Detection of Cardiac Geometry via Difference Intensity of Echocardiogram Images

Mohd Azrul Hisham Mohd Adib[1,*], Mohd Fadhlan Yusof[2], Zulkifli Ahmad[1], Nur Hazreen Mohd Hasni[3]

[1]Sport & Human Engineering Group (SHEG), Faculty of Mechanical Engineering, Universiti Malaysia Pahang, Pahang, Malaysia

[2]Advanced Structural Integrity and Vibration Research (ASIVR), Faculty of Mechanical Engineering, Universiti Malaysia Pahang, Pahang, Malaysia

[3]Department of Surgery, Hospital Tengku Ampuan Afzan (HTAA), Kuantan, Pahang Malaysia

Summary

Echocardiogram is an ultrasound image of the heart that demonstrates the size, motion and composition of cardiac structures and is also used to diagnose various abnormalities of the heart including abnormal chamber size, shape and congenital heart disease. Echocardiography provides important morphological and functional details of the heart. Most of the presented automatic cardiac disease recognition systems that use echocardiograms based on defective anatomical region detection. In this paper we present a simple technique for cardiac geometry detection via echocardiogram images which conquer these borders and exploits cues from cardiac structure. To demonstrate the effectiveness of this technique, we present results for cardiac geometry detection through difference intensity of echocardiogram images. We have developed a simple program code for the prediction of cardiac geometry using difference intensity of echocardiogram images. With this code, users can generate node or point for detection of cardiac geometry as ventricle and atrium in size, shape and location.

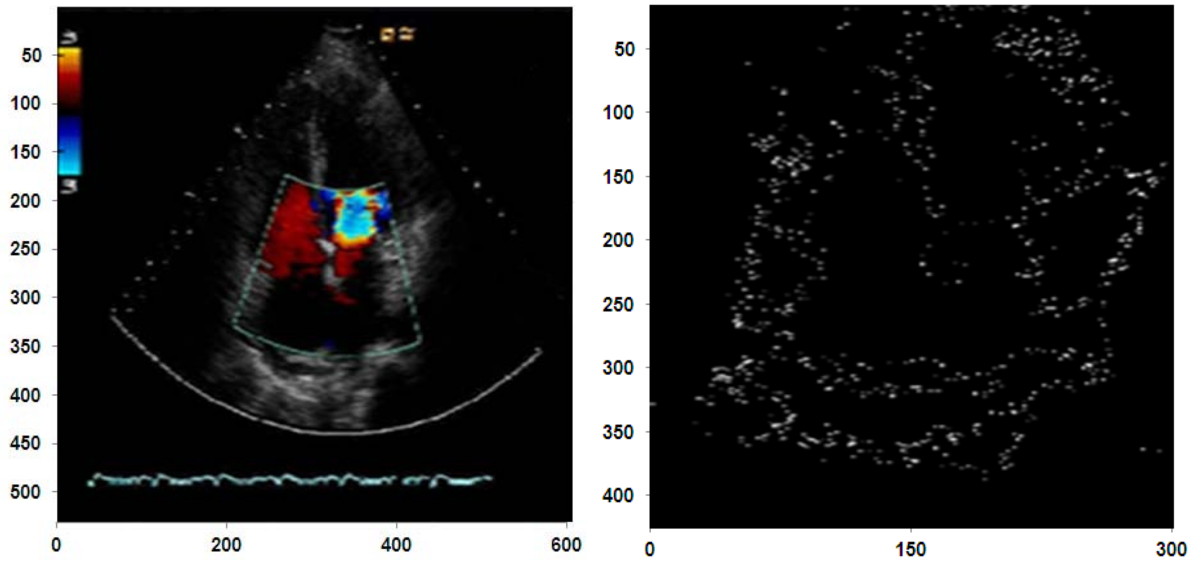
1 Introduction

The advantages of low cost and no radiation present by echocardiography images are one of the most convenient diagnostic tools for heart diseases. It can provide a wealth of helpful geometry information including the size and shape of the heart, its pumping capacity and the location and extent of any damage to its tissues. It is especially useful for assessing diseases of the heart valves. However, the current clinical practice requires manual intervention in both imaging and in interpretation. Among the various echocardiographs, the images collected using a transthoracic transducer is important in analyzing the heart valve diseases [1]. From echocardiogram we observed images for the patient who suffered from respiratory problems directly and more easily. The images produced are in video form. So it can be seen with more advanced on the movement of the heart valves and the doctors easy to identify the cardiac disease from their patients [**2**]. Tracking changes in cardiac shape that appear in medical images is critical for the analysis of the pathology of neurologic diseases. Conventional MRI has become the preferred imaging method for the diagnosis of autoimmune diseases. Several cardiac imaging tools exist which allocate the visualization of multiple 2D images and reconstructed surface models concurrently, volume render the resulting 3D images [3].

