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Convloutional Neural Network To Automatic Quality Assessment Of Echocardiography In Apical Four Chamber

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ABSTRACT

Neural network has been evolving day by day with many features. The core of the neural networks lies in the interaction between the neurons in the hidden layer. The neurons interact with each other by considering the weight between them. There are many applications in which neural network can be practiced. This system has implemented Convolution Neural Networks in medical science. This scheme has focused 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 the 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: Apical four chamber, Convolutional Neural Network, Echocardiography, Quality Assessment.

1.INTRODUCTION

Heart disease is a medical condition that impairs cardiac functioning. People are taking less care of heart. It is the leading cause of death around the world. The main component of human cardio vascular system is heart, blood and bold vessels. Cardiac output is the volume of blood being pumped by heart in one minute. Echocardiogram is a non-invasive imaging technique used to look at your heart, its valves, chambers and blood flow. 2D echocardiogram is the test in which pictures of heart and it is various parts are taken with the help of probe. The test is done by cardiologist.

Data mining has proved to be very effective in many fields. This system has focused on a very popular field i.e. healthcare field where data mining has served many applications. One of the applications in healthcare field is predicting the disease through some parameters which will be useful in decision making before diagnosis. This can save a good amount of life since the decision to be taken for diagnosis should be fast. But what if the decision is incorrect and contains some error? This kind of false decision for diagnosis can take a life of a person. To avoid such kind of risk it is the need to make a system which can be reliable and in which the doctor can easily trust.

This system has focused on echocardiography where the decision to detect the defect in the four chambers of heart is quick. The quality of acquired cine help to improve accuracy of estimations of chamber volumes, functions and ejection fraction in 2D echo views such as A4C views. Several research groups have made notable efforts in producing real time feedback. A number of groups have projected content-based cardiac interview classification technique. This technique uses statistical approaches as well as low-level features and machine learning. In echo system intra-view quality analysis is most challenging problem. Visual content of the different echo images that need scoring is highly correlated to intra-quality analysis.

This scheme proposed a regression model. The main use of this is model hierarchical feature extraction automatically from echo images. It is mainly related to images that obtain quality score which is determined by expert cardiologist. Extraction feature, recognize images, classifying echo images, train and test model for this proposed deep neural network model. The design of the proposed architecture does not include any a priori assumptions on the A4C view. This approach could be extensible to other standard echo views.

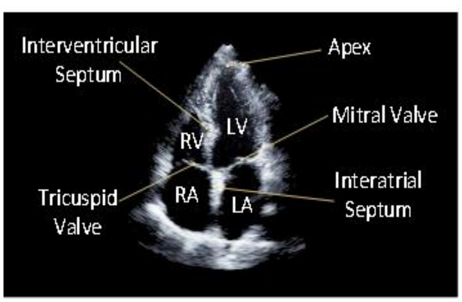

Fig1.Different View

Two-Dimensional Echocardiography can provide excellent images of the heart, Para cardiac structures, the great vessels and excellent assessment of structure and function of the heart. A transthoracic echocardiogram (TTE) is the most common type of echocardiogram, which is a still or moving image of the internal parts of the heart using ultrasound.[1]

2.RELATED WORK

In 2009 *Lasse Løvstakken et.al[3]* developed new technique using phased array transducer for real time feedback. They ensure that this method has obtained good image quality. The ultrasound imaging system k-space formulation method is useful.

Advantages

It has obtained good image quality that is reduced by acoustic contact or windows.

Limitation

This technique problem is reverberations from obstructing structure close to transducer.

J. H. Park el.at [7] have developed a system for cardiac view classification. This system used machine learning techniques. It is extracting the knowledge from database. It describes three features: 1) integrating local and global evidence, 2) utilizing view specific knowledge and 3) employing a multi-class Logit-boost algorithm The proposed method helps to achieve a classification accuracy test dataset and training dataset..

Advantage

The proposed method helps to achieve a classification accuracy test dataset and training dataset.

