THREE DIMENSIONAL COMPUTER AIDED DESIGN APPLICATION IN UPPER BODY MEASUREMENT STUDY USING KINECT CAMERA

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MUHAMMAD ARIF IZZUDDIN BIN FADZIL

A thesis submitted
in fulfillment of the requirements for the degree of
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2023

DECLARATION

I declare that this thesis entitled “Three Dimensional Computer Aided Design Application In Upper Body Measurement Study Using Kinect Camera” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology with Honours.

Signature :

Supervisor Name : *EN. MOHD FA'IZ BIN WAHID*

Date : 11 Jan 2023

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DEDICATION

A special dedication to my beloved parents Mr. Fadzil bin Mohtar and Mrs. Nor Aini binti Yusop for their support and pray for me in completing this final year project. They always supporting me and give very good advices. Not forgetting also to Mr. Mohd Fa'iz who helped a lot, gave encouragement, understood and gave guidance during the process of preparing this report.

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ABSTRACT

Anthropometric is the study of human body measurement. In recent decades, the process of anthropometry has traditionally been done by trained staff using manual tools like tape measures, calipers, and other equipment of different sizes and shapes. The benefits of using manual anthropometric methods include low cost and convenience, as they can be conducted during daytime. Nevertheless, in recent years, new three-dimensional anthropometric studies have emerged, where body measurements are taken quickly, without physical touch and utilizing 3D scanners. Manual measurement can be quite time-consuming and requires a significant amount of staff to measure all parts of the body. This study objective to study the use of CatiaV5 and Solidworks2020 in measuring upper body limbs, to investigate the error differences between manual and 3D measurements and to collect data using both conventional and 3D Camera Anthropometry System methods. To streamline the process, this study utilizes 3D measurement techniques, such as using software like CatiaV5 and Solidwork2020 for measurement. From the data that has been collected, a comparison between manual measurement and 3D measurement has been done to see if there is a significant difference between them. The conclusion of the study suggests that there are certain improvements in anthropometric measurements obtained using 3D software compared to manual measurements. As a result, this comparison may suggest potential changes in the future study of anthropometry.

Keywords: Catia V5, 3D CAD Measurement, Solidwork, Anthropometric measurement, 3D CAS

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ABSTRAK

Antropometrik ialah kajian tentang ukuran badan manusia. Dalam dekad kebelakangan ini, proses antropometri secara tradisinya dilakukan oleh kakitangan terlatih menggunakan alat manual seperti pita pengukur, angkup dan peralatan lain yang berbeza saiz dan bentuk. Faedah menggunakan kaedah antropometrik manual termasuk kos rendah dan kemudahan, kerana ia boleh dijalankan pada waktu siang. Namun begitu, dalam beberapa tahun kebelakangan ini, kajian antropometrik tiga dimensi baharu telah muncul, di mana ukuran badan diambil dengan cepat, tanpa sentuhan fizikal dan menggunakan pengimbas 3D. Pengukuran manual boleh memakan masa yang agak lama dan memerlukan sejumlah besar kakitangan untuk mengukur semua bahagian badan. Objektif kajian ini untuk mengkaji penggunaan CatiaV5 dan Solidworks2020 dalam mengukur anggota badan atas, untuk menyiasat perbezaan ralat antara pengukuran manual dan 3D dan untuk mengumpul data menggunakan kaedah Sistem Antropometri Kamera konvensional dan 3D. Untuk menyelaraskan proses, kajian ini menggunakan teknik pengukuran 3D, seperti menggunakan perisian seperti CatiaV5 dan Solidwork2020 untuk pengukuran. Daripada data yang telah dikumpul, perbandingan antara pengukuran manual dan pengukuran 3D telah dilakukan untuk melihat sama ada terdapat perbezaan yang signifikan antara mereka. Kesimpulan kajian menunjukkan bahawa terdapat peningkatan tertentu dalam pengukuran antropometrik yang diperoleh menggunakan perisian 3D berbanding dengan pengukuran manual. Akibatnya, perbandingan ini mungkin mencadangkan perubahan yang berpotensi dalam kajian antropometri masa hadapan.

