VALIDITY AND RELIABILITY OF 3D CAMERA BODY SCANNING ANTHROPOMETRIC MEASUREMENT SYSTEM

Submitted in accordance with the requirement of the University Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

…….....

(Puan Ruzy Haryati Binti Hambali)

ABSTRACT

Anthropometry is a study of human body measurement where it provides a dimension or parameters which taken from surface of landmark in human body. By tradition, manual or direct measurement technique are existed in anthropometric measurement. Generally, the measurement taken has its specified tools such as anthropometer, body tape, and ruler. However, these traditional method tends to contribute to problem of tedious process and time consuming. In order to reduce the difficulties and solve this issue, alternative method or other method suggested and employed. With the advance of technologies, 3D body scanner is one of the method that are being developed and widely used to provide alternative way to researchers. This study aims to identify numbers of anthropometric human body dimension and anthropometric method to be used as comparison. As the number of human body dimension being identified, the data taken will be used to measure the anthropometric body dimension using 3D body scanning measurement and traditional method. After implement both of the measurement method, the comparison of the validity and reliability analysis tests of data obtained will be analyzed through normality test, accuracy test, bias test, test-retest reliability and precision test. This study is to obtain the validity and reliability of 3D camera scanning anthropometric system. Consequently, to ensure safety and comfort in designing and create awareness to, all designers to cooperate to prevent long term health problems.

ABSTRAK

Anthropometri adalah kajian pengukuran tubuh manusia di mana ia memberikan dimensi atau parameter yang diambil dari permukaan mercu tanda dalam tubuh manusia. Mengikut tradisi, teknik pengukuran manual atau teknik pengukuran langsung ada dalam pengukuran antropometrik. Biasanya pengukuran yang diambil mempunyai alat khusus seperti antropometer, pita badan, dan pembaris. Walau bagaimanapun, kaedah tradisional ini cenderung kearah meremehkan dan memakan masa. Dengan kemajuan teknologi, pengimbas badan 3D yang sedang dibangunkan dan digunakan secara meluas untuk memberikan cara alternatif kepada penyelidik untuk menggunakan daripada menggunakan kaedah tradisional. Matlamat kajian ini untuk mengenal pasti bilangan dimensi tubuh manusia antropometrik dan kaedah antropometrik untuk digunakan sebagai perbandingan. Oleh kerana bilangan dimensi tubuh manusia dikenal pasti, data yang diambil akan digunakan untuk mengukur dimensi badan antropometri menggunakan pengukuran pengimbasan badan 3D dan kaedah tradisional. Selepas melaksanakan kedua-dua kaedah pengukuran, perbandingan ujian kesahihan dan ujian kebolehpercayaan data yang diperoleh akan dianalisis menggunakan ujian normal, ujian ketepatan, ujian bias, ujian kebolehpercayaan ujian dan ujian ketepatan. Kajian ini adalah untuk mendapatkan kesahihan dan kebolehpercayaan sistem anthropometri pengimbasan kamera 3D. Oleh itu, untuk memastikan keselamatan dan keselesaan dalam merekabentuk dan mewujudkan kesedaran semua pereka perlulah bekerjasama untuk mencegah masalah kesihatan jangka masa panjang.

DEDICATION

To my beloved family member

my beloved father, Jamingon Bin Sies

my appreciated mother, Hamidah Binti A. Hamid

my brothers Khairul Anwar Bin Jamingon, Khairul Azmi Bin Jamingon and Khairul Azhar Bin Jamingon

and my adored sister Nur Liyana Binti Jamingon

for giving me moral support, money, cooperation, encouragement and also understanding along this project.

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LIST OF ABBREVIATIONS

1D	-	One Dimensional
2D	-	Two Dimensional
3D	-	Three Dimensional
4D	-	Four Dimensional
FKP	-	Fakulti Kejuruteraan Pembuatan
UTeM	-	Universiti Teknikal Malaysia Melaka
SOP	-	Standard Operation Procedure
MAD	-	Mean Absolute Deviation
REM	-	Relative Error Magnitude
MM	-	Manual Measurement
KM	-	Kinect Measurement

CHAPTER 1

INTRODUCTION

This chapter gives a brief introduction the project, start with the background of the project on Validity and Reliability of 3D Camera Scanning Anthropometric Measurement System. Followed by next section which is on the problem statement of the project. Based on these problem statement, the aim and objective of this project can be identified in followed section. Lastly, the significance of study, planning and execution, and thesis organization are also presented in this chapter.

