

**ANALYSIS ON CAD DATA OBTAINED FROM NON-CONTACT REVERSE
ENGINEERING SYSTEM**

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A project report is submitted to the Faculty of Mechanical Engineering in partial
fulfillment of the requirement for the award of the degree of
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(Design and Innovation) Honors

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DECLARATION

I hereby declare that this report entitled “**Analysis on CAD data obtained from non-contact reverse engineering**” is the result of my own research except as cited in the references.

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APPROVAL

This report is submitted to the Faculty of Mechanical Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering (Design and Innovation) honours. The members of the supervisory committee are as follow:

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And

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DEDICATION

To all my family especially my beloved parent, *Mr. MD SALLEH IN SIMON*, and *Madam ZAINAB BINTI ALI*, to my Supervisor *Dr MOHD JUZAILA BIN ABD LATIF* and my Co-Supervisor *Mr. HAMBALI BIN BOEJANG*, all lecturer and all my friends.

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ABSTRACT

This report covers the final year project undertaken by student in University Technical Malaysia Melaka (UTeM) for fulfill the university requirement to graduation. This report describe about the project titled “Analysis on CAD Data Obtained from Non-Contact Reverse Engineering System”. The purpose of this project is to analyze and compares the STL file as a CAD data obtained from the two types of reverse engineering technology machines which are REXCAN structure light 3D scanning and FARO ARM laser scanning. These two types of reverse engineering machine will be compared and analyzed the STL file in term of its overlapped triangles (bad contour) and gap between edges (bad edge). This report also compares the total time required to scan an object. This report is divided into five chapters. Chapter one presents the introduction of this project. Then chapter two presents the literature review on the reverse engineering, 3D scanner, CAD file and some of the previous studies about RE and STL file. Chapter three describes the experimental works and methodology on how this project will be done and on how the experimental being done to come out the result. Next in chapter four, the result of the experimental had been show and the discussion of the result is made. Lastly the chapter five is including the conclusion and recommendation of the project.

ABSTRAK

Laporan ini adalah merupakan projek tahun akhir yang dijalankan oleh pelajar di Universiti Teknikal Malaysia Melaka (UTeM) untuk memenuhi syarat universiti untuk bergraduan. Laporan ini menerangkan tentang projek yang bertajuk "Analisis data CAD yang diperolehi daripada system tak sentuh kejuruteraan berbalik". Tujuan projek ini adalah untuk menganalisis dan membandingkan fail STL sebagai data CAD dari kedua-dua jenis mesin teknologi kejuruteraan berbalik iaitu mesin pengimbas jenis laser 3D REXCAN dan mesin pengimbas laser FARO ARM. Kedua-dua jenis mesin kejuruteraan terbalik akan membandingkan dan menganalisis fail STL dalam jangka segitiga bertindih (kontur buruk), dan jurang antara tepi (pinggir buruk). Laporan ini juga akan membandingkan jumlah masa yang diperlukan untuk mengimbas objek ini. Laporan ini terbahagi kepada lima bab. Satu bab membentangkan mengenai pengenalan projek. Kemudian bab 2 membentangkan kajian literatur ke atas kejuruteraan terbalik, pengimbas 3D, fail CAD dan beberapa kajian ilmiah mengenai kejuruteraan berbalik dan fail STL. Bab 3 menerangkan kerja-kerja ujikaji makmal (eksperimen) dan kaedah bagaimana projek ini akan dilakukan dan bagaimana eksperimen yang dijalankan untuk mendapatkan keputusan muktamad. Seterusnya dalam bab empat, hasil eksperimen ditunjukkan dan perbincangan keputusan akan dibuat. Akhir sekali bab 5 termasuk kesimpulan dan cadangan projek.

