

CMP3060M | Assessment Item 2

Peter Hart | 12421031

## Acknowledgements

Supervisor

Tryphon for additional comments supplied during supervisor meetings

Image Processing Module Co-ordinators

Parallel Computing Module Co-ordinators

Bruce for Project Module Co-ordination]

School of Computer Science

Lab Security team

Contents

[Acknowledgements 2](#_Toc476931592)

[1. Introduction 4](#_Toc476931593)

[1.1 Background 4](#_Toc476931594)

[1.2 Aim and Objectives 4](#_Toc476931595)

[2. Literature Review 5](#_Toc476931596)

[3. Software Development Life Cycle 5](#_Toc476931597)

[3.1 Methodology 5](#_Toc476931598)

[3.2 Design, Development and Evaluation 5](#_Toc476931599)

[4. Evaluation 5](#_Toc476931600)

[5. Reflective Analysis 5](#_Toc476931601)

[6. Reference List 5](#_Toc476931602)

[7. Appendix 5](#_Toc476931603)

## Introduction

### 1.1 Background

The following report will be providing an in-depth discussion regarding the methodology and execution of the proposed project, while supplying an academically justified set of results.

Within the medical image processing study area, an issue of paramount importance is the necessity of fast and accurate analytical data which can be derived from various patient data, for the purposes of this project an example area of study selected was a simple velocity estimation calculation which estimated the velocity of the muscle movement of a patient’s heart between frames of a DICOM image. As such, the implications of this statistical analysis are the need for real-time image processing techniques, such that the velocity calculation can be calculated as accurately as possible without the burden of expenditure of time and memory lost to serial processing. Therefore, the basis of this study is to investigate the possibility of enforcing various parallel processing techniques and assessing their impact when performing a simple motion-estimation image processing technique on a DICOM image.

(Applicability. Previous work in this area.)

### 1.2 Aim and Objectives

Predominantly, the aim of this project was to investigate and produce a fast, real-time block-matching motion estimation algorithm that was capable of analysing ultrasound images for patients that suffer with cardiac-related illnesses. This algorithm will be quantifying the speckle-pattern data that represents any movement from the myocardium during the cardiac cycle, the data of which will be used to calculate the average velocity of the muscle movement and provide additional data that can be used to help to further diagnosis or prognosis of a patient in a time efficient manner. Explained below are the objectives, which upon completion, will help to accomplish this aim:

* A key aspect of being able to achieve this is by accurately and efficiently extracting the relevant image data from the ultrasound image, which will be supplied as a digital imaging and communications in medicine (DICOM) image. Therefore, the initial objective of this project will be to investigate all aspects of the DICOM image format and establish how it can be manipulated and used effectively for the proposed project.
* Part of the aim for the proposed project is to develop an algorithm that is capable of tracking and calculating the velocity of the muscle movement based on the data extracted from the ultrasound image. This will be done by dividing each frame of the DICOM image into a series of equally sized blocks and then utilising the block-matching motion estimation algorithm for the motion estimation algorithm so the system can track the total displacement of each speckle representing the myocardium between each frame of the DICOM image, which subsequently can then be used for assisting with the diagnosis and prognosis for patients with cardiac-related illnesses.
* Imperatively, the parallel algorithm needs to be compatible with any patients being diagnosed for a cardiac-related illness, the implication of this being that the proposed algorithm must be developed in such a way that a fast, accurate muscle movement velocity estimation calculation can be derived regardless of any differing qualities each patient’s heart may be perceived to have.
* Another objective of the proposed project will be to ensure that the speed of the data being processed will remain paramount, this will ensure that the data being provided to the doctors and surgeons will be. The system will currently only be able to run under a serial architecture without concern for the speed of the algorithms, so the system will need to be converted under parallel architecture where the calculations and processes for the algorithms can be completed concurrently.

However, it was made apparent later in the project lifecycle that the initially proposed objectives were somewhat lacking in regards to contributing to the overall completion of the project aim, as such further significant objectives were defined for the completion of the project and are proposed in the bullet points below.

* The DICOM images that are supplied for the algorithm may contain an element of noise throughout the distribution of speckles, thus this may provoke a distortion in both the motion detection with each kernel as well as the overall average velocity estimation calculation. Thus, a further objective of this project was to process each frame of a DICOM image such that the majority, if not all, of the noisy pixels distributed throughout the image are removed, this in turn would promote the overall efficacy of the results obtained by the algorithm by significantly improving the accuracy of the motion estimation algorithm.

