisition is relatively a manual procedure and it is the sonographer's job to find the correct acoustic window. An echo with suboptimal quality may affect the accuracy of measurements and even result in the misdiagnosis and misclassification of the patient in terms of the final treatment. There have been some efforts in helping the sonographers during image acquisition. Some studies have tried to alert the operator on presence of shadows and aperture obstructions in the echo window via analyzing the power spectrum of the signal. However, these methods are blind to the anatomical structures on the echo image and cannot go beyond obstruction detection to determine the quality of a given echo. Other methods aimed for the expected anatomical structures and evaluated the quality based on the goodness of-fit of a predetermined template on the image. Due to the intrinsic nature of the echocardiography imaging, records from different patients may not follow a defined template. However, the mentioned methods rely solely on the low-level intensity-based features. Meaning, they do not capture the large range of variations present inside each echo view. Moreover, they are sensitive to the speckle noise, which is naturally present on echo images. Consequently, these template matching methods do not perform well in this domain. [1]

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In this research, a deep generative model is proposed to learn the appropriate features from a fairly large dataset of echo images. The trained model will then automatically evaluate the quality of a given echo frame, in real time. The experiments in this study only focus on the apical four-chamber view; but our approach is general and can be extended towards other views.

2. RELATED WORK

The main motive of this paper is to predict the defect in a cardiac arrest patient. This is done by processing the echocardiogram images. An echocardiogram is one kind of ultrasound test that uses high-pitched sound waves that are sent through a device called a transducer. But the quality of an echocardiogram image cannot be guaranteed to be good. It may also contain some distractions. Our enhanced approach will make sure that the echocardiogram images trained by Convolutional Neural Network should have less error for the algorithm to find the defect. To achieve this, we could start improving our neural network by adding some pooling layers in between them so that the more features are extracted from it. Also, minimum errors can be achieved by padding the spatial arrangement by zeros. This will help retaining image's actual size. This is helpful for preserving the image size which will recall the quality of the image. After the patient's defect has been discovered, our next contribution is to recommend the diagnosis of the patient. Meaning, the system will recommend the health risks and diagnosis methods for further treatment. For example, if the system detects the defect in Left Artery then this system will recommend the relevant disease and diagnosis methods for treating that disease.

3. PROPOSED SYSTEM

3.1 System Architecture

The dataset was examined by an expert cardiologist and an integer quality score of 0 (not acceptable) to 5 (excellent) was assigned to each image based on the following:

In this proposed system is to predict the defect in a cardiac arrest patient. This is done by processing the echocardiogram images. An echocardiogram is one kind of ultrasound test that uses high-pitched sound waves that are sent through a device called a transducer. But the quality of an echocardiogram image cannot be guaranteed to be good. It may also contain some distractions. Our enhanced approach will make sure that the echocardiogram images trained by Convolutional Neural Network should have less error for the algorithm to find the defect. To achieve this, we could start improving our neural network by adding some pooling layers in between them so that the more features are extracted from it. Also, minimum errors can be achieved by padding the spatial arrangement by zeros. This will help retaining image's actual size. This is helpful for preserving the image size which will recall the quality of the image. After the patient's defect has been discovered, our next contribution is to recommend the diagnosis of the patient. Meaning, the system will recommend the health risks and diagnosis methods for further treatment. For example, if the system detects the defect in Left Artery then this system will recommend the relevant disease and diagnosis methods for treating that disease.