TABLE OF CONTENTS

TITLE	PAGES
SUPERVISOR DECLARATION.....	ii
CO-SUPERVISOR DECLARATION.....	iii
DECLARATION	ii
APPROVAL.....	iii
DEDICATION	iv
ACKNOWLEDGEMENT	v
ABSTRACT	vi
ABSTRAK	vii
TABLE OF CONTENTS	viii
LIST OF FIGURES	xiii
LIST OF TABLES	xvi
CHAPTER 1	1
INTRODUCTION	1
1.0 BACKGROUND.....	1
1.1 OBJECTIVES	2
1.2 PROBLEMS STATEMENT	2
1.3 SCOPE OF PROJECT.....	3
1.4 PROJECT OVERVIEW.....	3
CHAPTER 2	5
LITERATURE REVIEW.....	5
2.0 INTRODUCTION OF REVERSE ENGINEERING (RE).....	5

2.1	TYPES OF REVERSE ENGINEERING	6
2.1.1	Tough Triggered Probe (Contact Method).....	6
2.1.2	Analogue Probe (Contact Method)	7
2.1.3	Photogrammetric (Non-Contact Method)	8
2.1.4	Laser Scanning (Non-Contact Method)	8
2.1.5	Computed Tomography (CT) Scanner (Non-Contact Method).....	9
2.2	ACTIVE AND PASSIVE SENSORS	10
2.3	ADVANTAGE AND LIMITATION OF RE	10
2.4	INTRODUCTION OF 3D SCANNER	12
2.4.1	Laser 3D Scanner	12
2.4.2	Structured Light 3D Scanner.....	13
2.5	ADVANTAGES USING 3D SCANNER	14
2.6	DISADVANTAGES USING 3D SCANNER	15
2.7	CAPABILITIES OF SCANNING OBJECT	16
2.8	OPERATION OF 3D SCANNER.....	17
2.8.1	3D Scanning Process.....	17
2.8.2	Object or Data Capture.....	18
2.8.3	Data Processing.....	18
2.9	INTRODUCTION OF COMPUTER AIDED DESIGN (CAD).....	18
2.9.1	History and Development Of CAD.....	19
2.9.2	Basic principle of CAD.....	20
2.9.3	Benefit of CAD	20
2.9.4	Geomagic and EzScan 4.5 Software	21
2.9.5	CATIA V5 R20 Software.....	21
2.9.6	Standard Triangulation Language (STL) File	21

2.9.6.1 Advantages and Disadvantages STL File	22
2.9.6.2 STL File Problem.....	23
2.9.6.3 Summary of Previous Study.....	24
CHAPTER 3	26
EXPERIMENTAL WORK.....	26
3.0 BACKGROUND.....	26
3.1 FLOW CHART OF EXPERIMENTAL WORK	26
3.2 STRUCTURE OF THE EXPERIMENT	28
3.3 SELECTION OF SCANNED OBJECT.....	29
3.4 SELECTION OF REVERSE ENGINEERING MACHINE.....	29
3.5 EXPERIMENT PROCEDURE.....	29
3.5.1 Pre-Processing (Set-Up Procedure).....	30
3.5.1.1 Set-Up Procedure (Faro Arm Laser Scanning).....	30
3.5.1.2 Set-Up Procedure (Rexcan 3D Scanning)	31
3.5.2 Scanning Procedure.....	32
3.5.2.1 Scanning Procedure (Faro Arm Laser Scanning)	33
3.5.2.2 Scanning procedure (Rexcan 3D Scanning)	37
3.5.3 Post-Processing (Data Manipulation)	42
3.5.3.1 Standard Of Procedure For Data Manipulation (Faro Arm Laser Scanning)	42
3.5.3.2 Standard Of Procedure For Data Manipulation(Rexcan Structure Light Scanning)	49
3.5.3.3 Standard Of Procedure For Data Manipulation(CATIA editing for both Faro Arm and Rexcan).....	51
3.5.4 Data Conversion.....	54
3.5.4.1 Direct Data Conversion	54