## Literature Review

Static B-scan ultrasound images, such as the DICOM images involved for this study, can be utilised in such a way that the speckles tracked on a frame of an ultrasound image can be used to describe details and features of an object contained within the image, for example any speckle patterns that may be reflecting from the myocardium. As such, Mondillo et al (2011) suggests that the speckle patterns that are being reflected could be quantified for additional analysis when regarding the speckle pattern spatial dislocation between each frame of an ultrasound image, to the extent where the spatial dislocation can be used as a representative of an object’s movement between multiple frames of the image.

More about what Mondillo’s paper was comprising of and what purpose it fulfilled

Clinically, Mondillo et al (2011) argues that speckle-tracking echocardiographic techniques could allow in-depth analysis for systolic and diastolic dynamics for a variety of different cardiac illnesses, this research paper argues that speckle-tracking is predominantly accurate for the quantification of the longitudinal, circumferential and radial strain of the heart. Similarly, Notomi et al (2005) investigates the validity and effectiveness of utilising the speckle displacement in the ultrasound images to establish a rotational velocity from the left ventricular and the left ventricular torsion of a heart,

On the other hand, Notomi et al (2005) also proposes that the speckle tracking imaging technique for ultrasound image analysis can be argued to present the shortcoming of the speckle tracking imaging technique of being inherently dependent on the two-dimensional image quality, whereby a patient who may have abnormal decorrelation scores can lead to the speckle tracking data not accurately representing the muscle movement and consequently lead to less reliable results being produced with the speckle tracking imaging technique.

http://ieeexplore.ieee.org/abstract/document/4122549/

## Software Development Life Cycle

### 3.1 Methodology

### 3.2 Design, Development and Evaluation

## Evaluation

## Reflective Analysis

## Reference List

Rosenzweig, S., Palmeri, M., Nightingale, K. (2011) GPU-Based Real-Time Small Displacement Estimation with Ultrasound. *IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control*, 58(2) 399-405. Available from <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=5716457> [accessed 12 March 2017].

Massanes, F., Cadennes, M., Brankov, J.G. (2011) Compute-unified device architecture implementation of a block-matching algorithm for multiple graphical processing unit cards. *Journal of Electronic Imaging*, 1-10. Available from <http://europepmc.org/backend/ptpmcrender.fcgi?accid=PMC3280822&blobtype=pdf> [accessed 12 March 2017].

Pavlopoulos, H., Nihoyannopoulos, P. (2007) Strain and strain rate deformation parameters: from tissue Doppler to 2D speckle tracking. *The International Journal of Cardiovascular Imaging*, 24(5) 479-491. Available from: <http://link.springer.com/article/10.1007/s10554-007-9286-9> [accessed 12 March 2017].

Mondillo, S., Galderisi, M., Mele, D., Cameli, M., Lomoriello, V., Zacà, V., Ballo, P., D’Andrea, A., Muraru, D., Losi, M., Agricola, E., D’Errico, A., Buralli, S., Sciomer, S., Nistri, S., Badano, L. (2011) A New Technique for Assessing Myocardial Function. *Speckle Tracking and Myocardial Function*, 71-83. Available from <https://www.researchgate.net/profile/Matteo_Cameli/publication/49716863_Speckle-tracking_echocardiography_a_new_technique_for_assessing_myocardial_function/links/0912f50ef4196012fe000000.pdf> [accessed 12 March 2017].

Zhu, S., Ma, K. (2000) A New Diamond Search Algorithm for Fast Block-Matching Motion Estimation. *IEEE Transactions on Image Processing*, 9(2) 287-290. Available from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.330.3947&rep=rep1&type=pdf> [accessed 12 March 2017]

Notomi, Y., Lysyansky, P., Setser, R.M., Shiota, T., Popović, Z.B., Martin-Miklovic, M.G., Weaver, J.A., Oryszak, S.J., Greenberg, N.L., White, R.D., Thomas, J.D. (2005) Measurement of Ventricular Torsion by Two-Dimensional Ultrasound Speckle Tracking Imaging. *Journal of the American College of Cardiology*, 45(12) 2034-2042. Available from <http://ac.els-cdn.com/S0735109705007539/1-s2.0-S0735109705007539-main.pdf?_tid=4ad93930-074b-11e7-b14c-00000aacb361&acdnat=1489340741_449891e47abe7e3cf8f174a9ba8062ee> [accessed 12 March 2017].

## Appendix