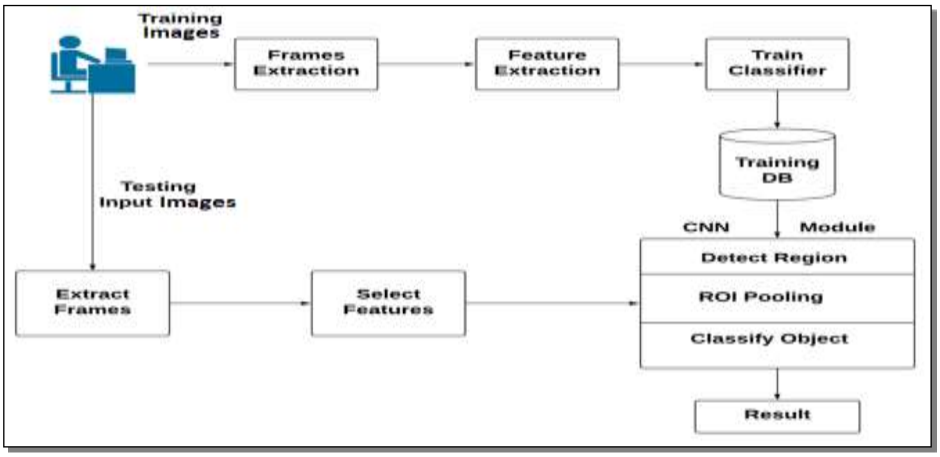

Fig 1: System Architecture

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4. SYSTEM MODELS

4.1 Module 1: Image preprocessing and normalization:

In this phase image preprocessing as well as normalization has done using two different methods. In preprocessing we apply various image filtration techniques like remove the noise from input images. The normalization can be set image dimensions according who standard length. In proposed system we need to write individual function for both techniques. Once the execution has done system returns buffered image and we need to convert it into the original object.

4.2 Module 2: Features extraction and train modules:

In the second not doing we extract the various features of image like luminescence and chrominance, as well as other required features from each constitutional layer. The particle swarm Optimization (PSO) has use to generate the random particles from given input images, this particles basically e input for model 3 called as the DCNN.

4.3 Module 3: Classification using CNN:

In this module we generate various cross fold validation for training as well as testing respectively. 5-fold, 10-fold and 15-fold has used to validate the proposed system. Before executing this module we generate the various random samples from particle Swarm Optimization algorithm, which is generate the multiple samples random which is given as input to DCNN. Around 3 convolutional layers has generated in proposed system and 3 pulling layers working DCNN consecutively. And finally we use FC layer for to detect specific global configurations of the features detected by the lower layers in the net, and generate the output from whole process.

4.4 Module 4: Disease Recommendation:

The major contribution of project to recommend the disease possibility according to given DCNN in classification and Systems background knowledge which is already generated in running database. This system recommend the disease possibility using respective machine learning algorithm, we use any machine algorithm like support vector machine (SVM), Naive Bayes (RB) or random forest (RF) respectively. Once the disease prediction execution has done system event the propose system accuracy with other disease prediction bass classification systems which is already used different machine learning algorithms.

5. ALGORITHM DETAILS

5.1 CNN Algorithm:

CNN is one of the main categories to do image recognition, image classification. Object detection, face recognition, emotion recognition etc., are some of the areas where CNN are widely used. CNN image classification takes an input image, process it and classify it under certain categories (happy, sad, angry, fear, neutral, disgust). CNN is a neural network that has one or more convolutional layers.

- **Step 1:** Dataset containing images along with reference emotions is fed into the system. The name of dataset is Face Emotion Recognition (FER) which is an open – source data set that was made publicly available on a Kaggle.
- **Step 2:** Now import the required libraries and build the model
- **Step 3:** The convolutional neural network is used which extracts image features f pixel by pixel
- Step 4: Matrix factorization is performed on the extracted pixels. The matrix is of m x n.
- **Step 5:** Max pooling is performed on this matrix where maximum value is selected and again fifixed into matrix.
- **Step 6:** Normalization is performed where the every negative value is converted to zero.
- **Step 7:** To convert values to zero rectifified linear units are used where each value is ffiltered and negative value is set to zero.
- **Step 8:** The hidden layers take the input values from the visible layers and assign the weights after calculating maximum probability.