3.5.4.2	Indirect Data Conversion	55
3.6	COMPARISON ANALYSIS	55
3.7.1	Faro Arm Laser Scanner	57
3.7.1.1	Specification of Faro Arm Laser Scanner.....	58
3.7.2	Rexcan 3D Structure Light Scanner.....	59
3.7.2.1	Specification of Rexcan 3D Structure Light Scanner.....	60
3.7.3	Geomagic And Ezscan Software.....	61
3.7.4	MagicRp Software	61
3.7.5	CATIA V5R20 Software.....	61
CHAPTER 4	62
RESULT AND DISCUSSION	62
4.0	INTRODUCTION.....	62
4.1	PRE-PROCESSING, SCANNING, MERGE AND POST-PROCESING	62
4.1.1	Before STL File Generation (Faro Arm)	63
4.1.2	Before STL File Generation (Rexcan)	64
4.1.2.1	Time Duration For Merge Time	65
4.1.3	Total Time Required Comparison Between Faro Arm And Rexcan Before STL File Generation	66
4.2	QUALITY OF STL FILE (DIRECT CONVERT TO STL FILE).....	67
4.3	QUALITY OF STL FILE (INDIRECT CONVERT TO STL FILE)	68
4.4	QUALITY STL FILE FROM BEST TO WORST	69
4.5	DATA TRANSLATION.....	70
4.6	CHALLENGE AND COUNTER	70
CHAPTER 5	71
CONCLUSION AND RECOMMENDATION	71
5.0	CONCLUSION	71

5.1 FUTURE WORKS AND RECOMMENDATION.....72

REFERENCE.....73

APPENDIX.....78

A. GANTT CHART PSM 1 & PSM 2

B. REVERSE ENGINEERING EQUIPMENT

LIST OF FIGURES

Figure No,	Title	Pages
Figure 1.1:	Flowchart of project overview.....	4
Figure 2. 1:	Tough Triggered Probe.....	7
Figure 2. 2:	Analogue Probe	7
Figure 2. 3:	Photogrammetric scanner	8
Figure 2. 4:	Laser Scanning	9
Figure 2. 5:	Computed Tomography (CT) Scanner	9
Figure 2. 6:	Faro Arm Laser Scanning [22]	13
Figure 2. 7:	Rexcan 3D scanning [23]	14
Figure 2. 8:	Left and right side show gap and no gap between triangles [19].	23
Figure 2. 9:	Overlapping between triangles [19].	23
Figure 2. 10:	Top and bottom show incorrect and correct direction in surface normal...24	
Figure 3. 1:	Process and planning for PSM 2	27
Figure 3. 2:	Scanning object.	30
Figure 3. 3:	SKD –S2 Developer.	30
Figure 3. 4:	Spray to object.	31
Figure 3. 5:	Object.....	31
Figure 3. 6:	Sticker point.....	31
Figure 3. 7:	Fast evaporating developer.....	32
Figure 3. 8:	Spray to object.	32
Figure 3. 9:	Equipment and apparatus of Faro Arm.....	33
Figure 3. 10:	Cable that connected between RE systems and hardware/laptop.....	33

Figure 3. 11: Software asks to make sure that Faro Arm machine is connected to laptop.	34
Figure 3. 12: Toolbar plug.	34
Figure 3. 13: Laser capture toolbars.....	35
Figure 3. 14: Start capture icon.	35
Figure 3. 15 Seven Arm of Faro Arm machine.....	35
Figure 3. 18: Collecting of scanned data.....	36
Figure 3. 16: Scanned object.	36
Figure 3. 17: Activities on conducting machine.	36
Figure 3. 19: Scanned data (points cloud) is ready for post-processing process.	37
Figure 3. 20: Equipment and apparatus of Rexcan.	37
Figure 3. 21: Turn on the hardware.....	38
Figure 3. 22: Turn on the Rexcan camera.	38
Figure 3. 23: Icon of Ezscan software.....	38
Figure 3. 24: Open camera toolbar.....	39
Figure 3. 25: Brightness toolbar.....	39
Figure 3. 26: Distance toolbar.	39
Figure 3. 27: Optimal distance of laser points.	40
Figure 3. 28: Scan button.	40
Figure 3. 29: Aligning process.	41
Figure 3. 30: Image (scanned data) after merge process.....	41
Figure 3. 31: Selected the overlap data.	43
Figure 3. 32: Deleted the overlap data.	43
Figure 3. 33: Icon of disconnected component.	44
Figure 3. 34: Reduce noise icon and process.	44
Figure 3. 35: Smoothness level process.	44
Figure 3. 36: Display deviations icon and process.....	45
Figure 3. 37: Uniform sample process.	45
Figure 3. 38: Wrap icon and process.....	46
Figure 3. 39: Repair intersection icon and process.	46
Figure 3. 40: Fill holes icon and method.....	47