Kata kunci: Catia V5, Pengukuran CAD 3D, Kerja Pepejal, Pengukuran antropometrik, CAS 3D

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LIST OF SYMBOLS AND ABBREVIATIONS

P – Percentile

n - Number of values in the data set

M = Mean (average).

K = Factor related to normal distribution on (Z tables).

S = Standard deviation.

R = Respondent

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CHAPTER 1

INTRODUCTION

1.1 Background

Anthropometry is the science that defines physical measures of a person's size, form, and functional capacities. Applied to occupational injury prevention, anthropometric measurements are used to study the interaction of workers with tasks, tools, machines, vehicles, and personal protective equipment, especially to determine the degree of protection against dangerous exposures. The core elements of anthropometry are height, weight, head circumference, body mass index (BMI), body circumferences to assess for adiposity (waist, hip, and limbs), and skinfold thickness.

The advancement of anthropometric methods, which is progressively moved from manual to three dimensional (3D Scanning Measurement increase the usage in the anthropometric survey data (Treleaven, 2004).

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Figure 1.1 Three-dimensional body scanning anthopometric setup (Treleaven, 2004)

Estimating the pose of a human in 3D given an image or a video has recently received significant attention from the scientific community. The main reasons for this trend are the ever increasing new range of applications (e.g., human-robot interaction, gaming, sports performance analysis) which are driven by current technological advances. Although recent approaches have dealt with several challenges and have reported remarkable results, 3D pose estimation remains a largely unsolved problem because real-life applications impose several challenges which are not fully addressed by existing methods. For example, estimating the 3D pose of multiple people in an outdoor environment remains a largely unsolved problem.

1.2 Problem Statement

In this anthropometric field, the size and shape of a person's body is very influential in making the decision to choose a design. So if there are multiple forms, it will pose some problems in collecting the required data.

First, if we use a manual method to measure it will take quite a long time to measure every limb of one's body using a typical instrument. It will take a long time to measure all the parameters only for one respondent. It also allows us to collect incorrect data due to human error when we want to measure difficult parts such as eyes, mouth, ears and so on.

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1.3 Research Objective

The main aim of this research are:

i) To study on measuring method of the upper limb body using CatiaV5 and Solidworks2020

ii) To investigate the error difference between manual measurement using anthropometry tools and 3D measurement using 3D CAD software and its pattern

iii) To collect the measurement data of respondent's upper limb body using conventional and 3D Camera Anthropometry System (3D CAS) method

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1.4 Scope of Research

This research will focus on the upper body anthropometric methods. The scope of this project are first all measurement will be conducted in a laboratory in Universiti Teknikal Malaysia, Melaka. The manual measurement have taken place in Makmal Ergonomic in Fakulti Teknologi Kejuruteraan (FTK) while 3D CAS measurement have been taken at Makmal Ergonomic at Fakulti Kejuruteraan Pembuatan (FKP). The parameters that used in this research contains only 15 parameters. The 3D model have been rendered by using Skanect Software.

Next, the respondent has been set up with 30 respondents and the age range are between 22-26 years old. This study focus on the range age group because every people when they get older, their body segment will be different. After all the data has been collected, the data analysis has been done by using statistical method. This method focus on the calculation on mean, standard deviation and percentile. In this research, the percentile that has been use is 5th, 50th and 95th percentile.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Anthropometric measurements are useful in many fields. For example, athletes needs to understand that body size and composition are important factors in their sports performance. In general, anthropometry is the study of the measurement of the human body. By tradition this has been carried out taking the measurements from body, such as circumferences, using simple instruments like calipers and tape measurement. It has been used as an alternative to measuring body height for some group of people, which differs between different races and genders. (Popovic, Bjelica, et al., 2016). Moreover, the anthropometric measurements involved are the size such as weight, surface area, height and volume. Futhermore, the anthropometric measurements that are involve in this research is upper body parameter such as shoulder width, arm length, waist circumference, neck width and breath width.

