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Convolutional Neural Network based Echocardiogram Quality Analysis for Cardiac Health Diagnosis of Heart Failure

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Abstract: Machine Learning has been evolving day by day with many features. The core of the Machine Learning lies in the interaction between the neurons in the hidden layer. The neurons interact with each other by considering the weights between them. This results in the output of the system. There are many applications in which Machine Learning can be practiced. This project proposes neural network 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. 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 approach considers the view of apical four-chamber (A4C) which considers 4 chambers of heart. This is a powerful approach which can detect even a little defect in heart which human eye tends to ignore.

Keywords: Machine Learning, Neural Network, Deep learning, Quality assessment, Echocardiography, Apical four-chamber, 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.1, 2 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 subcostal.3 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 sonographer 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.6, 7 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

Amir H. et. Al. [1] proposed a system has the potential to facilitate widespread use of echo at the point-of-care and enable early and timely diagnosis and treatment. 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. The CNN algorithm has used for classify the images for echo images.

R. Kumar et. Al. [2] proposed a system which exploits motion in echocardiogram videos as well as cues from both cardiac structures for automatic view classification. They represented set of novel feature. Every image is classified in independently in testing time. This system gives good result.

The various reasons for loss of quality of echocardiogram image also contain some distractions. So the result affect in further diagnosis of patients. Because of this quality of image is degrading. To overcome this problem developed method, Real time feedback of acoustic contact along phased array transducer is helpful to obtain good image quality. K-space formulation is used for ultrasound imaging system. The proposed method because problem is reverberations from obstructing structure close to transducer by L. Løvstakken et. Al. [3].

S. R. Snare et. Al. [4], Author proposed method Real Time Scan Assistant. This help to non -expert user to capture apical four chambers views in echocardiography. This algorithm used two techniques 1) parametric multi chamber-model 2) kalman Filter framework.

P. Coup´e et. Al. [5] the author described nonlocal (NL)-means useful for speckle reduction in ultrasound (US) images. Bayesian framework is proposed.

As compared to other state of art method has given better performance. It has obtained accurate information of edge and structure details of image and preserves its image data. This method is needed for image registration or image segmentation for Optimized Bayesian Nonlocal Means (OBNLM) filter.

N. Srivastava et. Al. [6] machine Learning System deep neural nets and large number of parameter are very powerful. Neural network is facing serious problem with over fitting. In prediction of test time large neural nets are slow due to over fitting problem. The solution of this problem is to develop a technique of Dropout. In Neural network during training randomly drop unit is basic idea of this technique.

They proposed a fully automatic system for cardiac view classification of echocardiogram [7]. The echo study has given different pre-defined standard views. Development of this system used machine learning technique. They extract knowledge from annotated database. They classify four standard cardiac views. This method is helpful to achieve accuracy of train and test dataset.

M. Grossgasteiger et al. [9] M. Grossgasteiger et al described how image quality influences different echocardiography methods. In a cardiac surgery evaluating left ventricular function Transesophageal echocardiography has become a standard tool. It is necessary to obtain the good quality of an image to find the defect in chambers of the heart.

Quality of image differs from examinations and patients. The operator skill is very important for the successful collection of ultrasound data. In echocardiography, the heart is bounded by ribs and lungs issues. They have some problem with naïve user to obtain correct position of probe so it is the need to provide the standard tool that can guide and train naïve users to obtain a position of the probe. They proposed B-mode images that provide user guidelines naïve user, improve their skill and Suitable acoustic windows for image quality [11].

R. M. Lang et al. [12] Proposed technique update normal values for cardiac chambers. It may assume that lot of parameter in convolutional layer is missing. Over fitting is not a problem and therefore dropout would not have much effect.

Kucera et al. [13] proposed a method with a regionally based external force in their early work on segmentation of the left ventricle. This force is used in an active contour 3D model with time as one dimension. Their method is fairly reliable on both short axis and long axis views of the heart.

Sarti et al. [14] also used a region based approach in their segmentation model where they incorporate the a priori knowledge of the statistical distribution of gray levels.

The level set method is used to drive the curve evolution to achieve a maximum likelihood segmentation of the target, with respect to the statistical distribution law of image pixels.

Mishra et al. [15] use an active contour model when segmenting the left ventricle in short axis view. They solve the optimization problem using a Genetic Algorithm (GA) and the performance is comparable with inter-observer variability. A multi-scale approach to the contour optimization is done by Mignotte and Meunier [16]. Their external energy in the snake energy function is also region based. They show some segmentation results for short axis views that are qualitatively good.