Limitation

It Include the negative class in the training sets as it creates complicated problem because the space of the class is infinite.

In this paper [8] it is described that how rectifying neurons are better model than other models. It is does not require unsupervised training data. Deep rectifier neurons give best performance.

Advantage

Rectifier units support to join the gap among unsupervised pre-training and no pre-training,

Limitation

The rectifier units in activation network perform unbounded behavior so that problem could arise.

Sten Roar et.al [4] have proposed a novel method real time scan assistant. This method helps for non-expert users in capturing the apical 4-chamber view in echocardiography.

***A*dvantage**

The Proposed method helps users in capturing the apical 4-chamber view in echocardiography.

Limitation

In this method, some challenges are remaining with respect to the detection of oblique views.

The various recent techniques have been developed for image classification. Conventionally, the job of hyper parameter optimization has been performed by humans. They have only few trials which are possible because they can have very efficient commands. They present a new system for hyper parameter optimizations. The technique gives the results on task of deep belief network and training neural network [10].

In this paper, author's described method is nonlocal (NL)-means speckle reduction in ultrasound (US) images. They propose to use a Bayesian framework. The proposed method when compared with other state of art method has given better performance. It has obtained accurate information of edge and structure details of image. This method is needed for image registration or image segmentation for Optimized Bayesian Nonlocal Means (OBNLM) filter[5].

Multiple non-linear hidden layer is present in deep neural networks. In this model, complicated relationship is present with input and output data. It generates sampling noise. Due to these reasons over fitting problem is generated. To overcome this problem new technique is Dropout developed [11].

3.SYSTEM ARCHITECTURE

The main motive of this system is to predict the defect in a cardiac arrest patient. This is done by processing the echocardiogram images. An echocardiogram is one kind ultrasound tests 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.

In this system, first user has to register and login to the system. Secondly add patient's details and echocardiogram images into database This system's 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, start improving the neural network by adding some pooling layers in between them so that more features are extracted from it. Also, minimum errors can be achieved by padding the spatial arrangement by zeros. This will help retaining of the actual size image . 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. It means 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.

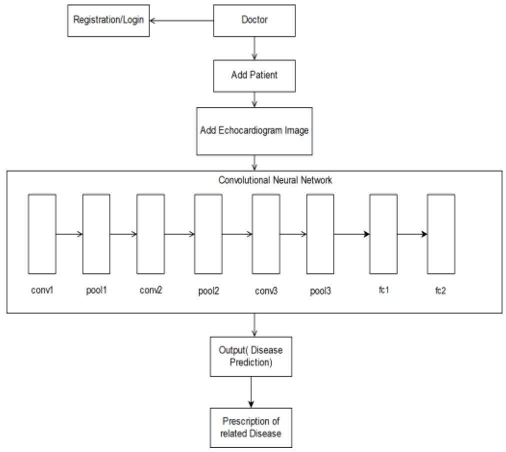

Fig2.System model

Input: Upload image dataset.
Output: Find defect in heart.
1] Convolutional Stage:

$$a^{l}_{i,jk} = \sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} w^{l}_{i,mn} a^{l-1}_{(j+m)(k+n)}.$$

The Conv layer is the core building block of Convolutional Network. First input image is passed to Convolutional layer. then Convoluted output is obtained as an activation map. further process is filter applied in conv layer extract relevant features from input image.
Fully-connected Stage:

$$f^{l}_{\mathrm{fc}_i}(a^{l-1}) = \sum_{j=1}^{n} w^{l}_{ij} a^{l-1}_{j} + b^{l}_{i},$$

Fully Connected stage Each neurons in fully connection layer have full connection to activation in previous layer. Gradient error is then calculated

Table 1.Notaion of Convolutional Stage

Notations	Description
a_i^l	output feature map of kernel.
w_i^l	Is the Weight matrix.
a^{l-1}	Represents the input feature-map of the layer.