1.1 Background

Anthropometry is the measurements of science and art of function which provide the physical geometry, properties of mass and the human bodies capabilities of strength (Zainon *et al*., 2009). The anthropometry has been used for identification of human physical variation which involves the properties of human body systematic measurement. In other words, anthropometry is use to describe the primarily dimensional of body size and shape. Nowadays anthropometry has been played as an important role in ergonomics, architecture, industrial

design, clinical and clothing design where all of the data that have been collected from the body dimension in the population are used to optimize the products (Othman *et al.*, 2016).

Three-Dimensional (3D) body scanners are one of the measuring instruments which used to take the measurement of anthropometric data from human body. The aim from this 3D body scanner is to know either it can be used as a long-term computer-based anthropometric or not. With the use of 3D body scanner, the anthropometric measurement can be done without having contact with the respondent and can save more time (Faust *et al*., 2010).

1.2 Problem Statement

Anthropometry measurement methods are divided into a few group. The tradition one is using manual anthropometric measurements. Reported that it is time consuming and hard to complete within its tolerance of intra- and inter-individual margins of error in a big study (Koepke *et al*., 2017).

The study also stated that 3D provides an alternative way for anthropometry measurement which give a better and fast within a few seconds. In addition, it is also time consuming for large sample of population and hard to perform even there are guidelines and operation procedure for the measurer to follow (Koepke *et al*., 2017). Study from other journals mentioned that that these 3D laser body scanners serve fast and valuable alternative method as compared to traditional method (Sims *et al.*, 2012).

In order to overcome this problems, with the advance of technologies nowadays, a three-dimension body scanner have been suggested and developed as an alternative to help in taking the measurement of human body. However, collecting anthropometric data for real-life applications demands a high degree of precision and reliability and it is important to test new equipment that will be used for the data collection (Rinaldo *et al.*, 2015).

1.3 Objectives

To overcome this issues, the study came out with several objectives:

1. To identify the number of anthropometric human body dimension and anthropometric method to be used as comparison.
2. To measure the anthropometric body dimension using 3D body scanning measurement and traditional method.
3. To establish the validity and reliability for both anthropometric method using Minitab Analysis software.

1.4 Scope

This study focuses on identifying the number of anthropometric human body dimension and anthropometric method to be used as comparison. This project also need to compare of body dimension data between the traditional anthropometry data with 3D camera scanning body. Beginning of the study, a simple briefing held for the participants. Next, the respondents need to complete the consent form before the measurement method are applied to the respondent. Next, the basis form includes the basic information of the respondent such as name, age, weight, and height are needed in the survey form which need to be filled before starting the measurement. As mention before, there are two methods to be used during the measurement process. The tools that used for the traditional method are measuring tape, body measurement tape, large anthropometer and small anthropometer. While for the 3D camera scanning, it consists of XBox One Kinect Camera, rotating disk, remote of rotating disk, adjustable camera stands, power supply and Microsoft Kinect software. The validity and reliability of 3D camera scanning anthropometric measurement system will be validating either it achieved the "gold standard" that have been set by applying a few analyses on the data. The analysis that used is accuracy, bias, test retest reliability and precision by Minitab software and Microsoft Excel. Participants for this study randomly selected for 30 female students and staff from Fakulti

Kejuruteraan Pembuatan (FKP) from Universiti Teknikal Malaysia Melaka (UTeM). In presenting the young adult population in UTeM, the range of the respondents age are around 20 to 24 years old. As other ethical issues, the measurement are taken from female student only due to the measurer is a female. All respondents required to wear a light clothes or a tight clothes when the measurement is taken. Lastly, the process of the measurement held in the Ergonomics Lab located at Block A, Fakulti Kejuruteraan Pembuatan, UTeM.

1.5 Significance of Study

The significance of this study is likely related to the objectives of this project. The number of dimension of human body can be used for further study in anthropometric field. Once the number of data have been identified, it will be compared between manual method and 3D body scanner method. In addition, the validity and reliability of the data taken can be used for the other related study such as in designing for human. Consequently, to create the awareness in designing, all designers should cooperate to prevent long term health problems into user in order to ensure safety and comfort.

1.6 Planning and Execution

In this project, all of the task related and the specific time to finish the respective task which start from the beginning until the end of the project has been constructed into a Gantt chart. This schedule will be presented in Appendix A.

