

**ANALYSIS OF SCALING FACTOR IN TERRESTRIAL LASER  
SCANNING PRE-PROCESSING PROCEDURE**

**Dissertation / Project**

**Delivered to meet the Award of Terms  
Bachelor of Surveying Science and Geomatics  
Faculty of Architecture, Planning and Surveying  
Universiti Teknologi MARA, Perlis**

**Prepared By:  
NURATHIRAH MAT ZAIN  
2013514857**

**JULY 2017**

## AUTHOR'S DECLARATION

I declare that the work in this thesis/dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student : Nurathirah Bt Mat Zain  
Student I.D. No. : 2013514857  
Programme : Degree of Science Geomatic – AP220  
Faculty : Architecture, Planning & Surveying  
Thesis/Dissertation Title : Analysis of Scaling Factor in Terrestrial Laser Scanning Pre-Processing Procedure.

Signature of Student :   
Date : July 2017

### Approved by:

I certify that I have examined the student's work and found that they are in accordance with the rules and regulations of the Department and University and fulfills the requirements for the award of the degree of Bachelor of Surveying Science and Geomatics (Honours).

Name of Supervisor: Sr Dr. Mohd Azwan Bin Abbas

Signature and Date:  11.08.17.

## ABSTRACT

Similar to other instruments in Geomatics field, terrestrial laser scanner has its own coordinate system. The scanner measures start from local coordinate system for each terrestrial laser scanner station. Then, perform registration process to convert into one global coordinate system. In terrestrial laser scanner the scale factor is neglected by most researchers because it is shown to be irrelevant in laser scanner pre-processing procedure. However, for total station and global positioning system that have similar concept with terrestrial laser scanner, applied scale factor in coordinate transformation calculation. For this reason, this study focused on investigation of the effect of scaling factor in terrestrial laser scanner pre-processing procedure. Investigations began by develop a datum transformation program. Australis software was used as a benchmarking for developed datum transformation program and the results were evaluated by using statistical testing. The develop program was applied for three experiment with three different configurations network (i) reduction of scan stations, (ii) reduction of surfaces, and (iii) reduction of target points. Statistical analysis was executed and results show that the scaling factor in laser scanner pre-processing procedure was not significant at 95% confidence interval. It is statistically verified that scaling factor is shown to be irrelevant in laser scanner coordinate transformation procedure.

## TABLE OF CONTENTS

	<b>PAGES</b>
<b>CONFIRMATION BY PANEL OF EXAMINERS</b>	iii
<b>AUTHOR'S DECLARATION</b>	iv
<b>ABSTRACT</b>	v
<b>ABSTRAK</b>	vi
<b>ACKNOWLEDGEMENT</b>	vii
<b>TABLE OF CONTENTS</b>	viii
<b>LIST OF FIGURES</b>	xi
<b>LIST OF TABLES</b>	xii
<b>LIST OF ABBREVIATIONS/NOMENCLATURE</b>	xiii
<b>LIST OF APPENDICES</b>	xiv
<b>CHAPTER 1</b>	
<b>INTRODUCTION</b>	1
1.1 Introduction	1
1.2 Problem Statement	3
1.3 Research Gap	5
1.4 Aim	7
1.5 Objectives	7
1.6 Brief of Methodology	7
1.7 Contributions of Research	8
1.8 Structure of Thesis	8
<b>CHAPTER 2</b>	
<b>LITERATURE REVIEW</b>	10
2.1 Introduction	10
2.2 Terrestrial Laser Scanning (TLS)	10
2.2.1 Distance Measurement System	12
2.2.1.1 Phase Modulation	12
2.2.1.2 Pulse Based	13
2.2.1.3 Laser Triangulation	13

2.2.2	Angular Measurement System	14
2.3	Registration	15
2.4	Seven Rigid Body Transformation	17
2.4.1	Rotations	18
2.4.2	Scaling and Translations	20
2.5	Summary	21
<b>CHAPTER 3</b>		
<b>METHODOLOGY</b>		22
3.1	Introduction	22
3.2	Data Acquisition	23
3.3	Data Processing	24
3.3.1	Development of Datum Transformation Program	25
3.3.2	Assessment of Datum Transformation Program	28
3.3.3	Three Experiment with Different Network Configurations	29
3.3.3.1	Reduction of Scan Stations	30
3.3.3.2	Reduction of Surfaces	31
3.3.3.3	Reduction of Targets Percentage	32
3.4	Software	33
3.4.1	Developed Datum Transformation Program	33
3.4.2	Australis	33
3.5	Summary	34
<b>CHAPTER 4</b>		
<b>RESULT &amp; ANALYSIS</b>		35
4.1	Introduction	35
4.2	First Objective	35
4.2.1	The Reliability of Develop Program in Matlab	36
4.3	Second Objective	38
4.3.1	Reduction of Scan Stations	38
4.3.2	Reduction of Surfaces	39
4.3.3	Reduction of Target	40
4.4	Summary	41