UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Comparative Study between 3D Scanner, Vernier Calliper, and Coordinate Measurement Machine.

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree in Mechanical (Automotive) Engineering Technology (Hons.)

By

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ABSTRAK

Kordinat Mesin Pengukuran (CMM) dan Pengimbas 3D adalah alat yang berkuasa untuk menghasilkan sesuatu dimensi objek ke dalam model Computer Aided Design(CAD). Terdapat banyak jenis pengimbas untuk melaksanakan tugas ini tetapi kedua-duanya alat ini diberi keutamaan apabila menghasilkan pengukuran dari reka bentuk objek yang sedia ada. Perkembangan teknologi terkini di dunia sekarang dalam industri berharap dapat menghasilkan produk dengan ketepatan yang baik. Produk berkualiti tinggi membawa kepada pertumbuhan ekonomi yang lebih baik. Menggunakan semua mesin ini hampir mustahil tanpa perisian CAD dan teknologi pengeluaran pemodelan objek. Untuk membantu mesin-mesin ini, perisian Design Aided Computer, perisian Polywork dan Calypso akan digunakan. Tiga bentuk produk dipilih untuk projek ini yang persegi, bulat dan kompleks. Tiga profil dipilih dari setiap bentuk dan tiga jenis alat digunakan untuk mengukur semua profil yang terdiri daripada caller vernier, pengimbas 3D dan CMM. Semua penyimpangan profil telah dibandingkan berdasarkan tanda aras pengukuran produk. Nilai deviasi terkecil telah ditentukan dan mesin ketepatan terbaik diberikan untuk projek ini yang membuktikan spesifikasi dan ketepatan pembuatan untuk mesin.

ABSTRACT

Coordinate Measurement Machine (CMM) and 3D Scanner is a powerful tool for generating a dimension of an object into a Computer Aided Design (CAD) model. There are many types of scanners to perform this task but these two comes first to demand when it comes to produce back the measurement from an existing design of an object. The current technological world development in industries looking forward to come up with products with good precision and accuracy. Higher quality product leads to a better growth of the economy. Using all these machines almost impossible without the computer based design and production technologies modelling of objects. To aid these machines, Computer Aided Design software, Polywork and Calypso software will be used. Three shapes of product were chosen for this project which are square, round, and complex. Three profiles were selected from each shape and three types of tools were used to measures all those profiles which consist of vernier calliper, 3D scanner and CMM. All the profile deviations were compared based on the benchmarks of the products measurement. The smallest deviation values were determined and the best accuracy giving machine was chosen for this project thus proving the manufactures specifications and accuracy for the machines.

DEDICATION

I would love to dedicate this report to my beloved and respectful parents. Thank you for everything and I hope that this achievement will fulfil their dreams and hope that you had for me when you chose to sacrifice everything just to provide me the best education you can possibly could.

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As the letter A is the first of all letters, so the eternal God is the first in this world. Praise to God for His blessings and divine guidance that this project was successfully completed.

To my dear family members, I would be forever in debt with your unconditional love, support and care. Thank you for everything.

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CMM	-	Coordinate Measurement Machine

1.0 Background

In this chapter, an overview of performance analysis of 3D scanner and coordinate measurement machine will be elaborated. The main idea, problem statement, objective and scope of this project will be introduced. The organization of the report is stated below.

1.1 Project Overview

A 3D scanner is a gadget that investigations a genuine object or condition to gather information on its shape and potentially its appearance (e.g. shading). The gathered data information would then be able to be utilized to build computerized three-dimensional models.

A wide range of advancements can be utilized to construct these 3D-checking tools; every innovation accompanies its own impediments, preferences and expenses. Numerous impediments in the sort of articles that can be digitized are as yet present, for instance, optical innovations experience numerous challenges with glossy, reflecting or transparent items. For instance, modern computed tomography scanning can be utilized to develop computerized 3D models, applying non-destructive testing.

Coordinate Measurement Machine (CMM) is a gadget utilized for measuring the physical geometrical attributes of an object. This machine might be physically controlled by an administrator or it might be PC controlled. Measurements are characterized by a probe joined to the third moving axis of this machine. Probe might be mechanical, optical, laser, or white light, among others. A machine which takes readings in six degrees of flexibility and showcases these readings in mathematical shape is known as a CMM.

The common 3D Probe CMM is made out of three axes, X, Y and Z. These axes are orthogonal to each other in a normal three-dimensional arrange system. Every hub has a scale framework that shows the area of that pivot. The machine peruses the contribution from the touch probe, as coordinated by the administrator or software engineer. The machine at that point utilizes the X, Y, and Z directions of each of these focuses to decide size and position with micrometer accuracy commonly.