[*] To whom correspondence should be addressed. Email: azrul@ump.edu.my

doi:10.2390/biecoll-jib-2012-195

However, none of these tools makes necessities for visually exploring changes of the cardiac disease geometry. In order to provide researchers with a competent visualization tool for the observation of changing cardiac disease geometry, we have developed a program code tool to visualize local and global changes recorded in image loads of cardiac geometry, enabling the simultaneous display of 2D and 3D spaces. Figure 1 shows comparison echo image in original and after translate through program code. Our program code has been designed to be an integrative visualization image based on difference intensity of echocardiogram images.



(a) (b)

Figure 1: (a). Original image from echocardigraphy ; (b). Image after zoom in and translate through program code based on basic echocardiogram images.

2 Methodology

Based on statistics, around 63% methods for cardiac geometry detection are using echocardiogram images. Since most of such methods including ours require an estimation of cardiac motion, we begin with a statistics of cardiac motion estimation methods. The estimation of cardiac motion and deformation from echocardiograms has been a difficult problem due to the natural characteristics of echo video. Obtainable methods can be generally classified into two categories: intensity-based methods and feature-based methods. The intensity-based methods include optical flow [4], demons' algorithm [5] and spline-based [6] approaches. The estimates resulting from these approaches are often not dependable with the actual observed motion in the echo videos for cardiac geometry due to the low quality of the echo videos and non-smooth heart motion. Due to feature-based methods, where they first segment the myocardial regions [7] and the motion is then recovered by aligning the segmented shapes. This method has the advantage of accounting for the strand directions in the left ventricle when estimating the cardiac motion. As compared to the previous work, we would demonstrate that our method achieves higher cardiac geometry detection as well as is more extendible. But more generally, our paper makes an important contribution in its geometry and intensity for the task of cardiac detection and for detail process flow from program code shows in figure 2. In this work, each image from the echocardiogram is represented by a set of novel salient features. These features are located at scale invariant points in the edge filtered magnitude images and are encoded using local images information. Our system in dissimilarity, tackles completely different intensity of echocardiogram images. For the echo view detection problem, it is quite possible for a trained eye to differentiate among views based just on individual intensity images. We can improve the results by lower and higher intensity of echocardiogram image sectors as a preprocessing step in coding shows in figure 6. We achieve this using a two step process, where we first extract the image and set the coordinate of overall image. The coordinate were obtained based on the pixel in the image. In this study, the number of pixel of image obtained from the echocardiography was M x N. Therefore, the maximum coordinate value in x-axis and y-axis should be M and N respectively which contains the actual region of interest either manually or images split to RGB component and then zoom in the images. Find coordinate which had shown the border of heart image using difference intensity value. We know that the shape in magnitude image is meaningful only when it corresponds to some essential anatomical structure and we can obtain its good estimate using an edge map of the difference intensity image. To get the best of cardiac geometry images, we ranging from 1 to 5 for obtaining sharp feature. These steps were implemented in order to eliminate the image noises which were affected by the range of intensity. It was done by equally segmenting the intensity range between the low intensity value and high intensity value which had been set in the previous step into a 5 segment. The first segments correspond to the less intensity value and 5^{th} segment correspond to the highest intensity value. Then, the sharper images were obtained by considering only the 5^{th} segment for coordinate plot. These features have also been previously used for solving the echocardiogram view detection problem. In order to avoid spurious features due to simulated edges, we first detect the scale invariant features on images and then retain only those which lie within certain distance of some intensity and the output is new images by node or point.