Figure 3. 41: Fill holes process.	47
Figure 3. 42: Relax polygon icon.....	48
Figure 3. 43: Sandpaper icon.	48
Figure 3. 44: Final data after repair (Faro Arm).	48
Figure 3. 45: Selected of the overlap data.....	49
Figure 3. 46: Hole on the scanned data.	49
Figure 3. 48: Improve shape quality toolbar.	50
Figure 3. 49: Smoothing toolbar	50
Figure 3. 47: Clean toolbar.	50
Figure 3. 50: Final scanned data after repair (Rexcan).	51
Figure 3. 51: Icon CATIA V5R20.	51
Figure 3. 52: Step to open the digitized shape editor environment.....	52
Figure 3. 53: Example after open the Iges file (data in point cloud).	52
Figure 3. 54: Mesh creation icon.....	53
Figure 3. 55: Triangle foam.	53
Figure 3. 56: Fill hole icon.....	53
Figure 3. 57: Process finish.....	54
Figure 3. 58: Faro Arm 3D scanner [31].....	57
Figure 3. 59; Rexcan 3D scanner [29]	59
Figure 3. 60: Top view of Rexcan 3D scanner [29].....	59
Figure 3. 61: Front view of Rexcan 3D scanner [29].....	60
Figure 4. 1: Graph of comparison between Faro Arm and Rexcan due to total time	66

LIST OF TABLES

Table No.	Title	Pages
Table 2. 1	shows the advantage and limitation between contact and noncontact reverse engineering systems [4]:.....	11
Table 2. 2	show the capability of 3D scanner machine [4, 25]......	17
Table 2. 4	show the summary of previous study [2, 35, 36].....	24
Table 3. 1:	Show process and time which is used to compare the Faro Arm and Rexcan...	56
Table 3. 2:	Show the consideration of STL file to determine the best method.....	56
Table 3. 3	shown the specification of Faro Arm 3D scanner [30, 31].....	58
Table 3. 4	shown the specification of Rexcan 3D scanner [29].....	60
Table 4. 1:	Time for Faro Arm 3D Scanner	63
Table 4. 2:	Time for Rexan 3D Scanner	64
Table 4. 3:	Calculation Scanning for Merge time	65
Table 4. 4:	Comparison between Faro Arm and Rexcan for STL file quality (direct data translation).....	67
Table 4. 5:	Comparison between Faro Arm and Rexcan for STL file quality (indirect data translation).....	68
Table 4. 6:	Quality of STL file from best to worst.....	69

LIST OF ABBREVIATIONS

3D	: Three Dimensions
CAD	: Computer Aided Design
RP	; Rapid prototyping
RE	: Reverse engineering
STL file	: Standard triangulation language file
IGES	: International Graphics Exchange Standard
SOP	: Standard of Procedure
UteM	: Universiti Teknikal Malaysia Melaka
FKM	: Faculty of Mechanical Engineering

