Effective Method for Enhancement and Analysis of Doppler Echocardiography Images for Medical Diagnostic

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Abstract:
Echocardiography has become one of the most commonly used cardiac diagnostic techniques, applicable to the assessment of a wide variety of disorders of the heart. In recent years, digital techniques (both computer and electronics) have been increasingly applied to echocardiography. The utilization of digital technology has been fruitfully applied to all aspects of two-dimensional (2D) echocardiography, including image acquisition, preprocessing analysis to help for the medical diagnosis. Echocardiography images are noisy and having low contrast. These Echocardiography images are preprocessed to get clearer images. The Transthoracic Echocardiography images are processed for diagnosis of valvarual heart and diseases quantification of LV volume.

Keywords: Echocardiography, Transthoracic Echocardiography, Mitral valve Regurgitation, Aortic valve Regurgitation, Mitral Stenosis, Left Ventricle

I. INTRODUCTION

Image processing is one of the rapidly developing domains of computer science. In several domains of science and engineering, processing color and gray scale images has become a motivation tool for research and investigation. Extracting precious information from images is the fundamental task of digital image processing. Computers are playing very important role to accomplish this with negligible time and no human involvement. Advanced medical systems are available to investigate the internal structure of the body. Realistic two-dimensional images are produced in computer-generated planes by the most comprehensively used 2D Ultrasonography. Turbulent flow because of narrowing or blockage of blood vessels can be detected by Doppler Ultrasonography as it shows the direction and velocity of blood flow. Color Doppler Ultrasonography shows different rates of blood flow in different colors. Echocardiography used in the diagnosis of cardiovascular system using pulsed or CW Doppler ultrasound estimates the blood velocity and cardiac tissue. The size, shape, and movement of the heart's valves and chambers and also the flow of blood through the heart can be shown by the ultrasound waves. This allows the estimation of cardiac valve areas and functions, any abnormal interactions between the right and left side of the heart, any leaking of blood through the valves (Valvular Regurgitation), and calculation of the cardiac yield. Measurements concerned to Flow of blood can be improved by using them with ultrasound Doppler. Abnormalities in heart wall motion can be detected. The quantity of blood pumped from the heart with each beat is measured using Echocardiography. The functioning status of Heart is examined by using two types of tests i.e TTE & TEE. In Transthoracic Echocardiography (TTE) test image is taken through the chest wall by placing the transducer or probe on the chest wall (thorax) of the patient. Then the transducer can be moved to different parts of the chest to obtain heart views. TTE is non-aggressive, highly precise technique used for evaluating the overall health of the heart. In Tran’s esophageal Echocardiography (TEE) test, the probe is passed down the esophagus. This probe is placed near the heart and the lungs also, bones of the chest wall which do not block the sound waves produced with probe. TEE has many advantages over Tran thoracic Echocardiogram. The images acquired by TEE are better in clarity as compared to TTE. Doppler Echocardiography explores flowing of the blood through vessels, heart valves and chambers. The movement of the blood reflects sound waves to a transducer. Then the ultrasound computer measures the direction and speed of the blood flowing through the heart and blood vessels. Doppler measurements may be displayed in black and white or in color. An Echocardiography image of a normal heart is shown in fig. 1.

II. LITERATURE REVIEW

Echocardiography has emerged as the primary tool for investigation of the cardiovascular system. The heart vital organ and it is in motion, and echocardiography must additionally capture that movement. An understanding of echocardiography requires the knowledge of both cardiac physiology and anatomy. The acquired image is noisy and with low contrast. Different techniques are applied to enhance the image resolution and to improve the contrast. The medical images are enhanced in order to get better understanding of the abnormalities. [1], the enhancement of images is done by adaptive histogram equalization technique. [2,3]. Echocardiography evaluates cardiac chamber size, wall thickness, wall motion, arioventricular and semilunar valve anatomy, valve motion, the proximal great vessels and the pericardium.