Table 2.Notation of Fully Connected

Notations	Description
f_{fci}^l	Fully Connected.
a^{l-1}	Represents the input feature-map of the layer.
w_i^l	Is the Weight matrix.
a_i^l	output feature map of kernel.
b_i^l	Bias value .

4.MATHEMATICAL MODEL

Considering I, M, O are taken as inputs, outputs, and functions sets respectively.

Now I is the set of input:
I = input as echocardiogram dataset
M is the set of the functions::
M = F1, F2, F3, F4
Whereas,

F1= echocardiogram dataset (This function is used insert echocardiogram dataset (images)),
F2= train via Convolutional neural network Function (This function is used to classify the dataset),
F3= test data function (This function is used to test in echocardiogram dataset) ,
O is the set of outputs:
O= predicted data show
Further,
O1=Success Case (It is the case where we find chambers predicted result)
O2=Failure Case (It is the case we are not able to find out defect)

5.SYSTEM ANALYSIS

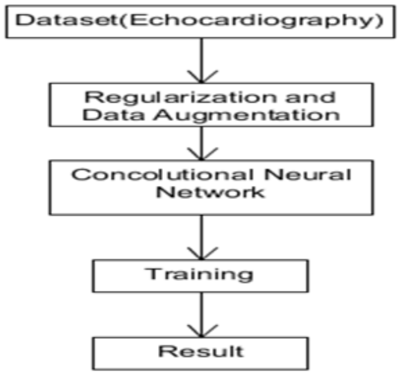

Fig3.Flow of proposed system

Dataset:
The dataset is fed into the system. This dataset contains echocardiography images of patients who are previously diagnosed, i.e. their decision tend to be true. Dataset is divided into three set, i.e. trainset, tuneset and testset.

Regularization and Data Augmentation:
Regularization and Data augmentation is a technique that reduces the generalization error of a machine learning algorithm and best way to improve the generalizability of a model is to train on more data.

Convolutional Neural Network , Training and Result System uses CNN algorithm to detect the disease from given ECG image. System has used three layers of the CNN. These are Convolutional Layer, Pooling Layer and fully connected layer. CNN algorithm first extracts the features from the images then it generates the patterns and finally it classifies the images. Here, convolutional layer and pooling layer, both layer work together. First, it represents the image into three dimension vector space then applies filters to convert that image into 2 dimensions. Again fully connected layer applies the filters to recognize the image. After training the system when we pass the image to test it, as per the specified categories it classifies the image and detects the disease accurately. Then the disease detection system suggests the medicine on the detected disease.
The performances of the trained models will evaluated as the mean absolute error(MAE) between the predicted AES and the experts manual echo scores (MES).

6.RESULTS AND DISCUSSION

Table 3.Comparison Result table AES&MES

Image ID	Accuracy AES	Accuracy MES
1	87.0%	90%
2	70. 0%	71%
3	44.0%	80%
4	72.0%	70%
5	72.0%	75%
6	64.0%	78%
7	45.0%	75%
8	79.0%	75%
9	30.0%	78%
10	79.0%	73%

In this table show the comparison between Manual echo score value and Absolute echo score value.
In this research, we have collected echo image dataset from the hospital . These echo images were acquired mostly by echo-technicians, with a small contribution from cardiology trainees and trainee technicians, during routine cardiac exams.

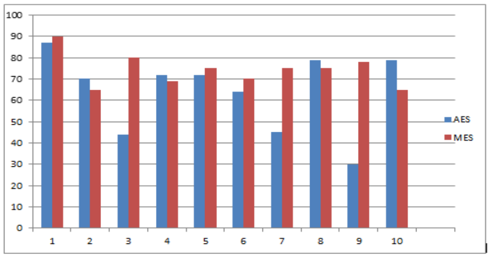

Fig4.Result Graph of AES &MES

In an echo acquisition, the heart is imaged from at least seven standard (parasternal long and short axes, apical 2-, 3-, and 4-chamber, subcostal, and suprasternal) and atypical imaging views for which the sonographer places a transducer on the patient's chest to obtain ultrasound frame stacks (cine clips) in a specific order from each of the standard echo views.