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2.2 Anthropometry History

The history of anthropometry includes its use as an early tool of anthropology, use for identification, use for the purposes of understanding human physical variation in paleoanthropology and in various attempts to correlate physical with racial and psychological traits. The word "anthropometry" is derived from the Greek word "anthropic," meaning "human," and the Greek word "metron," meaning "measure" (Ulijaszek, 1994). In 1883, Frenchman Alphonse Bertillon introduced a system of identification that was given

name as "Bertillonage". Bertillon concluded that when these measurements were recorded systematically, every individual would be distinguishable.

The nose, as it cannot be disguised, is extremely important in identification. The types above, taking them from the left, show a low, narrow nose, a hooked nose, a straight nose, a snub nose, and a high, wide nose.

Figure 2.1 : Illustration from “The Speaking Potrait”:The principle of Bertillon’s anthropometry (Person’s Magazine, Vol XI, January to June 1901)

2.3 Three-Dimensional Anthropometry

In 1973, the study of the human body as a three-dimensional has been proposed by Lovesey with a light sectoning technique (Lovesey, 1966). As the interpretation of data was extremely take time to collect, it was label as labor intensive. This make that technology evolved to what we known as 3D body scanner. One of the earliest 3D body scanning systems was a shadow scanning method developed by the Loughborough University in the UK, the Loughborough Anthropometric Shadow Scanner – LASS – (Jones et al., 1989).

For the past several years, the technology of anthropometry measurement have been evolving very quick. Now it is possible to have a complex geometrical features like curve or partial volumes because the measurement are not limited, just not like the traditional one-dimensional measurement. This three-dimensional body scanner have make a big impact in anthropometry field. It makes the measurement more accurate, being more practical, less expensive or cheaper and fast, compared to the conventional anthropometry.

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2.3.1 3D Genex Camera System

The digital anthropometric measurement are increasingly being use in clinical settings that monitor and manage the patients with obesity and related metabolic disorder. It was admisnistered with three-dimensional (3D) optical devices. It give a new powerful tool to the science of anthropometry when using digital device for body scanning. It allows deeper investigation on human body shape too.

In an experiment that have been done by Seth M. Weinberg, Nicole M. Scott, Katherine Neiswanger , Carla A. Brandon and Mary L.Maratiza , they have compared the anthropometric measurement through 3D photogrammetry system which is Genex and 3dMD. There also use conventional measurrement to evaluate the intraobserver precision across these methods. In this experiment thaey have use 18 mannequin heads with 12 linear distance were measured twice by each of that methods. Next after the measurement has finished they find that no significant differences were recorded for for precision. This experiment is the first attepmt to silmultaneously compared 3D image surface with one another and with conventional anthropometry measurement. The result indicate that overall mean different when use this three methods were small enough to be a little practical importance and in term of the intraobserver precision, all methods fared equally well.

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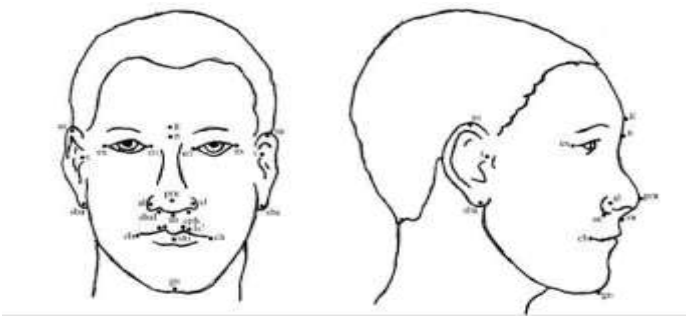

Figure 2.2 : The carniforcal landmarks that have been used in this study(Weinberg et al,. 2001)