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Diagnosis of DCM and HCM Heart Diseases Using Neural Network Function

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Abstract

The Major Heart Disease like heart muscle damage and valvular problems are detected and diagnosed using Echocardiogram. The Echocardiogram is an ultrasound test that uses high pitched sound waves through a transducer. This device picks up echoes that bounce off from different parts of brain. These Echoes are turned into moving picture in sequence of images with less information. Since it is a sequence of images, there is a possibility of some vulnerability. So, the cardiologist spends more time for predicting and decision making. An Efficient and Automatic detection, diagnosis and classification of DCM and HCM disease using Neural Network is proposed in this work. The Echocardiogram video or frame sequences often suffer with speckle noise. So each frames are subjected to preprocessing to remove the noise where median filter out performs with good PSNR and low MSE. The preprocessed image is segmented by FCM clustering which efficiently segments the Left Ventricle region. Features like statistical feature, Gray Level Difference statistical features are extracted from Normal, Dilated Cardiomyopathy (DCM) and Hypertrophic Cardiomyopathy (HCM) images. The extracted features are analyzed and are classified using Neural Network classifier. Experimental analysis is performed using normal and abnormal images to efficiently diagnosis the DCM and HCM and the system achieved around 90% of accuracy.

Keywords: Left Ventricle, DCM, HCM, Echocardiogram, Image Processing.

INTRODUCTION:

The heart could be a muscular organ placed merely behind and slightly left of the bone. The center pumps blood through the network of arteries and veins knows as the vascular system. Heart condition is wherever the center cannot beat out enough blood to fulfill the requirements of the body. it's usually a chronic condition, related to age that progresses bit by bit. Each side of the heart can fail independently of the other, leading to heart condition of the right heart or the left heart. Left heart condition can even cause right heart failure (cor pulmonale) by increasing strain on the right heart. If the heart is unable to pump sufficient blood, it should accumulate throughout the body, inflicting dyspnoea within the lungs (pulmonary congestion; pulmonary edema), swelling (edema) of the feet or different gravity-dependent areas, decrease exercise tolerance, or cause different clinical signs like enlarged liver, internal organ murmurs, or a raised jugular blood pressure. Common causes of heart failure embody artery disease, valve disorders and diseases and diseases of muscle.

Disease Identification

Hypertrophic cardiomyopathy (HCM) is a disease in which a part of the themyocardium (heart muscle) is hypertrophic (enlarged) without any obvious cause, creating functional weakness of the heart. It is the leading cause of fast heart-related death in young athletes. The event of hypertrophic cardiomyopathy is a significant cause of sudden heart related death in any age group and a cause of disabling cardiac symptoms. HCM is often without symptoms until sudden cardiac death, and for this reason some suggest routine screening for this disease. In most patients, HCM is related to very little or no incapacity and normal life expectancy Diagnosis typically by echocardiogram. Whereas there's no known prevention or cure, symptomatic patients are also treated effectively by medication or, in severe cases, by surgery. HCM is most usually due to an adjustment in one among nine genes that prompts to a mutated super molecule inside the segment, the essential segment of the myocyte (the muscle cell of the heart). These square measure prevalently missense changes inside the genes for the beta-myosin vital chain (MHC), myosin-binding super molecule C, internal organ troponin T, troponin I, or tropomyosin. These mutations cause myofibrilla and myocyte structural abnormalities and attainable deficiencies operative generation. Every child of an HCM parent has 50% chance of inheriting the illness -causing change. Family-specific genetic testing will often typically determine at-risk relatives, though illness severity and age of beginning can't be predicted.

Dilated cardiomyopathy (DCM) may be a condition during which the heart becomes enlarged and can't pump blood with efficiency. The minimized heart function can affect the lungs, liver, and alternative body systems. Different cardiomyopathies have totally different causes and have a affect on the heart in numerous ways. In DCM a number of the myocardium is expanded (dilated), sometimes with none obvious cause. Left or right ventricular systolic pump operate of the heart is impaired, bringing about progressive heart enlargement via ventricular hypertrophy and ventricular dilation, a technique referred to as ventricular remodeling.