Bosch et al. [17] developed an Active Appearance Motion Model (AAMM) that was used to do a segmentation of the left ventricle. This is an extension of Active Appearance Models (AAM) and they did an automated segmentation over the full heart cycle. Several other methods have also been evaluated for this segmentation problem, including artificial neural Networks, a fuzzy multi-scale edge detector [20] and a Kalman filter based tracking method [21]. All of these methods give acceptable segmentations of the left ventricle in the long axis and/or short axis views.

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III. PROBLEM STATEMENT.

To implement region based segmentation and convolutional neural network based feature extraction and classification for cardiac health monitoring.

A. Objectives

1) To design and developed a system for end-systolic echo images for measure the quality assurance.
2) To reduce user variability in data acquisition by automatically computing a score of echo quality for operator feedback
3) To build a train as well as test modules and define the quality class for individual test images.
4) To achieve the classification result using Convolutional Neural Network (CNN).
5) To validate the proposed system accuracy with available existing systems.

IV. METHODOLOGY OF IMPLEMENTATION

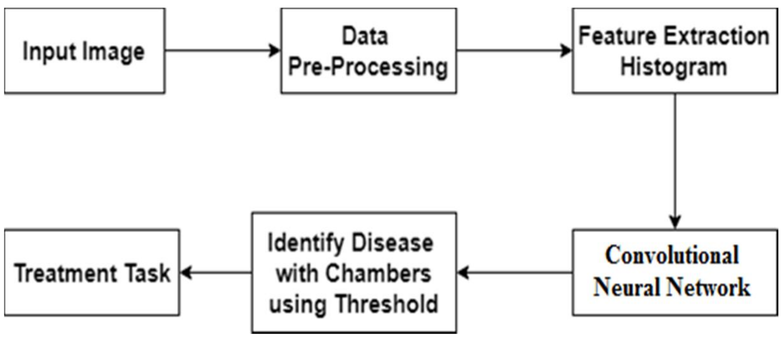

Fig.1: Design Flow of Propose System

A. Endocardial Border Detection

The most popular approach has been to treat echocardiographic endocardial segmentation as a contour finding approach. This is not straightforward as the contrast around the border of the left ventricle chamber varies depending on the relative orientation of the border to the transducer direction, and attenuation. Thus conventional intensity gradient-based methods have had limited success on typical clinical images. The active contour solution where the optimization was performed using a genetic algorithm. Manual delineations were done at 20 frames by two experts and the average compared to the automated algorithm to show that the inter-variability between experts was similar to the difference between the manual and automated methods. The region- based segmentation method of follows a Bayesian methodological approach. Level sets are often considered as an alternative to active contours and this approach has also been considered for echocardiographic image segmentation. Some system considered applying the level set method to echocardiographic images using an adaptation of the fast marching method. To reduce errors attributed to using local features (intensity gradient) measurements, they used an average intensity gradient-based measures in the speedy term. The method was applied to a parasternal short axis and an apical four-chamber view sequence but the results were only discussed qualitatively. Existing system presented an interesting variant of the level set segmentation idea which combines edge and region information in a level set approach across spatial scales. For instance, Binder applied a two-layer back propagation network to end-diastolic and end-systolic parasternal SAX images from 38 patients with the data being of variable quality. This is one of the few studies that have explicitly looked at data of varying quality. Segmentation was successful in 34 of the 38 datasets. The automated method was compared with manual tracing by two experts.

B. Myocardium and Epicardium Detection

There is a very limited literature explicitly looking at segmentation and analysis of the myocardium [1] and epicardial border detection. These are both challenging to do with native B-mode images. There is also very little literature specifically focused on getting methods to work on general clinical data rather than data from subjects with a good acoustic window i.e., which give good images, which considers how to enhance B-mode images to reduce the effect of attenuation and enhance features. Although that method was shown quantitatively to reduce attenuation, enhance features, and not introduce artifacts after enhancement, that approach has not to date been fully tested in clinical practice.

C. Dataset and Manual Quality Assessment

For this project, echo views were fetched from the Vancouver General Hospital echo database with ethics approval from the Clinical Medical Research Ethics Board of the Vancouver Coastal Health (VCH) and consultation with the VCH Information Privacy Office. No new patients were scanned for this study.

At VGH, these echo images are acquired mostly by echo-technicians. For each patient, echo images are obtained from different standard views.

