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Automatic Cardiovascular Disease Assessment with Convolutional Neural Networks

Shirsath Nikita Rajendra¹, Shaikh Mohammad Arsh Navid², Musale Harshada Sajerao³,
Prof. Avhad G.T.⁴

Students, Department of Computer Engineering, Vishwabharti Academy's College of Engineering, Ahmednagar,
Maharashtra, India^{1,2,3}

Assistant Professor, Department of Computer Engineering, Vishwabharti Academy's College of Engineering,
Ahmednagar, Maharashtra, India⁴

ABSTRACT: The most common cause of cardiovascular disease is narrowing or blockage of the coronary arteries, the blood vessels that supply blood to the heart itself. Early sign of cardiovascular 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.

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

I. INTRODUCTION

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.

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.

II. LITERATURE SURVEY

Lasse Løystakken and Fredrik Orderud have proposed, a method for the visualization of the effective aperture of phased-array transducers is described. The method operates in real-time during acquisition, and can indicate if a contiguous part of an aperture does not contribute in the image formation. They believe the method can be helping ensure that a good image quality is obtained in contexts where the acoustic contact or window is likely to be reduced. The method is based on the k-space formulation of the ultrasound imaging system, which has proven useful for investigating imaging system performance. [1]

J. H. Park¹, S. K. Zhou has proposed a fully automatic system for cardiac view classification of echocardiogram. Given an echo study video sequence, the system outputs a view label among the pre-defined standard views. The system is built based on a machine learning approach that extracts knowledge from an annotated database. It characterizes three features: 1) integrating local and global evidence, 2) utilizing view specific knowledge, and 3) employing a multi-class Logit-boost algorithm. In this prototype system, they classify four standard cardiac views: apical four chambers and apical two chambers, parasternal long axis and parasternal short axis (at mid cavity). Proposed method helps to achieve classification accuracy over 96% both of training and test data sets and the system runs in a second in the environment of Pentium 4 PC with 3.4GHz CPU and 1.5G RAM. [2]

Xavier Glorot Antoine Bordes Yoshua Bengio have proposed a technique, that shows rectifying neurons are an even better model of biological neurons and yield equal or better performance than hyperbolic tangent networks in spite of the hard-non-linearity and non-differentiability at zero, creating sparse representations with true zeros, which seem remarkably suitable for naturally sparse data. Even though they can take advantage of semi-supervised setups with extra-unlabelled data, deep rectifier networks can reach their best performance without requiring any unsupervised pre-training on purely supervised tasks with large labeled datasets. Hence, these results can be seen as a new milestone in the attempts at understanding the difficulty in training deep but purely supervised neural networks, and closing the performance gap between neural networks learnt with and without unsupervised pre-training. [3]

Geoffrey E. Hinton and Vinod Nair have shown how to create a more powerful type of hidden unit for an RBM by tying the weights and biases of an infinite set of binary units, then approximated these stepped sigmoid units with noisy rectified linear units and showed that they work better than binary hidden units for recognizing objects and comparing faces. They also showed that they can deal with large intensity variations much more naturally than binary units. [6]

Sten. Roar Snare, Hans Torp, Fredrik Orderud, Bjorn Olav Haugen have proposed a novel method for assisting no expert users in capturing the apical 4-chamber view in echocardiography has been presented. A Wilcoxon signed pair rank test yielded a statistically significant improvement of the view quality. [7]

III. 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.

IV. PROPOSEDSYSTEM

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.

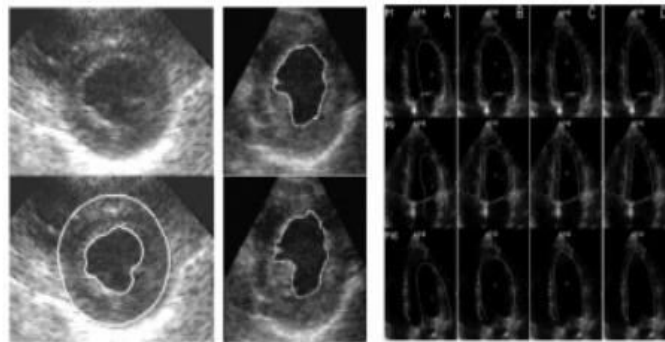


Fig. 1: Examples of echocardiographic image segmentation. Short axis images from (a) and from (b) (c) Long axis images

A. 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:

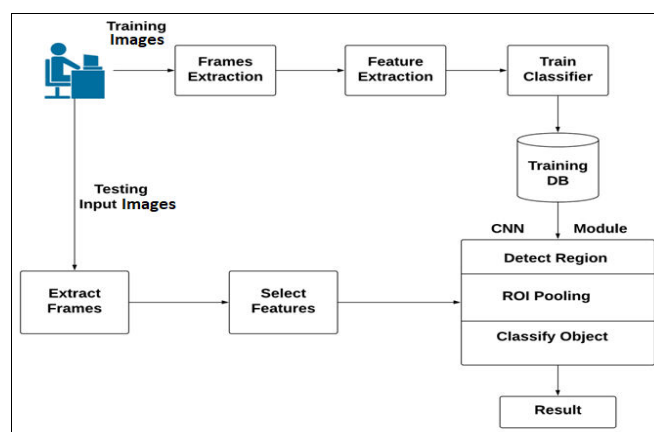


Fig.1: System Architecture

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V. 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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