Multi-view of 3D Echocardiography fusion using filtering techniques to reduce speckle noise

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Abstract: Three-dimensional ultrasound is an emerging technology in assessment to the complex cardiac anatomy and function. It promises 3-D image acquisition with the potential of more objective and complete functional analysis. In 3D echocardiography the anatomic information is missing and has limited field of view, the approach of this paper is to present multi-view fusion of 3D echocardiography where multiple images are achieve from different probe positions with an reduction of speckle noise using filtering techniques in order to improve the field of view. The multiple images are aligned and fused together for preserving a structure in a single multi-view fused image by improving field of view, this paper demonstrate the electromagnetic tracking system with an integration of sensors to the transducer which can be use for the fusion of multiple echocardiography images with an reduction of speckle noise by using filtering techniques.

IndexTerms- Echocardiography, speckle noise

INTRODUCTION:

This project proposes unusual method to combine multiple views into a single image using an electromagnetic tracking system in order to improve the field-of-view, the 3d echocardiography permits the accession and visualization of heart beat in 3D . The images are captured by positioning the ultrasound probe at the thorax and finding the parasternal view yet due to the large size of the ultrasound probe its difficult to find the suitable acoustic window through which the complete heart or left ventricle chamber can be image but by using this multiview technique we can fill in missing information I,e; the anatomy of heart and by extending the field of view it improvises the image quality and also by providing filtering technique speckle noise can be reduced. Multiview fusion has been proved to improve image quality and analysis over single view. Previously the multiview fusion acquired by using an optical tracking system which also improves the image quality, contrast, signal-to-noise ratio and anatomical information but the optical tracking is restrain by line of sight which intercept the sonographer to move the transducer freely during the scanning and it also requires bulky equipment. This project presents an electromagnetic tracking system as a substitute to the optical tracking system. It does not require the initial calibration like previous tracking system. This system utilizes three electromagnetic sensors to track the transducer and by using the laser scanner to find the accurate geometric configurations which doesn't requires initial calibration as it allows for direct computation. The electromagnetic sensors can be integrated with the ultrasound transducer. Though the sensors needs wired connection to the transducer along with the ultrasound machine but it does not prevent the movement of sonographer. By using this standardize method the image quality is obvious still the presence of noise can be detected, in order to minimize the presence of signal dependent noise the filtering technique is used. Ultrasound is mainly based on measuring the echoes transmitted back from from a medium when sending an ultrasound wave to it. The wave gets interact with tissue and some of the transmitted energy comes back to the transducer to be detected by the instrument. Because of the speckle noise the imaging resolution and contrast become reduced. In return it effects the value of the imaging modality in order to get rid of these the pre processing step is necessary. Therefore without effecting the important feature of the image it should be despeckled out. The common filters which are considered to filter out the speckle noise are Lee, Kuan and Wiener filters but these filters has some disadvantages as they are rely on local statistical data related to the filtered pixel. An alternative approach to these filters is to use wavelet transform. At the end of these project the images which acquired will have the improved field of view and aswell as the speckle noise is removed effectively.

ELECTROMAGNETIC TRACKING SYSTEM

To track the transducer position and orientation using electromagnetic tracker we attached three electromagnetic sensors to the transducer and tracked the position of the sensors during the echocardiography scan. This system is used to obtain the location of the sensors position. It is expected to provide the RMS accuracy of 1.4mm for position and 0.5 degree for orientation tracking we computed 4x4 geometric transformation matrix T marker,n based on the position of sensors captured from the system, for the nth scan Let S=(S1,S2,……Sn) be the set
of sensor point obtained using the laser scanner and Q=(q1,n,q2,n,……qn) be the
set of points obtain using the system at scan n, the computation of the transformation can be formulated as following
Tmarker,n = arg Σ =1(, −) ………(1)
The above problem can be solved using least square approximation

To obtain the geometric transformation matrix, Ttotal,n which transforms the ultrasound image acquired on nth scan to a common coordinate system is computed by

Ttotal,n=Tprobe Tsensor,n …………………..(2)

Proposed System

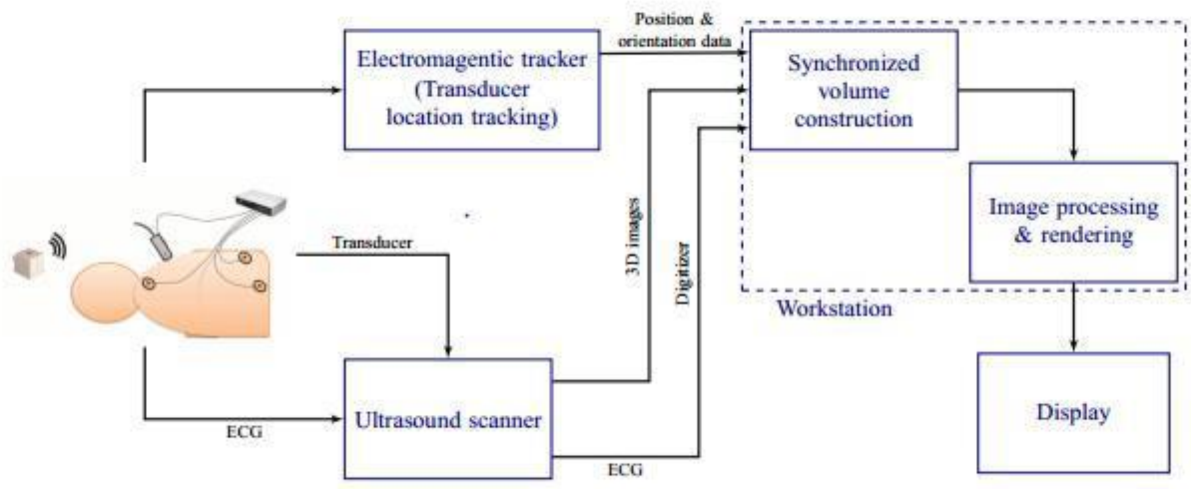

Fig 1.The proposed system show the tracking system for multi-view echocardiography