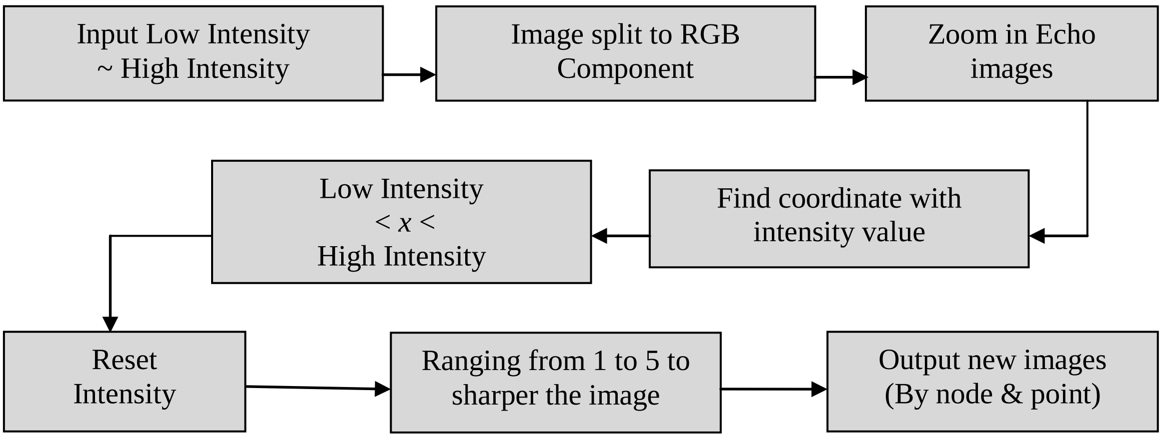


Figure 2: Process flow from program code of cardiac geometry detection using difference echocardiogram images.

3 Result & Discussion

To demonstrate the effectiveness of this technique, we present results for cardiac geometry detection from difference intensity of echocardiogram images. We have developed a simple program code for the prediction of sequential changes of cardiac image using difference intensity of echocardiogram images. With this code, users can generate nodes or points for detection of cardiac geometry as ventricle and atrium in size, shape and location. Major effectiveness of the technique presented here is that it is not reliant on the position from which images is obtained as long as all the images is consistently obtained in the same position. This advantage does not carry over to techniques based on anatomical structures, since some anatomical structures are not visible from all the position. In fact, during a given patient treatment, image is generally obtained through various position and our techniques provide the possibility of concurrently using the information in more than one position to obtain better results. This is also something we would like to investigate in future. Our technique also sidesteps the problems of main frame selection for cardiac geometry analysis [8].

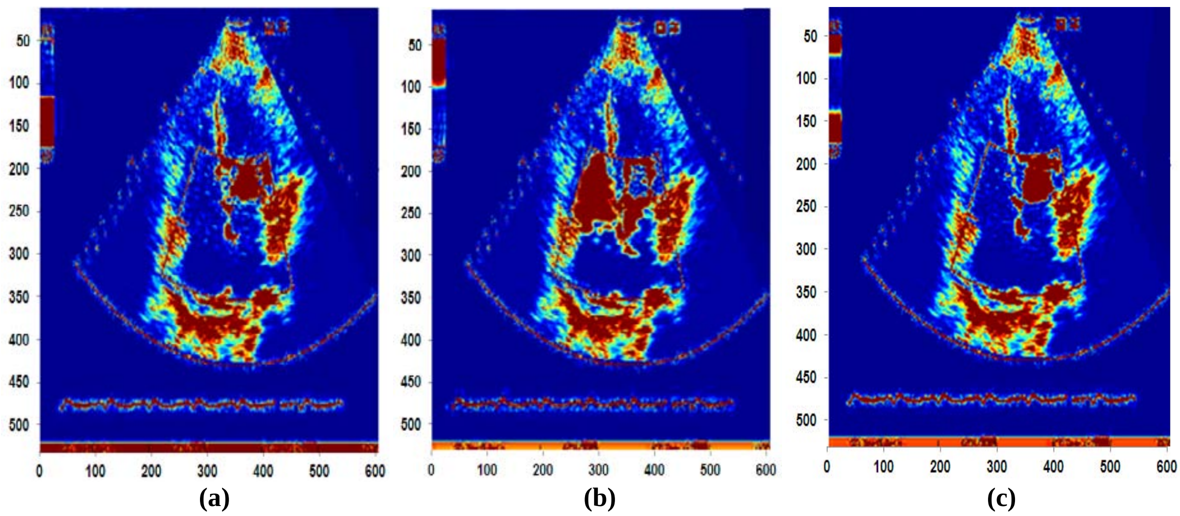


Figure 3: Three basic difference intensity color that was apply in detection of echocardiogram images. (a) Blue ; (b) Red ; (c) Green.

Beside with the effectiveness of our techniques mentioned above, it also has some limitations that we would like to concentrate in our future work. The quality of the selected feature is critically dependent on the quality of the estimated capture images. Since echo video is known to be difficult videos for motion estimation, this dependence could be a possible limitation of our technique. We would also like to appraise our technique on a larger images set without partiality in the number of the samples for any cardiac images.