5.2 Naıve Bayes Classifier:

It is probability based algorithm mostly used in text classification. Naive Bayes model is easy to build and particularly useful for very large data sets. Along with simplicity, Naïve Bayes is known to outperform even highly sophisticated classification methods. Na¨ıve bayes algorithm observes each feature independently even if they are related.

6. RESULT AND DISCUSSION

Result Analysis:

The dataset was examined by an expert cardiologist and an integer quality score of 0 (not acceptable) to 5 (excellent) was assigned to each image based on the following:

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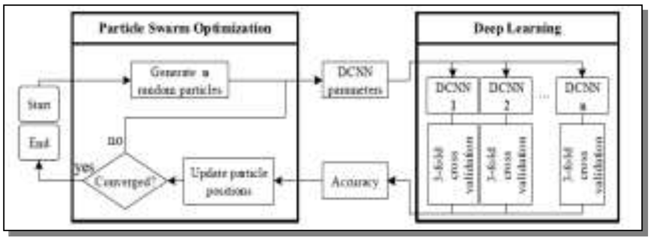

Fig. 2: Proposed System Design

0) Clear presence of the aortic valve and/or only the interatrial or interventricular septums is visible;

1) Chamber boundaries of one or two chambers are visible;
2) Chamber boundaries of three chambers are visible;
3) Chamber boundaries of three or four chambers are visible, but not sharp enough for quantification of all chambers; heart is off-axis (crooked) or significantly foreshortened;
4) Boundaries of three or four chambers are clear for quantification, proper axis, mildly foreshortened;
5) Boundaries of four chambers are clear for quantification, proper axis, sharp edges, not foreshortened. According to the above scoring system and the expert's opinion, samples with a score of below 3 are considered uninterruptable with minimal clinical value.
Distribution of data among the six quality-levels is demonstrated in Fig. 3

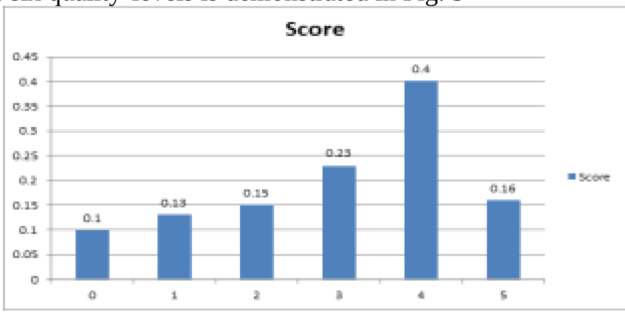

Fig.3: Distribution of dataset, consisting various samples, among six quality-levels based on manual echo scores. Since the data is obtained mostly by expert sonographers with several years of echocardiography examination experience, the distribution leans more towards higher quality scores.

7. CONCLUSION

This partly reflects the difficulty in defining realistic simulations and phantoms. Manual delineation of clinical data is by far the most popular means of performance assessment, although depending on the clinical area, there can be significant inter-expert and intra-expert variability and delineation can be difficult to do. Therefore, one needs to take care in interpreting results when manual delineation is used as the reference. There is also a general lack of standardization of performance measures, which makes it difficult to directly compare methods. This has the advantage that multiple experts are used to define the reference. There are also no standard databases on which different groups can compare methods, so comparisons have only been made between methods developed by individual groups. This is problematic in the field as a whole, as clinical ultrasound image quality varies a lot, more so than in other areas of medical imaging such as CT and MRI. The proposed approach provides framework for automatic quality assessment of echo data using deep neural network model. In this survey, it is observed that there are various echocardiography methods. This method is very useful capturing various positions of Probe. It is necessary to obtain good quality of images for analysis of defects. By minimizing operator dependency on echo acquisition and analysis, this research would lead to widespread use of echo at any point-of-care; hence it would enable early and timely diagnosis and treatment of high-risk patients with improved accuracy, quality assurance, work-flow and throughput.

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