Figure 1: Echocardiogram Image of Normal Heart
Doppler Echocardiography is a technique used for identifying the direction and velocity of flowing blood in chambers of the heart. It identifies the regurgitation, stenosis and other abnormal flows. Doppler test gives quantitative data which helps in the decision-making process concerned to the patient with heart disease. It also provides evaluation of normal and abnormal flow conditions. A special microphone has been utilized by Doppler Echocardiography to allow technician for analyzing the speed and direction of blood flow in the vessels. Thus it enables to know the direction and evaluation of regurgitation. The Doppler Echocardiography has become the most consistent, noninvasive, sensitive and specific technique for diagnosing Valvular Regurgitation [9]. The structural cardiac abnormalities in the valves, congenital defects, enlargement of heart chambers and walls found in patients with high B.P. can be detected. In addition, 3D echocardiography has provided important insights into functional and ischemic mitral regurgitation resulting from derangements of the ordinary spatial associations of the mitral valve leaflets to its chordal attachments, papillary muscles, and the left ventricle. The 3D echocardiography technique has identified changes in annular shape occurring with functional mitral regurgitation. These mechanic and anatomic insights based on 3D analysis have provided the basis for the development of new approaches to treating ischemic mitral regurgitation. Three-dimensional echocardiography has been used to define and localize mitral leaflet lesions in mitral valve prolapse, and congenital mitral abnormalities. [4] This approach has also demonstrates the calculation of mitral valve area in mitral stenosis. Calculation of mitral valve area by 3D echocardiography has been demonstrated to be accurate, reproducible, and less variable than conventional 2D methods. [6] Three-dimensional echocardiography has been applied for anatomic assessment of the aortic stenosis. The technique has been used to delineate aortic flow patterns and has demonstrated feasibility and accuracy in quantifying aortic regurgitation. [10]. In Aortic Regurgitation, backflow of blood from the aorta into the left ventricle, it may due to inadequacy of the aortic semilunar valve. Aortic Regurgitation can be found by using the parasternal long axis and apical long axis view. If red, yellow or mosaic signals are coming out from aortic valve and spreading in to the left ventricle during diastole, and then the presence of Aortic Regurgitation is suspected. Mitral Regurgitation is due to the mitral valve prolapsed, rheumatic heart disease, or a problem of cardiac dilatation. Mitral Regurgitation is analyzed from the apical, parasternal long axis, apical long axis and subcostal views. If blue, green and mosaic signals are observed coming out from mitral valve and spreading into right atrium during the systole, then the presence of MR is suspected. A lot of research has been performed in this field of color Doppler Echocardiography images based Mitral Regurgitation and Aortic Regurgitation quantification. But lack of effective research methodologies still there is scope to development better algorithms to do the analysis and efficient quantification of Mitral and Aortic Regurgitation. Mitral stenosis, Left ventricle volume with the help of image processing techniques.

III. METHODOLOGY

- Preprocessing: Acquired Echocardiography image is noisy and have low contrast. The image processing techniques are applied to filter the noise component and enhance the contrast of the image in order to get clearer and superior quality image.

- Image segmentation: Segmentation of
- Echocardiography image is performed by using Fuzzy K means clustering
- Quantification: To develop algorithms for improving the quantification of Mitral and Aortic regurgitation. To development of effective algorithm for quantification of LV volume.
- Classification and Detection: After extracting the features, data classification algorithm will be developed and detection of MR, AR, MS will be performed. The flow chart of the proposed methodology for investigation of MR and AR regurgitation is shown fig. 6.

**Figure 6. Flow chart to investigate MR and AR regurgitation**

**Aortic Regurgitation :**

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Input TTE AR Image

Image Pre Processing (filtering, Contrast, Enhancement)

Quantification using PISA method

Fracture Extraction

Classification & Detection

Severe AR, Moderate AR, Mild AR
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**Mitral Regurgitation:**

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Input TTE AR Image

Image Preprocessing (filtering, Contrast, Enhancement)

RGB to YCbCr

K-means Clustering

Quantification using PISA method

Fracture Extraction comparison & Detection

Severe AR, Moderate AR, Mild AR
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IV. RESULTS

The different preprocessing techniques are applied to the acquired transthoracic echocardiography images which results in clear and improved brightness images. The results are shown in fig. 3. & 4.

The data used for the present study are transthoracic echocardiography images of a patient.

V. CONCLUSION

The developed algorithms are effectively applied to all aspects of two-dimensional (2D) echocardiography images. The acquired echocardiography images which are noisy and low contrast are processed to get better quality images i.e. clear images with improved contrast. The enhanced echocardiography images help in better understanding of the abnormalities in cardiovascular structure of heart.

VI. REFERENCES