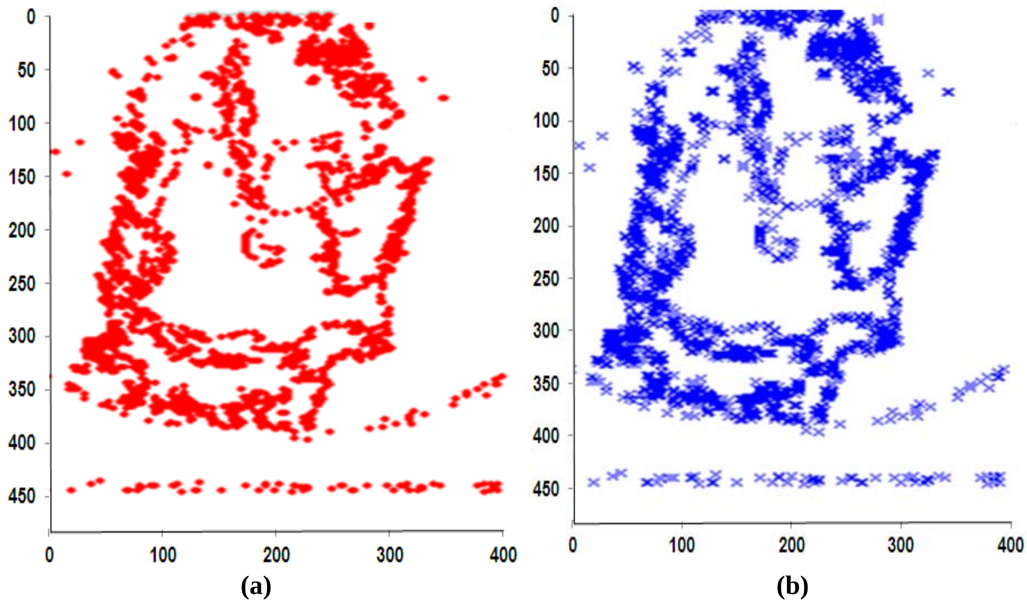


Figure 4: Detection of cardiac geometry based on difference intensity of echocardiogram images after shaper process by considering 5th segment only.