Echocardiogram

An echocardiogram is a sort of ultrasound look at that applies high-pitched sound waves sent by a tool referred to as

electrical device known as transducer. As the sound waves bounces off varied region of the heart, the resultant echoes are acquired by echocardiogram device. These echoes are transformed into moving picture that are obvious in the screen

RELATED WORK:

R. Hussein, et.al., (2010), [1] analysed the Echocardiography to appear various cardiac functions, particularly to detect the left ventricular wall motion abnormality. Each one of the test were performed using MATLAB to exhibit the effectiveness of this system and describe the features and limitations of the method . The 2D echocardiograph pictures obtained for various patients were reviewed and diagnosed by an expert cardiologist, who graded wall movement in each part (three segments) as normal or abnormal. Based on the left ventricle wall thickness there classified into three segment (seg A < seg B < seg C) 42 videos were carefully studied and therefore the proposed scheme achieved a recall ratio as 71%.

G.N. Balaji, et.al., (2013), [2] prepossessed a completely unique and study automatic LV segmentation by measurement the properties of each connected part within the echocardiogram pictures and a cardiac abnormality detection methodology supported ejection fraction is projected. The left ventricle is initial segmental exploitation connected component labeling scheme, and accordingly the left ventricle diameter is calculated from the segmented region. The diameter derived is utilized to calculate the varied LV parameters. In every heart beat or cardiac cycle, the volumetrical part of blood pumped out of the left ventricle (LV) and the ejection fraction (EF) were calculated in view of which the cardiac abnormality is decided. The proposed methodology gave a quality of 93.3% and it will be used as an effective tool to segment left ventricle region and for classifying the heart as either normal or abnormal.

Köhler B, et.al., (2013), [3] examined in detail about the cardiovascular diseases (CVD) which is the leading cause of death worldwide. Their initiation and evolution depend strongly on the blood flow characteristics. In recent years, advances in 4D PC-MRI acquisition enable reliable and time-resolved 3D flow measuring, which allows a qualitative and quantitative analysis of the patient-specific hemodynamics. Now, medical researchers investigate the relation between expected flow patterns like vortices and completely different study of disease. The manual extraction and quality of something is tedious and needs knowledgeable data. Standardized, (semi-)automatic and reliable approach are necessary to form the analysis of 4D PC-MRI related for the clinical routine. An approach for the extraction of vortex flow within the arterial blood vessel and arterial blood vessel incorporating line predicates is given an intensive comparison of existent vortex extraction way is provided to see the most suitable vortex criterion for cardiac blood flow and apply our approach to ten datasets.

R. Chacko, et.al., (2014) [4] analyzed the sequential change in shapes of left ventricle (LV), which are the result of cellular interaction and their levels of organization complexity. The changes that are present in the term of shape descriptors are analyses from the normal and two patients with dilated left ventricular cardio-myopathy. These images are processed, frame by frame, by a semi-automatic algorithm. This is consisting of gray scale conversion, The LV contour extraction by application of media and SRAD filter and morphological operation. By filling the identification region with pixels and number of pixels along its contour the area and perimeter are calculated, respectively. From these the changes in LV volume and shapes index are calculated and based on these the stroke volume(SV) and ejection fraction (EF) are calculated. The changes in LV area, perimeter, volume and shapes index in cardiac patients are less than that of normal subject. The calculated SV and EF of normal subject are within the range as obtained by various imaging procedure.

A. Mohanapreethi1, et.al., (2014), [5] examine the Ultrasound images for disease identification. Speckle noise is associate inherent property of medical ultrasound imaging. Since speckle might hinder the detection of image details, it's usually regarded be noise and there is a strong need to remove speckle noise effectively permanently and quick interpretation. A Multiresolution analysis is that the vital tool in eliminating noise from images effectively. A multiresolution analysis is planned to distinguish noise and image data better than a single resolution level. The proposed algorithmic combines the features of filtering techniques in multiresolution framework to mix the advantage that everyone will contribute. This algorithmic keeps up a balance between speckle to the suppression and have preservation. The outcomes appeared to be promising and outperforms alternative despeckling approaches. Inspect the Ultrasound pictures for sickness identification. The Execution Performance are assessments area unit performed by using statistical parameters.