Table 4 Width, height, Depth parameter respectively.

Layer	Parameter	Value
Conv1	Convolutional size Number of Convolutions Input Size Output Size	3×5×5 20 3×32×32 3×28×28
Poll1	Window width Window height Input size Output size	2 2 3×28×28 3×14×14
Conv2	Convolutional size Number of Convolutions Input Size Output Size	1×5×5 20 3×14×14 3×10×10
Poll2	Window width Window height Input size Output size	2 2 3×10×10 3×5×5
Conv3	Convolutional size Number of Convolutions Input Size Output Size	1×3×3 20 3×5×5 3×3×3
Fc1	Number of Input Number of Nodes	180 300
Fc2	Number of input Number of Nodes	300 5

TABLE 5 PREDICTION OF DEFECT IN CHAMBER BY SYSTEM AND DOCTOR

SR. No	Image ID	Defect detected in chamber by current system	Defect Said to by Doctor
1	1	R3	R3
2	2	R2	R2
3	3	R1	R1
4	4	R3	R4
5	5	R2	R1
6	6	R3	R3

In this network, give the detail information of with respective convolutional , polling ,Fully Connected layer. Convolutional layer size, number of convolutions, input, output size .

7.CONCLUSION

The proposed approach provides framework for automatic quality assessment of echo data using deep neural network model. The goal of the proposed technique is to improve echo by reducing observer variability in data acquisition using a real-time feedback mechanism that helps the operator to read just the probe and acquire an optimal echo.

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, workflow and throughput.

REFERENCES

1]Amir H. Abdi, Christina Luong" Automatic Quality Assessment of Echocardiograms using Convolutional Neural Networks: Feasibility on the Apical Four-chamber View", DOI 10.1109/TMI.2690836, IEEE Transactions on Medical Imaging, 2017.

2] R. Kumar, F. Wang, D. Beymer, and T. Syeda-Mahmood, "Echocardiogram view classification using edge filtered scale-invariant motion features," in 2009 IEEE Conference on Computer Vision and Pattern Recognition, June 2009, pp. 723–730.

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

5] P. Coup´e, P. Hellier, C. Kervrann, and C. Barillot, "Nonlocal meansbasedspeckle filtering for ultrasound images," IEEE Transactions on Image Processing, vol. 18, no. 10, pp. 2221–2229, 2009.

6] N. Srivastava, G. Hinton, A. Krizhevsky, I. Sutskever, and R. Salakhutdinov, "Dropout: A simple way to prevent neural networks from overfitting," Journal of Machine Learning Research, vol. 15, pp. 1929–1958, 2014.

7] "Automatic cardiac view classification of echocardiogram," Proceedings of the IEEE International Conference on Computer Vision, pp. 0–7,2007

8] X. Glorot, A. Bordes, and Y. Bengio, "Deep Sparse Rectifier NeuralNetworks," Aistats, vol. 15, pp. 315–323, 2011.

9]M. Grossgasteiger et al., "Image Quality Influences the Assessmentof Left Ventricular Function: An Intraoperative Comparison of Five 2-Dimensional Echocardiographic Methods With Real-time 3-Dimensional Echocardiography as a Reference," Journal of Ultrasound in Medicine,vol. 33, no. 2, pp. 297–306, 2014.

10] J. Bergstra, R. Bardenet, Y. Bengio, and B. Kegl, "Algorithms for Hyper-Parameter Optimization," Advances in Neural Information Processing Systems, pp. 2546–2554, 2011.

11] N. Srivastava, G. Hinton, A. Krizhevsky, I. Sutskever, and R. Salakhutdinov,"Dropout: A simple way to prevent neural networks from overfitting,"Journal of Machine Learning Research, vol. 15, pp. 1929–1958,2014.

12] R. M. Lang et al., "Recommendations for Cardiac Chamber Quantificationby Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of CardiovascularImaging," Journal of the American Society of Echocardiography,vol. 28, no. 1, pp. 1–39, aug 2016.