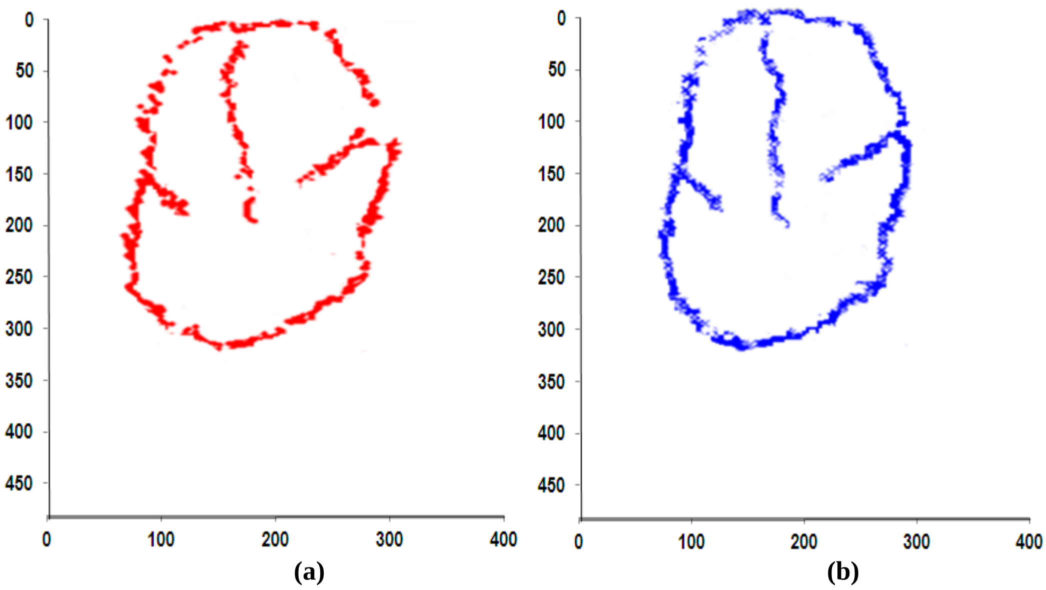


Figure 5: Feature points extrected from the left and right side of heart image after clearance process to find actual shape, size and location of cardiac geometry.

```
function[Coordinate,SharpenCoordinate,NewImData,SharpenNewImData]
    (ImData,LowerIntensity,HigherIntensity)
ImDataR=ImData(:,:,1);
ImDataG=ImData(:,:,2);
ZoomImDataB=ImDataB(79:488,160:550);
[row col]=find(LowerIntensity < ZoomImDataB & ZoomImDataB <HigherIntensity);
Coordinate=[col row];
NewImData=zeros(size(ZoomImDataB));
Step=Range/5;
for i=1:1:n;
    iter=iter+1;
    if ZoomImDataB(Coordinate(iter,2),Coordinate(iter,1))<LowerIntensity+Step;
        NewImData(Coordinate(iter,2),Coordinate(iter,1))=1;
    elseif ZoomImDataB(Coordinate(iter,2),Coordinate(iter,1))<LowerIntensity+2;
            NewImData(Coordinate(iter,2),Coordinate(iter,1))=2;
    elseif ZoomImDataB(Coordinate(iter,2),Coordinate(iter,1))
                    +3*Step;
            NewImData(Coordinate(iter,2),Coordinate(iter,1))=3;
    elseif ZoomImDataB(Coordinate(iter,2),Coordinate(iter,1))<...
                        LowerIntensity+4*Step;
            NewImData(Coordinate(iter,2),Coordinate(iter,1))=4;
        end
NewImData=NewImData;
SharpenNewImData=zeros(size(ZoomImDataB));
j=size(SharpenCoordinate,1);
for i=1:1:j;
    it=it+1;
    SharpenNewImData(SharpenCoordinate(it,2),SharpenCoordinate(it,1))=5;
end
figure;
subplot(1,2,1);
subplot(1,2,2);
colormap(gray(5));
image(SharpenNewImData);
colormap(gray(2));
```

Figure 6: Sample text file that is created to detect the point of cardiac geometry as ventricle and atrium in size, shape and location.

4 Conclusion

In conclusion, we have demonstrated the usefulness of feature based methods for cardiac geometry detection using echocardiogram images to support for cardiac disease diagnosis. Moreover, it is more significant if the image magnification ratio from the echocardiography studied in order to obtain the exact size of each pixel in unit of length and automatically get the actual size of the heart, vane size and backflow. These findings are helpful to medical practitioners in making better decisions on the treatments for their patients as they have additional diagnosis on the heart problem based on biomedical engineering study.

Acknowledgements

The support of the Universiti Malaysia Pahang (UMP), under grant RDU110331 and under Sport & Human Engineering Group (SHEG) is gratefully acknowledged. The authors of this paper also would like to express their gratitude to Hospital Tengku Ampuan Afzan (HTAA) also to Advanced Structural Integrity and Vibration Research (ASIVR) for supporting these research activities.

References

[1] Y.-T. Ching, S.-J. Chen, C.-L. Chang, C.-Y. Lin and Y.-H. Liu. Finding the Mitral Annular Lines From 2-D+1-D Precordial Echocardiogram Using Graph Search Technique. *IEEE Transactions on Information Technology in Biomedicine*, 8(1):1–4, 2004.

[2] M. A. H. M. Adib, N. H. M. Hasni and P. O. A. Razak. Analysis of Echocardiography Images Using Grid Independent Technique for Patients with Mitral Valve Problems. *In* International Conference on Information Science and Applications (ICISA), pages 1–5, 2011.

[3] A. A. Efros, A. C. Berg, G. Mori and J. Malik. Recognizing action at a distance. *In* Ninth IEEE International Conference on Computer Vision (ICCV), pages 726–733, 2003.

[4] S. Behbahani and K. Magholi. Evaluation optical- flow based methods for estimation of wallmotions. *In* Second International Multi-Symposiums on Computer and Computational Sciences, pages 164–169, 2007.

[5] T. Syeda-Mahmood, F. Wang, D. Beymer, M. London and R. Reddy. Characterizing spatio-temporal patterns for disease discrimination in cardiac echo videos. *In* Medical Image Computing and Computer-Assisted Interventation (MICCAI), LNCS 4791, pages 261–269, 2007.

[6] M.J. Ledesma-Carbayo, J. Kybic, M. Desco, A. Santos, M. Suhling, P. Hunziker and M. Unser. Spatio-Temporal Nonrigid Registration for Ultrasound Cardiac Motion Estimation. *IEEE Transactions on Medical Imaging*, 24(9):1113–1126, 2005.

[7] G. Jacob, J. A. Noble, C. Behrenbruch, A. D. Kelion and A. P. Banning. A shape-space based approach to tracking myocardial borders and quantifying regional left-ventricular function applied in echocardiography. *IEEE Transactions on Medical Imaging*, 21(3):226–238, 2002.

[8] S. Ebadollahi, S.-F. Chang and H. Wu. Modeling the activity pattern of the constellation of cardiac chambers in echocardiogram videos. *In* Computer Vision Approaches to Medical Image Analysis (CVAMIA), LNCS 4241, pages 202–213, 2006