UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TO STUDY THE DEVELOPMENT OF REVERSE ENGINEERING TECHNOLOGY THAT USING COMMON CONSUMER ELECTRONIC DEVICE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours

by

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I hereby, declared this report entitled “To Study The Development Of Reverse Engineering Technology That Using Common Consumer Electronic Device” is the results of my own research except as cited in references.

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Date	:	……

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Product Design) with Honours. The member of the supervisory is as follow:

…….

ENCIK MOHD QADAFIE BIN IBRAHIM

(Project Supervisor)

ABSTRAK

Fotogrametri adalah teknologi dalam imbasan 3D yang digunakan dalam teknologi kejuruteraan terbalik untuk rakaman sesuatu objek. Fotogrametri boleh digunakan dengan bantuan kamera digital untuk mengubah imej 2D ke 3D data model CAD. Perkembangan teknologi fotogrametri boleh dilihat dimana teknologi ini boleh digunakan kepada pengguna biasa yang menggunakan peranti elektrik untuk menghasilkan semula model digital 3D daripada gambar-gambar pada telefon mereka. Kajian ini akan menyiasat prestasi perisian fotogrametri dengan melakukan imbasan 3D dan menghasilkan semula 3D dengan perisian pada telefon mudah alih dan komputer untuk menjana data 3D dan membuat perbandingan dengan kaedah fotogrametri pengimbasan profesional. Keputusan dinilai dan dibincangkan dengan membandingkan keputusan data 3D dan model yang dicetak menggunakan kaedah 3D kaedah ciri-ciri fizikal mereka, analisis sisihan dan dimensi fizikal. Daripada keputusan, ia menunjukkan bahawa untuk mendapatkan output yang baik pembinaan semula data 3D dengan fotogrametri input berkenaan mestilah baik iaitu kualiti gambar yang diambil dan sifat-sifat objek adalah faktor yang paling kritikal.

ABSTRACT

Photogrammetry is a one technology in 3D scanning which is used in reverse engineering technology for recording or capturing an objects. Photogrammetry can be used with the help of digital camera to transform a 2D images into 3D model CAD data. The development of photogrammetry technology can be seen as this technology can be accessible to the mainstream users that used common electric devices to be able to reconstruct 3D digital models from the pictures on the devices. This research will investigate the performance of the photogrammetric software by doing the 3D scanning and 3D reconstructing with the software on the mobile phone and computer to generate 3D data and make comparison with the professional photogrammetry scanning method. The results is evaluated and discussed by comparing the results of 3D data and the 3D printed model of the both methods by their physical features, deviation analysis and physical dimensions. From the results, it shown that to get a good output of the 3D data reconstructions with photogrammetry the input must be good which means the quality of the images captured and the properties of the object scan are the most critical factors.

DEDICATION

This project is especially dedicated to me as a final year student that will complete my degree in 2017. Besides that, it is also for my beloved family, project supervisor and all my friends which support me throughout my journey of education.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

CAD	-	Computer Aided Design
3D	-	3Dimensional
2D	-	2Dimenional
CT	-	Computed Tomography
CMM	-	Coordinate Measuring Machines
DEM	-	Digital Elevation Model
BAE	-	British Aerospace
SOCETSET	-	SOftCopy Exploitation Toolkit
EOS	-	Electronic Operating System
STL	-	Stereo Lithography
OBJ	-	Wave front
PLY	-	Polygon File Format
VRML	-	Virtual Reality Modelling Language
DSLR	-	Digital Single Lens Reflex
Mm	-	Millimetre
MP	-	Megapixel
OS	-	Operating System
IOS	-	IPhone operating System
FOV	-	Field of View
Kg	-	Kilogram

CJP	-	ColorJet Printing
CCD	-	Charge-coupled Device
USB	-	Universal Serial Bus
LED	-	Light-emitting Diode
OLED	-	Organic light-emitting Diode
AMOLED	-	Active Matrix OLED

CHAPTER 1
INTRODUCTION

1.0 Introduction

In this chapter it will show about the background of the project title which is about the Reverse Engineering (RE) technology. It will also show the problem statement, objective and work of scope of this project.

1.1 Background

The development of Reverse Engineering technology has been increases significantly throughout the years. Reverse engineering (RE) is the process that build a copy of existing products into a 3D model CAD data to duplicating it or make improvement to it. It is a process without using the engineering drawing but other technique such as scanning or digitizing to get the CAD model. There are two types of engineering, which is the reverse engineering and another type is the forward engineering. Forward engineering is different compare with the reverse engineering because it is a normal process from a high-level abstractions and logical designs that use engineering drawing to implement to a physical of a system. Some definitions of RE by researcher RE is the process of retrieving new geometry from a manufactured part by digitizing and modifying an existing CAD model (Yau Hong Tzong, et al., 1993).