This research only focuses on the A4C view, which is one of the most challenging views to obtain for novice sonographers. The end-systolic frame of each echo cine was extracted and then examined by an expert cardiologist. The clinician assigned an integer value of 0 to 5 to each image based on its quality.

D. Modeling Viewpoint using Edge filtered Motion Features

Since the native form of the data obtained from echocardiogram is a video of anatomical structures in motion, widely seek a model which exploits all the information (structural, textural and motion) present in video for view-point discrimination and is not limited to using a few key frames.

Further, we want a method which can be seamlessly applied to any viewpoint and is not limited to any particular subset of viewpoints, and thus our technique should be independent of the presence of specific anatomical structures in the images. And finally, our technique should provide recognition rates which are competitive with respect to the existing state-of-the-art.

In order to satisfy these conditions, we propose a frame-work which works with a few salient features obtained from analysis of both intensity frames (structural and textural in-formation) and optical flow (motion information) in a given video sequence. In the next subsections we describe the basic preprocessing and the two important aspects of salient feature selection process-localization and encoding.

V. POSSIBLE OUTCOME

Deep convolutional neural networks, like most learning algorithms, rely on a set of hyper parameters that can affect performance of a trained model. In practice, hyper-parameters are chosen in order to minimize the generalization error.

Training computational models to represent medical images requires a large annotated dataset. In this research, we had the advantage of an echo database available on the Picture Archiving and Communication System of the Vancouver General Hospital (VGH).

These echo images were acquired mostly by echo-technicians, with a small contribution from cardiology trainees and trainee technicians, during routine cardiac exams, below are the motivational points which are behind the proposed research

A. To classify the automatic class of echo-systolic images.
B. Low accuracy issues.
C. False error rate very high.
D. To eliminate manual validation of echo images.

VI. CONCLUSION

We presented a method for automatic view classification of 2D echocardiograms. Our approach relies on low-level image features and uses classification methods, which are efficient in both training and testing. We have proposed support vector machine image classification techniques in which SVM feature are extracted by obtaining key-points and prediction is given for each detected point of view. We have also performed classification using SVM classifier that gives maximum accuracy. The inclusion of machine learning models in echocardiography appears very promising, as they are able to accurately identify various echocardiographic features and predict outcomes, without the limitations currently inherent to human interpretation.

A. Future Scope

1) Future work may include exploring hierarchical classification strategies with our features to attain higher recognition rates with even more view classes.
2) Also in future scope proposed system is used for echo-cardiogram cardiologist center or echo-cardiogram medical equipment's to get better result as compare to existing manual approach.

REFERENCES

[1] Amir H. Abdi, Christina Luong, Teresa Tsang, Gregory Allan, Saman Nouranian, John Jue, Dale Hawley, Sarah Fleming, Ken Gin, Jody Swift, Robert Rohling, and Purang Abolmaesumi, "Automatic Quality Assessment of Echocardiograms Using Convolutional Neural Networks: Feasibility on the Apical Four-chamber View". TMI.2017, IEEE Transactions on Medical Imaging.

[2] Ali Bahrami Rad, Trygve Eftestøl, Kjersti Engan, Unai Irusta, Jan Terje Kvaløy, Jo Kramer-Johansen, Lars Wik, and Aggelos K. Katsaggelos, "ECG-based Classification of Resuscitation Cardiac Rhythms for Retrospective Data Analysis". IEEE Transactions on Biomedical Engineering TBME-00153-2017.

[3] L. Løvstakken, F. Ordernd, and H. Torp, "Real-time indication of acoustic window for phased-array transducers in ultrasound imaging," Proceedings of IEEE Ultrasonics Symposium, pp. 1549–1552, 2007.

[4] J. H. Park1, S. K. Zhou, "Automatic cardiac view classification of echocardiogram," Proceedings of the IEEE International Conference on Computer Vision, pp. 0–7, 2007.

[5] X. Glorot, A. Bordes, and Y. Bengio, "Deep Sparse Rectifier Neural Networks," Aistats, vol. 15, pp. 315–323, 2011.

[6] V. Nair and G. E. Hinton, "Rectified Linear Units Improve Restricted Boltzmann Machines," 27th International Conference on Machine Learning, pp. 807–814, 2010.

[7] S. R. Snare, H. Torp, F. Orderud, and B. O. Haugen, "Real-time scan assistant for echocardiography," IEEE Trans. Ultrasonics, Ferroelectrics, and Frequency Control, vol. 59, no. 3, pp. 583–589, 2012.