PROPOSED METHODOLOGY:

In the proposed system, echocardiogram video is processed into frames and each frame is analyzed separately. The echocardiogram images often suffer with speckle noise. Various filters are used for preprocessing out of which Median filter shows good performance. The Preprocessed images are segmented by FCM clustering where the Left Ventricle is efficiently segmented for Normal, Dilated Cardiomyopathy (DCM) and Hypertrophic Cardiomyopathy (HCM) disease. Features like statistical feature, Gray Level Difference statistical features are extracted from images. The extracted features are analyzed and are classified using neural network for normal and abnormal images for diagnosing efficiently and automatically.

Preprocessing of the echocardiogram images

During the preprocessing technique, various filters were applied to the image in order to remove the speckle noise. Filters like Median, Adaptive weighted median filter, Fourier Ideal, Fourier Butterworth, Wavelet, and homomorphic filter are used for noise removal out of which median filter show the good performance based on the obtained PSNR and MSE values.

Left Ventricle Segmentation

Preprocessing of frames is followed by left ventricle segmentation. FCM clustering is used to partition N objects into C classes where, N is equal to the number of pixels in the image i.e.$N = X * Y$ and C = 3 for 3-class FCM clustering. The FCM algorithm uses iterative optimization of an objective function based on a weighted similarity measure between the pixels in the image and each of the C-cluster centers. Each repetition of the method is additionally knowing as associate "iteration", and also the results of one iteration are used because the place to begin for the consequent iteration. They are 32 iteration count for every object, if one iteration is complete, then iteration of next object is started. These processes square measure recurrent for n- number of objects. The fuzzy *c*-means algorithm is fundamentally same as the *K*-means algorithm. to start with the numbers of clusters and assign a random coefficient for being in the clusters. They follow the method till the algorithmic lead has joined and process the focal point of mass for each group. For every purpose, reason its coefficients for being within the clusters

$$c_{k=\sum_x w_k(x)^m x} / \sum_x w_k(x)^m$$

After performing FCM clustering, every pixel is assigned to the cluster with maximum membership values. Based on the intensity distribution obtained from histogram analysis, the threshold value is computed by using the cluster mean values. This choice helps in obtaining optimum threshold values for different images obtained under different conditions. The central connected component that corresponds to the LV is segmented and area of LV is calculated for each individual frame.

Feature Extraction

After the segmentation of left ventricle region, the process moves towards the feature extraction. During the feature extraction process, various statistical features are extracted from the segmented image. Statistical features like Histogram, Entropy, Skewness, mean and kurtosis feature are extracted from the segmented image.

Disease Classification

The extracted features are fed to Neural network classifier to classify whether the heart is normal, DCM or HCM. The various schemes like Levenberg- Marquarat, Bayesian Regulation and Scaled Conjugate Gradient based neural network is performed for promising outcomes in disease analysis. Further these classifiers are utilized in this study to see how the extracted features are helpful in accurate classification of normal and abnormal hearts using supervised pattern classification.

EXPERIMENTAL ANALYSIS AND RESULTS:

Preprocessing of the Echocardiogram Images

During the Preprocessing technique, various filter like Median filter, Adaptive weighted median filter, Fourier Ideal, Fourier Butterworth, Wavelet homomorphic filter are used. These filter techniques were used for preprocessing, out of which median filter show the good performance. The preprocessing technique can be evaluated by performance metrics like Mean-Square Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). The main process of PSNR and MSE value is used to measure the improved quality of image, compared to original image. Preprocessing using various window size was performed PSNR and the results are shown in (Table 1). These PSNR and MSE are used to compare the squared error between the original image and the preprocessed image. If the PSNR value is high, then the image has good preprocessed quality. Whereas when the PSNR value is low it refers to degradation of the Preprocessed Image, normal, DCM, HCM images and the preprocessed images are shown in (Table 2).

Table 1: PSNR and MSE value of preprocessed image

HEART TYPES	FILTER	WINDOW	MSE	PSNR
Normal Heart image	Median filter	3×3	0.000645	80.03591
		5×5	0.003191	73.09145
		7×7	0.005279	70.90525
		9×9	0.0063	70.13193
DCM Heart Image		3×3	0.00129	77.02429
		5×5	0.004655	71.45144
		7×7	0.006996	69.68211
		9×9	0.007943	69.131
HCM Heart image		3×3	0.001248	77.16855
		5×5	0.00469	71.4191
		7×7	0.007051	69.64806
		9×9	0.008103	69.04433

Left Ventricle Segmentation

Preprocessing of frames is followed by segmentation of left ventricle using FCM clustering. The FCM algorithm chosen's FCM threshold based on the intensity distribution of the image. The intensity distribution is computed using the histogram distribution. The segmented normal, DCM and HCM regions are shown in (Table 2).