3D scanning is one of technology that use reverse engineering techniques to measure the physical objects to produce the CAD data. The 3D scanning technology is divided into two classification which is contact and non-contact. Some examples of 3D scanning technologies are Coordinate Measuring Machines (CMM), laser scanners, structured light digitizers, photogrammetry and Industrial CT Scanning (computed tomography).

This project is to study about the development of reverse engineering technology. The particular technology is the photogrammetry 3D scanning. Photogrammetry is the science of making measurements from photograph. By using the principle of photogrammetry in 3D scanning it can produce a real physically 3D model objects from a set of photos. The study will be focus on the photogrammetry software by using common electronic device such as smartphone and computer. The scope of the project is to investigate the software and finding the best solution to do 3D scanning and 3D reconstruction for public users.

1.2 Problem Statement

Some of 3D scanning methods required high cost to conduct it. Before this, to do 3D scanning, they need to build a high cost scanning system such as the traditional photogrammetry which need to build with many camera and lighting system. Besides that, some people might face difficulty to use 3D scanning because it need an expert to operate it. Furthermore, it might require special training to do the 3D scanning methods.

1.3 Objectives

1) To study about the 3D scanning photogrammetry software that available in market.
2) To determine the optimum methods on how to use 3D photogrammetric software to generate 3D data.
3) To discuss the accuracy of the photogrammetry software from the 3D printed models by using the common electronic devices scanning method and professional scanning method.

1.4 Work Of Scope

In this project, the research is about the Development of the Reverse Engineering Technology which is the Photogrammetry 3D Scanning. The study will be focus on understanding the technology and photogrammetric software that available in market which can be used by common consumer electronic device such as computer and mobile phone. This research will investigate the performance of the photogrammetric software by doing the 3D scanning and 3D reconstructing simulation with the software to generate 3D data and make comparison with the professional photogrammetry scanning method. From the 3D scanning photogrammetry by do it by yourself (DIY) scanning method which is through the mobile phone and computer and the 3D print model will be print and compare with the 3D model that will be produce by the professional scanner. The results will be evaluate and discuss to know the accuracy of the both methods.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In literature review it will discussed about the researches related to the project title which is “To Study the Development of Reverse Engineering Technology That Using Common Consumer Electronic Device”. It will continuously carried throughout this project to study about the past and current research work related to project title. The RE technology that has been chosen is the photogrammetry 3D scanning technology which some of important issues and data of it have to be studied, reviewed, determined and applied for this project.

2.1 Photogrammetry

In the past, about 20 years, there are many intensive research of Photogrammetry has been conducted for the automation of information extraction digital images, based on image analysis method (Baltsavias 1999). Earlier, photogrammetry was not considered able to scan and measure small parts and complex surfaces but these days on the contrary, new possibilities to use photogrammetry for accurate 3D scans of small object have been assessed, also for sub millimeter scale (Galantucci et al. 2015). Photogrammetry is one of many techniques that has been used in reverse engineering such as in 3D scanning methods. Photogrammetry is mean by the science of making measurement from multiple pictures to produce a 3D printing model. It capture the 3D data by using the photographic tools. In photogrammetry there are several types of output it which is it used for map taken from aircraft (Figure 2.1), drawing (Figure 2.2), measurement (Figure 2.3) and 3D model of some real world

object or scene or more known as 3D reconstruction (Figure 2.4). (Alan Walford, 2007)

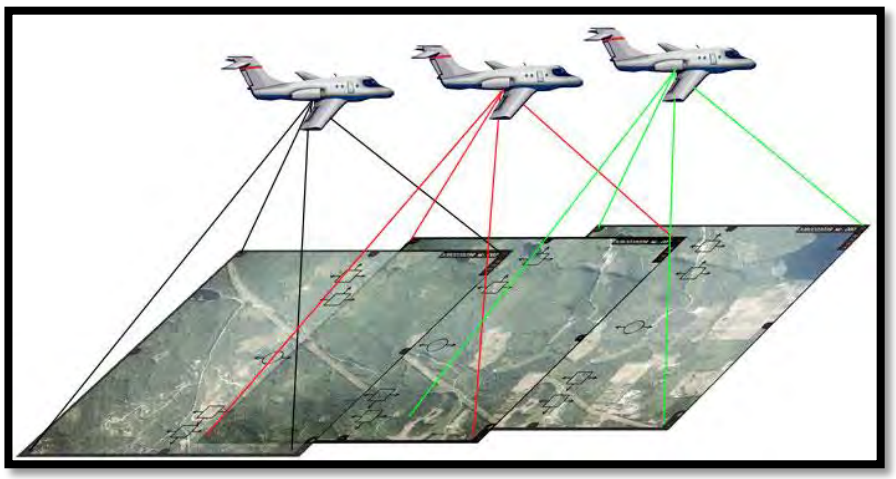

Figure 2.1 Picture of Output of Photogrammetry used for Map taken for Aircraft. (Mike Foster, 2016)

