



UNIVERSITI PUTRA MALAYSIA

**PRE-PROCESSING EDGE DETECTION IMAGE ENHANCEMENT
AND SPATIAL OBJECT VELOCITY ESTIMATION FOR
ECHOCARDIOGRAPH DIAGNOSTIC TEST**

ZINAH RAJAB HUSSEIN

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By

ZINAH RAJAB HUSSEIN

**Thesis Submitted to the School of Graduate Studies, University Putra
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October 2010



**Dedicated
To
My Family**



Abstract of the thesis presented to the Senate of the University Putra Malaysia
in fulfillment of the requirements for the degree of Master of Science

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Faculty: Computer Science and Information Technology

Echocardiograph imaging is a primary modality in the diagnosis of heart disease. Compared to other imaging techniques, such as X-Ray, MRI, and PET, echocardiograph imaging owes its great popularity to the fact that it is a safe and non-invasive procedure for visualizing the heart and vasculature. The echocardiograph image however is corrupted by speckle noise and low contrast, which make feature detection and tracking difficult.

This thesis focuses on two important issues for the clinical applications of medical echocardiograph images: speckle suppression and motion estimation.

The thesis first presents visualization enhancement method to clarify the heart structure and the movement of the valves. This method is designed to extract the contours of heart boundaries from a sequence of echocardiograph images, where it started with pre-processing to reduce noise and get better image quality. These pre-processing operations involved the use of median filtering, morphological opening and contrast adjustment. Thereafter, Sobel edge



detection was applied and the resulted image combined with image after opening stage. This method validated visually by medical students using real echocardiograph images. Performance improvement of this method evaluated as it provides very significant speckle suppression and edge enhancement for the purposes of visualization and automatic structure detection.

Second issue in this thesis is improving the detection of wall motion abnormality by quantitative analysis. The analysis of the left ventricular wall motion in routine is mostly based on visual interpretation of echocardiograph image. The interpretation of these images is widely dependent on operator training and is subject to large variability. To reduce this inter and intra-observers variability, the utilization of optical flow technique presented to estimate the left ventricular wall motion and create a cardiac motion profile based on the anatomical structure of the left ventricular wall in cross sectional view. This profile presenting the anatomical structure provides an additional means for functional imaging and eliminates the need to build a large dataset containing specific parameters of the patient to obtain an accurate diagnosis. In addition, the segmentation into three parts corresponding to the three major coronary arteries was meaningful for cardiac surgery. As a result, this method achieves an estimation of regional myocardial function with percentage of validations 71.4%, which is encouraging. In conclusion, estimation of regional myocardial deformation from intracardiac echocardiography by depending on anatomical knowledge is feasible. This work could be an important aid to improve and support diagnostic accuracy and the prognostic method for left ventricular diseases.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
Sebagai memenuhi keperluan untuk ijazah Master

**PRA-PEMROSESAN PENGESANAN TEBING PENINGKATAN IMEJ
DAN KECEPATAN OBJEK SPASIAL EKOARDIOGRAF ESTIMASI
UNTUK TEST DIAGNOSTIK**

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Pengimejan ekokardiograf merupakan modalitas utama dalam diagnosis penyakit jantung. Dibandingkan dengan teknik-teknik pengimejan yang lain, seperti sinar-X, MRI dan PET, populariti pengimejan ekokardiograf disebabkan fakta bahawa ia selamat dan merupakan prosedur non-invasif bagi visualisasi jantung dan pembuluh darah. Walau bagaimana pun, imej ekokardiograf dirusakkan dengan hingar spekel dan kontras yang rendah, yang mana akan menyukarkan pengesanan dan pelacakan.

Tesis ini focus kepada dua isu yang penting bagi aplikasi klinikal imej perubatan ekokardiograf: spekel penindasan dan estimasi gerakan. Pertama tesis akan persembahkan kaedah peningkatan visualisasi bagi memperjelas struktur jantung dan pergerakan injap. Kaedah ini direkabentuk bagi mengekstrak kontur-kontur batas jantung dari jujukan imej-imej ekokardiograf, yang mana ia bermula dengan pra-pemprosesan bagi pengurangan hingar dan

kuality imej yang lebih baik. Operasi pra-pemprosesan ini melibatkan penggunaan penapis median morfologi pembukaan dan penyesuaian kontras. Setelah itu, pengesanan tebing Sobel di laksanakan dan hasil imej digabungkan dengan imej selepas tahap pembukaan. Kaedah ini divalidasi secara penglihatan oleh pelajar perubatan menggunakan imej-imej sebenar ekokardiograf. Peningkatan prestasi bagi kaedah ini dinilai dari peningkatan penekanan spekel yang signifikan dan peningkatan tebing bagi tujuan visualisasi dan pengesanan struktur secara automatik.

Isu kedua dalam tesis ini adalah pengesanan kelainan bagi pergerakan dinding dengan menggunakan analisa kuantitatif. Analisa gerakan dinding ventrikel kiri secara rutin umumnya berdasarkan tafsiran visual bagi imej ekokardiograf. Penafsiran imej-imej ini sangat bergantung kepada latihan operator dan akur kepada variabilitas yang besar. Bagi mengurangkan variability pemerhatian inter dan intra, pemanfaatan teknik aliran optic menyajikan penganggaran gerakan dinding ventrikel kiri dan menghasilkan gerakan jantung berdasarkan struktur anatomi dinding ventrikel bagi pandangan potongan rentas. Profil ini menyajikan struktur anatomi yang menambahkan maksud tambahan bagi fungsi pengimejan dan menghilangkan keperluan bagi membangunkan set-set data yang besar yang mengandungi parameter spesifik pesakit bagi mendapatkan diagnosis yang tepat. Sebagai tambahan, segmentasi dibahagikan kepada tiga bahagian bersesuaian dengan tiga koroner arteri utama yang bererti untuk operasi jantung. Sebagai hasil, kaedah ini mencapai anggaran bagi fungsi kawasan miokardial dengan peratusan validasi sebanyak 71.4%, yang mana ia sangat memberangsangkan. Secara kesimpulan, penganggaran

bagi kawasan defomasi miokardial dari eokardiografi intrakardiak dengan menyandarkan pengetahuan anatomi dapat dilaksanakan. Kerja ini boleh menjadi bantuan penting bagi meningkatkan ketepatan diagnostikdan sokongan juga kaedah prognostik bagi penyakit ventrikel kiri.

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I certify that a thesis Examination Committee has met on **14 October 2010** to conduct the final examination of Zinah Rajab Hussein on her thesis entitled “Pre-processing Edge Detection Image Enhancement and Spatial Object Velocity Estimation for Echocardiograph Diagnostic Test” in accordance with the Universities and University College ACT1997 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not currently submitted for any other degree at University Putra Malaysia or other institutions.

Signed

ZINAH RAJAB HUSSEIN

Date: 14 October 2010

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