



MINISTERI  
PENDIDIKAN  
MALAYSIA

**FINAL REPORT**  
**FUNDAMENTAL RESEARCH GRANT SCHEME (FRGS)**  
*Laporan Akhir Skim Geran Penyelidikan Fundamental (FRGS)*  
*Pindaan 1/2015*

**A RESEARCH TITLE: A Multi-Scale Approach for Estimating Gradient from Volumetric Data**

**PHASE & YEAR: 1/2013**

**START DATE : 01 May 2013**

**END DATE : 30 April 2015**

**EXTENSION PERIOD (DATE): RMC LEVEL: 30 October 2015**

**KPM LEVEL:**

**PROJECT LEADER : Bahari Belaton**

**I/C / PASSPORT NUMBER: 660823-08-6065**

**PROJECT MEMBERS: 1. Jamaludin Md. Ali (Retired end of 2015)**  
**(including GRA) 2.**

**PROJECT ACHIEVEMENT (*Prestasi Projek*)**

**B**

**ACHIEVEMENT PERCENTAGE**

<b>Project progress according to milestones achieved up to this period</b>	<b>0 - 50%</b>	<b>51 - 75%</b>	<b>76 - 100%</b>
<b>Percentage (please state #%)</b>		<b>55 - 65%</b>	

**RESEARCH OUTPUT**

<b>Number of articles/ manuscripts/ books</b> <i>(Please attach the First Page of Publication)</i>	<b>Indexed Journal</b>	<b>Non-Indexed Journal</b>
<b>Conference Proceeding</b> <i>(Please attach the First Page of Publication)</i>	<b>International</b>	<b>National</b>
<b>Intellectual Property</b> <i>(Please specify)</i>	2 Technical Reports	

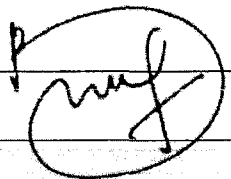
<b>E</b>	<b>PROBLEMS / CONSTRAINTS IF ANY</b> ( <i>Masalah/ Kekangan sekiranya ada</i> )
	<p>The main problem is no GRA (local) to work on the project since the beginning of the project (May 2013). We have advertised on MyGrant's system to recruit &amp; hire GRA post for the project. Through my co-supervisor, we have also broaden the recruitment advertisement to School of Mathematic, USM. While at the same time, in every new semester starting in September 2013 intake, I have personally invited new Master in CS students to be part of the project. Unfortunately, despite all these efforts we have not get GRA interested in the project. We have taken a "piecemeal" approach for over a period of time, to only partially address the project's objectives – refers to the past progress reports. We hired on honorarium monthly basis, existing PhD's students to work on the specific tasks of the project. The problem with this approach is no sustainability &amp; continuity of the research work – several of these PhD students have then left, and furthermore, they are not trained with the specific knowledge required in the project. They were mainly employed to implement &amp; deliver specific tasks that we've formulated and modelled as per module (or piece by piece) e.g. implementing specific task/module on Matlab/C for testing purposes. The transition period of hiring new student, once the last one left also quite substantial, often it takes months to get one good (and willing) candidate, case in point was the recent situation where we have not get any student assistant to work on the project from Feb 2015 till the end of the extended project's period – this explain why there was no real progress from Feb 2015 to Oct 2015.</p> <p>There are other related issues as well, for instance, we have failed to fully devise a comprehensive idea of the research problem in the midst and rush of preparing the proposal form. Upon further research in the specific area of spatial filter design, we have found extensive works in gradient filter design have be done, both in the area of spatial as well as in signal processing field (mainly in EE). Attempts were made to re-focus the work on a few other possibilities, this includes extending the gradient's filter into 3D domain and looking at the aspect of accelerating the gradient filter algorithm using GPU. All these efforts requires fulltime engagement of GRA, which as explained above this was not fully materialized. The other part of the problem is more of a personal issue. For a period of 5 months from April 2014 – August 2014, I have served my sabbatical leave locally and abroad (spent 3 months at NUS). This event of my personal development undoubtedly have affected the progress of the project.</p> <p>In general, we have achieved 55-65 % progress with the spending of 13% on the budget, the extension period seeked and granted (6 months) was part of the attempt to salvage and to address some if not all of the issues impeding the research project's progress. It is now clear, despite my efforts to complete phase 3 of the project, I may not be able to fulfil the originally stated research objectives, and the expected deliveries as agreed in the original proposal.</p>
<b>F</b>	<b>RECOMMENDATION</b> ( <i>Cadangan Penambahbaikan</i> )
	<ol style="list-style-type: none"> <li>1. It is clear, to fully deliver in a fundamental research project such as FRGS, first we need to secure a PhD/MSc student prior to applying for the grant.</li> <li>2. Second, with such student secured idea or plan in the problem to be researched is better conceived with prior thematic review of the research relevant works have been done</li> <li>3. Flexibility should be given to engage Non-Malaysian GRA in FRGS – in the earlier part of my project (circa 2013), we were not allowed to recruit Non-Malaysian GRA, but the rule has been "relaxed" since then.</li> </ol> <p>On personal basis, I will continue researching on this topic with the focus as highlighted in section E above. This is my first failure of completing a research project, and it is a first of it kind in "fundamental" research that I have headed. Certainly I have learnt some very good lessons including those issues that appear to be crucial for FRGS.</p>
<b>G</b>	<b>RESEARCH ABSTRACT – Not More Than 200 Words</b> ( <i>Abstrak Penyelidikan – Tidak Melebihi 200 patah perkataan</i> )
	<p>Gradient is mostly used to approximate a quantity called normal vector, which is widely used in techniques such as ray-casting or shading to calculate the shade of a pixel. Central Different Equation (CDE), Forward Difference Equation (FDE) and Backward Difference Equation (BDE) [1] are examples of common finite-difference gradient filters to estimate gradient from discrete data. We observed that gradients estimated these ways are very sensitive to the method employed, and worse if the volumetric data exhibits some patterns (or noise) which is common in CT-scan and MRI, the results we obtained are unpredictable, as small perturbations in the dataset results in significant difference in the results.</p> <p>In this research we are proposing to study the fundamental properties and structures of finite-differences gradient</p>

estimators for discrete volumetric data. This will enable us to discover causal relationships within the discrete volumetric data that are prone to uncertainties. We would also explore and carry out empirical research to discover key causal relationships inherent on complex 3D data. Thus the main objective is to address the instability problem in Finite-Difference (FD) method by proposing an alternative multi-scale approach.

Extracting shape features from 3D volumetric data directly is crucial for certain critical applications e.g. performing surgery or laser cancer treatment on a patient's brain. With this FRGS grant, we hope to uncover the inherent limitations in existing finite difference methods to estimate gradients (the key component for feature extraction) and proposed a much robust methods to handle uncertainties in discrete volumetric data.

Date : 28 Jan 2016  
Tarikh

Project Leader's Signature:  
Tandatangan Ketua Projek



**H** COMMENTS, IF ANY/ ENDORSEMENT BY RESEARCH MANAGEMENT CENTER (RMC)  
(Komen, sekiranya ada/ Pengesahan oleh Pusat Pengurusan Penyelidikan)

PI ini akan disuarai kotan

Name:  
Nama:  
Date:  
Tarikh:

PROF. DR LEE KEAT TEONG  
Directo:  
Research Creativity & Management Office  
Universiti Sains Malaysia

Signature:  
Tandatangan:



6/2/16