Feature Extraction

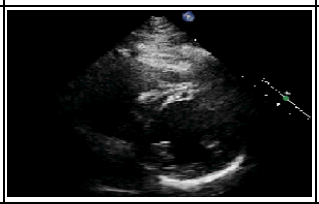
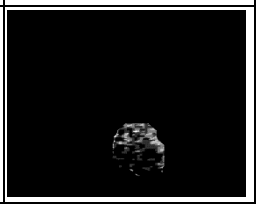
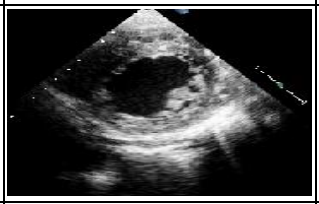
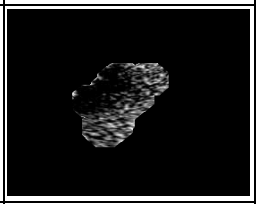
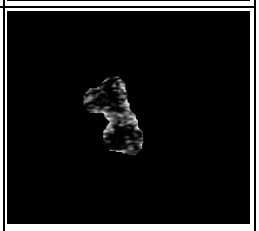
Segmentation of left ventricle region is followed by feature extraction, from which statistical features are extracted. Statistical features such as histogram, entropy, skewness,

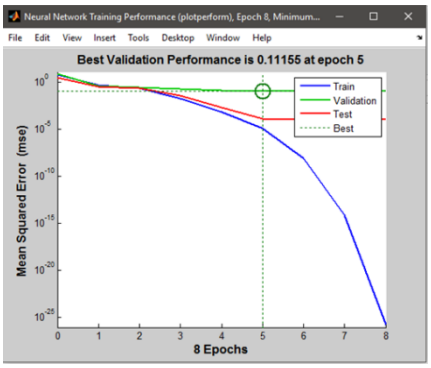
kurtosis, mean is extracted from the segmented region. The total number of feature used for further processing is 1×37 values.

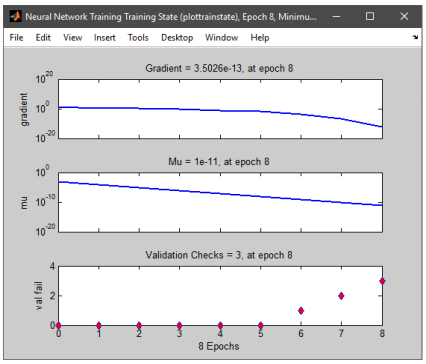
Disease Classification

During the classification of disease various schemes like Levenberg- Marquarat, Bayesian Regulation and scaled conjugate Gradient of neural network classifier are chosen out of which Levenberg- Marquarat shows the good performance. The performance is evaluated by Hidden Neuron values taken as 5, 10, and 15. The classification analysis of neural network is shown in (Table 3)**.** The Performance, Training State, Error Histogram and Regression of Levenberg-Marquarat and Bayesian Regulation are shown in the (Fig 1) and (Fig 2). Levenberg- Marquarat with the Hidden Neuron value 10 gives the best result with performance=**6.07**, Regression=**0.98889**

Table 2: original, preprocessed and segmented region

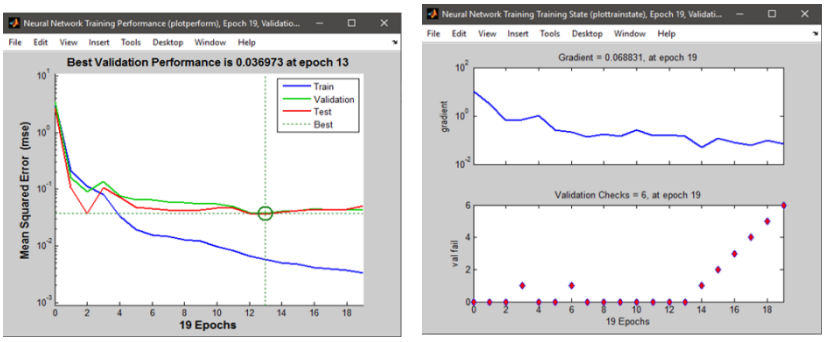
Echo Cardiogram Images	Original Image	Preprocessed Image	Segmented Region
Normal Heart			
DCM Heart			
HCM Heart			