CHAPTER 1

INTRODUCTION

1.0 BACKGROUND

Nowadays there are so many reverse engineering (RE) technologies commercially available with different specifications and ranges. Generally, they are categorized into contact (probe base) and non-contact (laser based) methods [1]. Both RE methods are used to capture data or information from physical object. The scanned data obtained can be used for many downstream applications such as rapid prototyping (RP), computer aided design (CAD), computer aided manufacturing (CAM) and etc. In this era of millennium, product is more complex than before [4]. One of the most recent technological developments that have significant impact on product development and enable to overcome problem from product geometry is reverse engineering. Generally, a model of a product will be digitized or scanned to obtain its graphical representation before being manipulated the geometry data for downstream operational application. The technology of reverse engineering can change object or part to solid or surface model' to the end user. However, this project focuses on analysis of standard triangulation language (STL) data produced from two different products/brands of non contact RE systems.

1.1 OBJECTIVES

There are several objective of this project which can be concluded as the following:

- To identify the quality of STL file obtained after direct and indirect data translation from reverse engineering.
- To carry out comparison analysis of CAD data produced from two different non contact reverse engineering.
- To perform the best practice (standard of procedure) of both reverse engineering system.

1.2 PROBLEMS STATEMENT

Reverse engineering is one of the time compression technologies that can be used to scan an object. This project compares two different non contact reverse engineering machine available in University Technical Malaysia Melaka (UTeM) and determines which one is the best in producing Standard Triangulation Language (STL) from a scanned object (fake hand). Generally, in the scanning /digitizing process of an object there a many tasks must be done such as setting-up, scanning, editing and repairing data, and data conversion for various applications. For example the generation of STL file format for rapid prototyping application in producing a part or product. This project is focuses on investigating the quality of STL files.

There are many research works from previous studies in investigating the quality of STL file. Zhong and Shouwei had studied about new algorithm for generating STL files directly from points cloud [2]. The objective of the proposed algorithm is to reduce point data and generate STL file from point clouds by indicating a tolerance and to maintain precision. Bopapana found that the quality of STL file depends on tolerance [3]. The result can be seen that the most complex object i.e. “sphere” had the most number of STL file error.

From the research works, it could be said that the tolerance of scanned data is a very important factor in generating a decent quality of STL file. Similarly, the main purpose of this project is to investigate the quality of STL files obtained through direct and indirect data translation from non contact RE systems. However, the quality is defined from 3 criteria of the triangles: the gaps between edges, normal orientation, and overlapped triangles.

1.3 SCOPE OF PROJECT

The scope of this project is:

- To do literature search.
- To familiarize with both non contact reverse engineering systems.
- To carry out the experimental works such as scanned the selected object, data manipulations and data conversion from scanned data to STL file.
- To do comparison analysis on the quality of the STL file produced in term its normal orientation, overlapped triangles, and gap between edges.
- To compare the setup procedures of each reverse engineering system.
- To compare number of triangles of each STL file produced from direct and indirect file conversions.
- To compare scanning speed (scanning time) for selected or assigned images.

1.4 PROJECT OVERVIEW

To ensure that the project is finish within the given time, a schedule is made and divided into PSM 1 and PSM 2. All activities within this project are shown or illustrate at Figure 1.1 below:

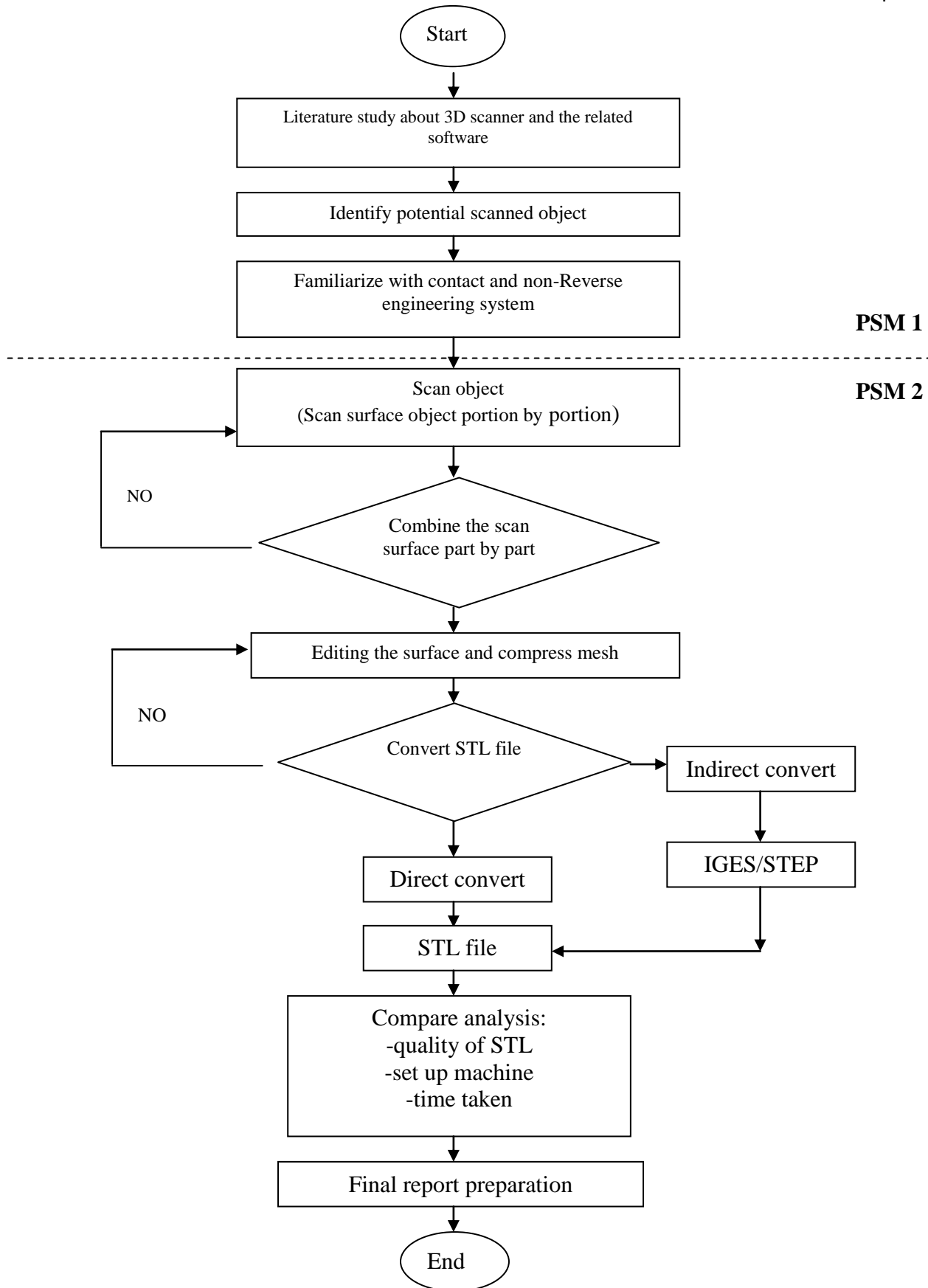


Figure 1.1: Flowchart of project overview

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION OF REVERSE ENGINEERING (RE)

Reverse engineering is the process whereby a replica is made of an existing physical object or part. It is very useful for generating a CAD model from object with no CAD data or information [4]. Basically, RE method is scan or capture the geometry of product or part by digitizer. The information of the product or part is registered on the computer and represent as a CAD data [4]. Reverse engineering is a way to redesign a product to reconstruct a new product which has similar functions and to improve the ability of the original product [5].

War and art is the main factor of reverse engineering development. Albrecht Durer as a driver to reverse engineering since 1400 and he is the people that introduce Albrecht Durer's apparatus [4]. This is to understanding the art of the Italian Renaissance. During the 1960, automation is made reverse engineering through copying process even a lot faster and broader in its application.