A coordinate measuring machine (CMM) is also a gadget utilized as a part of assembling and gathering procedures to test a section or get together against the outline expectation. By exactly recording the X, Y, and Z directions of the objective, points are created which would then be able to be broke down through relapse calculations for the development of features. These points are gathered by utilizing a probe that is situated physically by an administrator or naturally by means of Direct Computer Control (DCC). DCC CMMs can be modified to over and over measure identical parts; consequently a CMM is a particular type of modern robot.

Polyworks Software is a business programming package for the preparing and analysis of optically digitized, three-dimensional information and has been produced since 1994 by the Canadian organization InnovMetric Software Inc. of Quebec, Canada. It is for the most part utilized as a part of the fields of reverse engineering, design , quality confirmation advanced assembling, rapid prototyping, chronicling of social property, and in addition in medicinal fields. It read, processes and looks at three-dimensional measurement data information. Utilizing direct interfaces to laser scanners, arrange measuring machines, hand-held material measuring gadgets, photogrammetric systems and additionally uncommon X-beam and CT instruments, high – resolution 3D point clouds can be imported. It additionally offers the conceivable outcomes to examine the recorded data information or to contrast it and "PC Aided Design" design data information. In this way, for instance, the quality of segments and instruments can be checked.

CALYPSO software is software used for almost all type of measuring strategies and tasks. It is suitable for both skilled and non skilled operates. It also can be retrofitted to non-ZEISS measuring systems. Furthermore, it measures and calculated 2D and 3D curves, curve slops, curve form, surface area, profiles and more. This software has interface for all standard CAD formats. Besides that, this software can handle older DMIS coded programmes. Not much time needed and no difficult code or text editing is needed.

1.2 Problem Statement

The leading and fast growing economy is now looking forward for the better production of products of companies. In order to achieve market target, improvements on the production of manufacturing must be implemented regardless to produce better manufacturer not putting a side a better product which can save cost and time. Recently, studies had been made on analyzing and comparing the 3D scanner and the CMM machine on Comparison of Different Method of Measurement Geometry using CMM, Optical Scanner and Computed Tomography 3D. (Gapinski,B, Wieczorowskia,M, Podsadna,L.M, Dybala,B, Ziolkowski,G, (2013).

The problem statement that will be mainly focused here is:

1. How to get the best accuracy and precise reading that can be measured and determined to be processed by using 3D scanner, CMM and vernier calliper?
2. Which of the machine will be giving the best accuracy and precision?

1.3 Project Objective

The aims of this project are follows as:

- To create and read image surface using Polyworks software using 3D scanner and Calypso software using the CMM scanner.
- To analyse, capture surface data and compare data between 3D Scanner and coordinate measurement machine.
- To propose solution for further investigations between three measurement method and decide which gives the best accuracy.

1.4 Project Scope

The scope and limitation of the project are described in Figure 1. This involves:

1. Application of Polyworks software in design and analysis of three different shapes of object using the scanner.
2. Laboratory testing using the probe scanner and the CMM machine to identify the parameter, tolerance, and the accuracy of the machine.

CHAPTER 2
LITERATURE REVIEW

2.0 Background

In this chapter, brief information on 3D scanner research will be presented. Type of scanners, comparison method, and data analyzation will be explained. Review of 3D scanner equipment and machines will also be presented. The flow of the literature review is shown in Figure 2.1.