(a) (b)

Figure 1: (a), (b) performance and training state for Levenberg-Marquarat



(a) (b)

Figure 1: (a), (b) performance and training state for Bayesian Regulation

Table 3: classification and analysis of neural network

Algorithm	Levenberg- Marquarat			Bayesian Regulation			Scaled Conjugate Gradient		
Number of Hidden Neurons	5	10	15	5	10	15	5	10	15
Performance	1.07	6.07	2.29	1.39	2.13	3.73	3.08	0.389	3.30
Training State	6	3	0	6	0	0	6	6	6
Error Histogram	80.82	0.002	0.08	80.82	0.008	0.07.	0.015	0.002	0.002
Regression	3.3	0.988	0.02	3.3	0.974	0.94	0.996	0.972	0.991

CONCLUSION

This paper proposed an automatic technique to detect and diagnose the Dilated Cardiomyopathy and Hypertrophic Cardiomyopathy using Neural Network. Various filters are used for preprocessing where median filter out performs in removing speckles noise. Measurement metrics like PSNR and MSE is computed using which median filter is chosen for further processing. The preprocessed image is segmented by FCM clustering where the Left Ventricle region is efficient by segmented. During feature extraction, various statistical features like histogram, entropy, skewness, mean and kurtosis extracted from the regions. The classification is done using back prorogation neural network with Levenberg-Marquarat classifier with the hidden neuron value 10 given the best result with performance =6.07, regression=0.98889 in classifying the normal, hearts affected by DCM and heart affected by HCM. Hence the proposed system can be used as an effective tool for detecting and diagnosing heart affected with Dilated Cardiomyopathy and Hypertrophic Cardiomyopathy. In future, content-based video retrieval systems can be added to the system and larger dataset can be used to improve the efficiency of the system.

REFERENCES

[1] Z.R. Hussein, R.W. Rahmat, L.N. Abdullah, M.I. Saripan, D.M. Zamrin, (2010). "Quantitative Detection of Left Ventricular Wall Motion Abnormality by Two Dimensional Echocardiography", Comput. Inf. Sci. 3 (2)

[2] G.N. Balaji, T.S. Subashini, 2013, "Detection of Cardiac Abnormality from Measures Calculated from Segmented Left Ventricle In Ultrasound Videos, In: Mining Intelligence And Knowledge Exploration", Springer International Publishing, Pp. 251–259

[3] Köhler B, Gasteiger R, Preim U, Theisel H, Gutberlet M, Preim B. 2013 "Semi-Automatic Vortex Extraction in 4D PC-MRI Cardiac Blood Flow Data Using Line Predicates", IEEE Trans Vis Comput Graph.

[4] R. Chacko, M. Singh, (2014) "Sequential Functional Analysis of Left Ventricle from 2d-Echocardiography Images", Indian J. Exp. Biol. 52 (6) 630–636.

[5] A. Mohanapreethi1, Dr. V. Srinivasa Raghavan, 2014 "Multiresolution Based Hybrid Filtering Technique for Despeckling Ultrasound Images", Iosr Journal of Vlsi and Signal Processing (Iosr-Jvsp) Volume 4, Issue 3, Ver. I., Pp 07-15.

[6] Mahesh Kini, Rajesh Pandey, Arnab Das, SK Malani, 2014 "Comprehensive Image Processing For Automated Detection Of Hypertrophic Cardiomyopathy", Mahesh Kini, Et Al International Journal Of Computer And Electronics Research [Volume 3, Issue 2].

[7] S. Sudha, G.R. Suresh, R. Sukanesh, 2009,Speckle Noise Reduction In Ultrasound Images By Wavelet Thresholding Based On Weighted Variance, Int. J. Comput. Theory Eng. 1 (1) 1793–8201.