ASSESSMENT

The proposed algorithm was implemented using python programming language with numpy module and visualization toolkit. The fused output is generated using an graphics cards. The images are taken at three different orthogonal planes for single as well fused data set. The proposed method took 0.044±0.015 seconds to compute the transformation over an Intel Core.

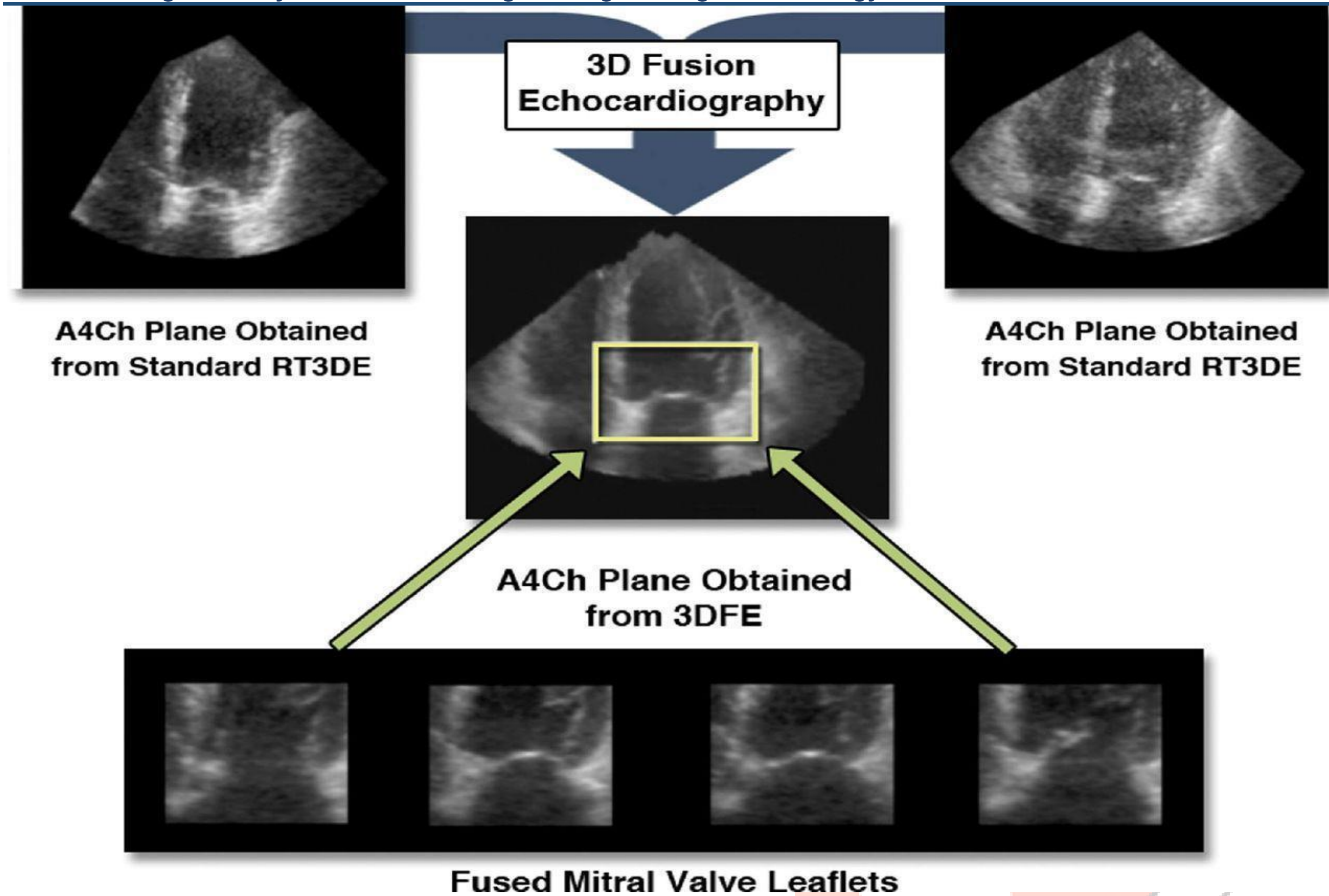

Fig 2. Illustrate the alignment of the image volumes and the field-of-view improvement by the proposed method diac ultrasound multiview fusion using a multicamera.

CONCLUSION

In this project we showed that the electromagnetic tracker systems can be used to align multiple 3D echocardiography in order to improve the field of view and also by using the filtering technique we improved the image quality. This inspection of the fusion results showed that this project is feasible in combining multiple echocardiography scans to reduce the measurement error by continuously tracking the sensor and applying recursive filtering and also initial calibration can be eliminated.

This method can also be used in ultrasound applications where signal-to-noise ratio is low as it does not rely in any image information for alignment, the time taken by this project is much smaller than the typical time required by an image registration based approach which often involves in computational expensive to find the solution.

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