1.7 Thesis Organization

In Chapter 1 the introduction on the project are briefly discussed. From surrounding manufacturing environment, the problem statements are being define. From problem statement, objective to overcome the problem identified. Scope of study on this project are discussed to make the project more understand to complete.

Chapter 2, the previous research on the project are being reviewed completely in generally in Malaysia and aboard about the anthropometry study. The requirement information on the project are taken from the previous experiment.

Chapter 3 for methodology, which is the section where the method, way and setup are fully described in order to fulfill all of the objective stated in chapter 1. Flowchart on overall project are included in this section. Experimental setup of 3D camera scanner and how to take the measurement using traditional anthropometric are describe in chapter 3.

In Chapter 4, the result obtained from the objective of this study will be stated in this chapter. The discussion about all of the test which are normality, accuracy, test-retest reliability and precision will be mention in this chapter. The result of the data obtained will be stated.

Lastly in Chapter 5, overall findings and discussion of the project will be discussing in this chapter and the recommendation for future works is outlined in this study.

CHAPTER 2

LITERATURE REVIEW

This chapter provides the literature review on the theory and the research which have been defined and done by the previous researchers. Related information about the previous studies have been extracting to discuss and as references based on their research about traditional anthropometric measurement compared to 3D body scanner measurement. The method used and the parameter of each previous research are extracted into a table to compare with each other. This literature review as well covers the validation and the reliability of new developed anthropometric measurement using 3D camera scanning method comparing to traditional and other method.

2.1 Anthropometry Measurement

Before this, the anthropometry has been carried out taking the measurements from the body landmarks, such as circumferences and breaths, using common equipment like calipers and tape measurement (Simmons, 2001). In addition, for learning of human physical variation, anthropometry also has been used in forensic science (Othman *et al.*, 2016).

2.1.1 Development of Anthropometry Measurement in Malaysia

Roughly, in Malaysia, the development of anthropometry measurement is still recognized at the early stage. The nearest anthropometric data we can refer is to Japan for Asian measurement (Nasir *et al*., 2011). The extended growth of youth population in Malaysia has built large demand in customer products which make it necessary to have anthropometric data to show to mark customers but only a few researchers which have been done the measurement. In other words, the research of anthropometric studies in Malaysia is still not comprehensive, unlike the western countries.

2.1.2 Overview of Malaysian Population Anthropometric Data

In biology, the total of a number of individuals of the same species which occupying a certain area at a given time is called population. From the previous research on anthropometric measurement, there is quiet variation number of a population used depends on the target of the researcher. In Malaysia, a lot of researchers have conducted anthropometric studies on a various group of people which mostly focused on a small sample size and used for a specific or certain design and purposed. Table 2.1 below shows the previous authors on several papers comparing the number of the size taken to conduct the anthropometric research of Malaysian population.

Table 2.1: Total Number of Population or Sample from the Previous Researcher

Title of Paper	Subjects
Anthropometric Study of Three-Dimensional Facial Morphology in Malay Adults (Othman *et al*., 2016)	109 respondents (54 males and 55 females)
Incorporating Malaysian's Population Anthropometry Data in the Design of an Ergonomic Driver's Seat (Deros *et al.*, 2015)	1405 respondents (795 males and 610 females)
Reliability and Validity of 3D Body Scanning for Anthropometric Profiling (Forchino *et al.*, 2012)	30 respondent (30 males)

Anthropometric Database for the Learning Environment of High School and University Students (Dawal *et al*., 2012)	High school: 41 respondents (21 males and 20 females) University: 143 respondents (74 males and 69 females)
Preliminary Findings on Anthropometric Data of 19-25-Year-Old Malaysian University Students (Chong & Leong, 2011)	100 respondents (50 males and 50 females)
Anthropometry of Malaysian Young Adults (Karmegam *et al.,* 2011a)	1032 respondents (595 males and 437 females)
Anthropometric Study Among Adults of Different Ethnicity in Malaysia. (Karmegam *et al.*, 2011)	300 respondents (150 males and 150 females)
Development of a Malaysian Anthropometric Database (Mohamad *et al*., 2010)	1007 respondents (516 males and 491 females)
Recommended Chair and Work Surfaces Dimensions of VDT Tasks for Malaysian Citizens (Deros *et al*., 2009)	638 respondents (273 males and 365 females)
Anthropometry Dimensions of Older Malaysians (Rizal *et al.*, 2009)	230 respondents (129 males and 101 females)