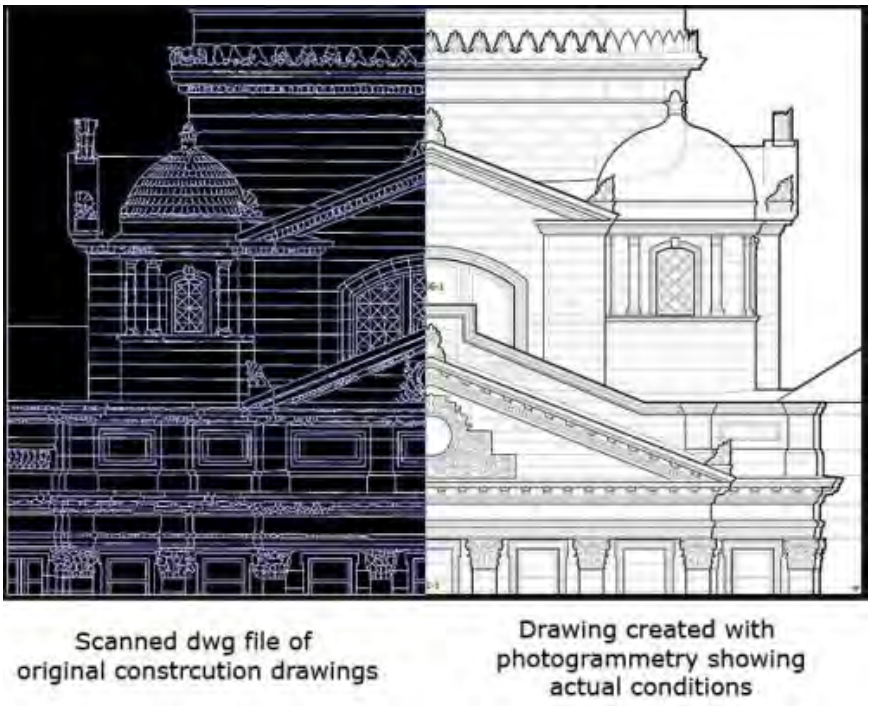

Figure 2.2 Picture of Photogrammetry used for Drawing. (Peter Aaslestad, 2011)

Figure 2.3 Picture of Photogrammetry used for Measurement. (Crashteams, 2008)

Figure 2.4 Photogrammetry used for 3D reconstruction. (CrunchBase Inc., 2016)

Nowadays, digital camera has become more advanced which more inexpensive camera but with high resolution camera has been made, resulting more expand in the application of photogrammetry (Baqersad et al. 2016) thus, initiated more developers

to create a photogrammetry program that exclusively for mobile phone other than for desktop used. This is because mobile phone has become more advanced and the resolution of the camera has increased which comparable with digital camera these days.

2.1.1 Types Of Photogrammetry

There are two types of photogrammetry which is the aerial photogrammetry and the close-range photogrammetry. Aerial photogrammetry use camera which is mounted to the aircraft and usually it is pointed vertically towards the ground to capture the scene. The processed picture is in a stereo-plotter which it act as instrument that lets an operator see two pictures at once. It is used in automated processing for Digital Elevation Model (DEM) creation which is the digital model of a terrain's surface such as planet, moon and asteroid. There are several types of software for aerial photogrammetry such as the BAE system SOCETSET, DAT/EM International Summit Evolution, Intergraph 2/1 Imaging, KLT Associates ATLAS and PCI Geomatics.

Another type of photogrammetry is the closed-range photogrammetry which use camera by hand-held or tripod to it close to the subject that need to be taken. It is also known as Image-Based Modeling. Some examples of the software are EOS System PhotoModeler (Full-Capability Close-Range Photogrammetry), GSI V-stars (High Accuracy Industrial Measurement Photogrammetry), and also Autodesk 123D Catch; PhotoModeler Scanner; Acute 3D (Textured 3D Model Extraction). (Alan Walford, 2007)

2.1.2 Photogrammetry Mechanisms

A triangulation process is the principle that is used in photogrammetry which this principle enables 3D scanning to determine the dimensions and geometry of the objects in a real-world. The base of a triangles is create from the distance and the angles between imagers and the projected light source, which then the projected light angle will return to the imager from the surface