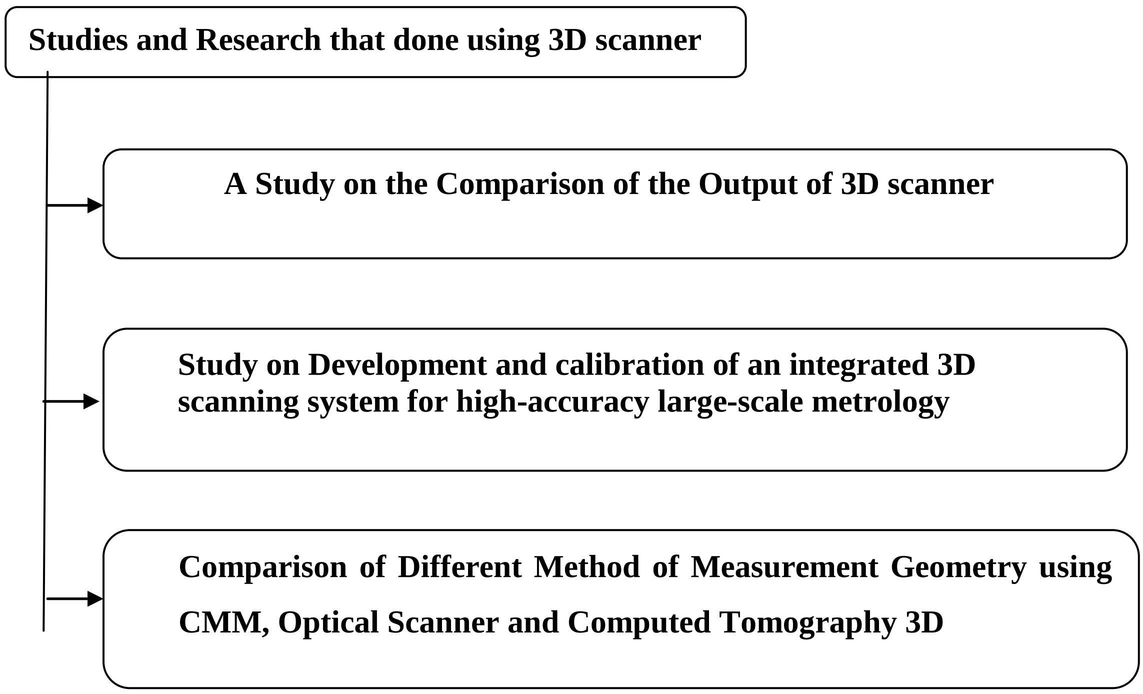

Figure 2.1: Flow Chart of literature Review

2.1 A Study on the Comparison of the Output of 3D scanner

A 3D scanner is a gadget serving for the change of a real object into digital frame. During the way toward detecting, the scanner gathers with the assistance of various advancements data about the shape and measurements of the scanned object and relying upon the innovation can likewise record, for instance, data about the color of the object. The scanned data, perhaps at the same color, is comprised of so called point clouds; this implies each scanned point has position in space regarding of a coordinate system. The data got can be then utilized for the formation of an advanced three-dimensional model of the scanned object. The data from the outcome result can be in this way prepared for various purposes through particular programming software products. 3D scanners can be separated by a few criteria – for instance construction, development and technique for scanning. Isolating of 3D scanners by construction:

- Stationary – they are bound to one place, these scanners used to scan large measurements

- Mobile – they have the advantage of being little in measure and can be conveyed to an immovable object. They can be partitioned by the strategy for scanning

- Contact – For scanning, they require mechanical contact with the scanned object. These are stationary 3D scanners, prevail measure coordinate measuring machines (CMM) and measuring arms.

- Non-contact – optical, laser and different technologies are utilized for scanning reason. They can likewise be partitioned in view of the technique for scanning

- Optical – they work on the photographic rule. The items are scanned from a few angles, and the sweeps are in this way consolidated, to make a digitized 3D picture of the object.

- Laser – these chips works on the triangulation rule. Light reflected off the items are detected and on the basic of the time of return of the light beam and the angle of effect the position of the scanned zone in spaces are resolved.

- Ultrasound – ultrasonic waves are utilized for scanning, and as with lasers the time of reflection and the angle of effect are detected using ultrasonic waves. They have a lower precision (0.3-0.5 mm), not at all like laser scanners.

- X-ray – RTG radiation is utilized for scanning reason. After the passing of the scanned object, the remaining radiation falling on the detector is recognized. With this sort notwithstanding the outer shape, complete data about the general volume of the object is acquired (inward geometry, imperfections of material).

- Mechanical – Known as contact scanner. These can be separated into measuring arms and CMM machines. With these sorts of scanners data isn't acquired from the whole surface of a profile yet from selected points which portray the given region of the object.

- Destructive – During scanning, the scanned object is crushed. This serves for getting the exterior and interior geometry of the object. During checking a thin layer of material is step by step skimmed off the object and the uncovered surface is consequently scanned. (Toth, T, Zivcak, J, 2013)

2.1.1 Scanners

- **Steinbichler Comet L3D**

The Steinbichler Comet empowers non-contact optical scanning and the version utilized for the comparison has resolutions of 2M pixel and 1600x1200 pixels.

The picture shows a portable scanner, where the scanning head is put on a tripod amid scanning. For positioning (Rotation) of the measured object it is conceivable to utilize a rotating table. The provided software takes into account essential alteration of the scanned data, their comparison with a model and exported in the IGES, STEP and STL positions.

Figure 2.2: Steinbichler Comet L3D during scanning.

- **Creaform EXAscan**

  A hand-held portable and self-situating laser 3D scanner, where amid scanning, it allows movement and development of both the scanner and the items being scanned. The scanned position is characterized by positional (referential) markers set on the scanned object; by doing these, it guarantees the spatial introduction of the scanner. The standards of scanning utilizing the Creaform EXAscan scanner are shown in the photo. (Fig.2.3)

Figure 2.3: Creaform EXAscan.

- **Design of the scanned specimen**

  For the necessities of looking at the scanning frameworks an example was outlined and assembled. In perspective of the scanning innovation utilized morphologically complex territories were wiped out in the outline of the measured object and its size, thickness and the composed gaps were set where it was conceivable to look over the whole depth. The states of the bodies were outlined on the basic requirement for scanning the most