UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE DEVELOPMENT OF MEASURING SYSTEM FOR HUMAN BODY USING IMAGE PROCESSING TECHNIQUE

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for bachelor's 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 requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons). The member of the supervisory is as follow:

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DR. RUZAIDI BIN ZAMRI

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ABSTRAK

Sistem ukuran adalah salah satu asas yang paling utama dalam idea sains. Tanpa fleksibilti untuk mengukur, ia mungkin menyukarkan para saintis, para pengkaji untuk menjalankan eksperimen atau mencipta suatu teori yang baru. Bukan sahaja pengukuran ini penting untuk sains, tambahan pula penting dalam pertanian, kejuruteraan, pembinaan, pembuatan, perdaganggan dan kepelbagaian dalam perkerjaan dan aktiviti. Selari dengan peredaran masa yang memerlukan dan mementingkan masa dan ketepatan, sistem ukuran juga tidak terkecuali dalam mengekori teknologi yang canggih. Sistem ukuran manual telah digantikan dengan sistem automasi. Keberkesanan automasi dalam sistem ukuran sangat membantu seluruh sektor yang inginkan kepantasan dalam mendapatkan ukuran data. Ukuran tinggi manusia menggunakan sistem ukuran yang manual mengambil masa dan ketepatan ukuran adalah berbeza setiap kali mengambil ukuran kerana factor alat ukur itu sendiri dan pengalaman atau kemahiran untuk mengendailkan alat ukuran tersebut. Oleh itu, objektif utama projek ini adalah membangunkan ukuran penglihatan untuk mengukur tinggi manusia dan panjang lengan. Gabungan antara perkakas seperti kamera, komputer riba dan papan komputer tunggal disertakan dengan pertolongan bahasa Python dapat menayambung perkakas-perkakas ini mengikut kehendak program. Teknik memproses gambar dijalankan untuk mendapatkan maklumat daripada gambar yang diambil dan mengambil ukuran daripada gambar teserbut. Skop projek ini adalah menggunakan bahasa Python sahaja. Ukuran yang diambil hanyalah tinggi manusia dan panjang lengan. Seramai tiga puluh rakyat Malaysia lingkungan umur 22 hingga 26 tahun dipilih untuk menjalankan projek ini. Data perbezaan dari segi pengunaan waktu untuk mengambil ukuran data antara dua cara iaitu sistem ukuran manual dan sistem ukuran penglihatan diambil dan dianalisis. Beserta ketepatan dan kejituan antara dua cara ini direkod dan diselidik.

ABSTRACT

Measurement system is probably one amongst the foremost fundamental ideas in science. without the flexibility to measure, it might be difficult for scientists, researcher to conduct experiments or creating a new theory. Not solely measuring is vital in science, it's additionally essential in farming, engineering, construction, manufacturing, commerce, and diverse other occupations and activities. In parallel with the fast-paced era that need and valued time and accuracy, system measurement isn't exceptional in following the sophisticated technology. Manual system measurement is being replaced with the automation system. Automation effectiveness in system measurement are really helpful in various sector that crave for the speed in getting the measuring data. Measuring height of a person using manual measurement system takes a longer time and the accuracy of the measurement are different for each time the measurement is taken because of the factor that the measurement tools itself and the experience and skill of the person handling the measuring tools. Because of that, main objective of this project is to develop vision measurement system to measure the height of human body and length of human arms. Combination between this hardware such as camera, laptop and single board computer with the aid of Python language helping to connect these hardware's in order to follow the desired program. Image processing technique is run to gather the information from the image and taking measurement for those images. Scope of this project is to use Python language only. Measurement that are take only height of human and arm's length. Thirty Malaysian citizen in age range of 20 until 26 years old is selected to execute this project. Comparison data in term of time consumption between manual measurement system and vision measurement system is being taken and analysis and also its accuracy and precision between these two methods is being record and study.

DEDICATION

A very special thanks to my one and the only my beloved parents, Ghazali and Norbiti and to my adored siblings, for the generous moral support, money, cooperation, encouragement and also understandings. Thank you to all my friends who willing to support me in data collection. I also want to say thank you to my kind and helpful supervisor, Dr Ruzaidi Bin Zamri for your helpful guidance and support through this project. Lastly, appreciation goes to my knowledgeable and experience examiners for spending your precious time reading my draft and corrected me during my presentation

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Thank you for my surrounding people and my strong determination and spirit I manage to complete this final year project successfully by solving all the difficulties one by one. It was really a long process with challenging hardship.

My respected supervisor, Dr. Ruzaidi Bin Zamri. His kindness, unwavering patience and mentorship guided me through the process, his easily understood explanations and open mind allowed me to grow and learn in such a way that I am now a better researcher.

Also, I would like to give a special thanks to my best friends who gave me much motivation and cooperation mentally in completing this report especially when I really wanted to give up and change title due to the stress of unable to solve the difficulties. They had given their critical suggestion and comments throughout my research. Thanks for the great friendship.

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LIST OF ABBREVIATIONS

SI	-	Système internationale / International system
CMOS	-	Complementary Metal-Oxide-Semiconductor
GUI	-	Graphic user interface
3D	-	3-Dimensional
2D	-	2-Dimensional
RGB	-	Red green blue
MRI	-	Magnetic resonance imaging
IEEE	-	Institute of electrical and electronics engineers
UTeM	-	University Teknikal Malaysia Melaka
RPi	-	Raspberry Pi
GPU	-	Graphics processing unit
OpenCV	-	Open source computer version
CPU	-	Central processing unit
RAM	-	Random access memory
HDD	-	Hard disk drive
LAN	-	Local area network
FDH	-	Fibre distribution hub
LED	-	Light emitting diode
OS	-	Operating system
Wi-Fi	-	Wireless fidelity
USB	-	Universal serial bus
HDMI	-	High definition multimedia interface
SD	-	Secure digital

FYP I	-	Final year project I
FYP II	-	Final year project II
FFC	-	Flexible flat cable
VNC	-	Virtual network computing
HPF	-	High-pass filters
LPF	-	Low-pass filters
LED	-	Light emitting diode

LIST OF SYMBOLS

SI	-	Système Internationale / International System
%	-	Percentage
π	-	Pi
m	-	meter
kg	-	Kilogram
s	-	Second
K	-	Kelvin
mol	-	Mole
A	-	Ampere
cd	-	Cande

CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Scientists and researcher make use of their skills and technique as they investigate the problem that occurred surround them. They doing an observation by gathering and collecting data with their senses. Some observations are straightforward. for instance, an easy observation would be determining the color or texture of an object. However, if scientists need to understand additional about a substance, they will have to be compelled to take measurements.

Measurement is probably one amongst the foremost fundamental ideas in science. without the flexibility to measure, it might be difficult for scientists, researcher to conduct experiments or creating a new theory. Not solely measuring is vital in science, it's additionally essential in farming, engineering, construction, manufacturing, commerce, and diverse other occupations and activities. The earliest and most blatant method of measurement things was using elements of the physical body. Ancient Egyptians used their hands and feet to measure length and width. Since these lengths invariably varied, the royal cubit was introduced, that was a granite rod that used the current king's dimensions as the customary by which to measure objects.

Back then, the concept of a standardize measurement system didn't exist and develop. Unified system of measurement taking place in late 18th century where the first standardize system of measurement which is metric system being develop in France in the 1790s. In year 1960, Système International d'Unites or as it's called SI unit system are came from the revise and simplified from the metric system that have been develop in the 18th century. There are seven base units of the SI system are listed in the table below (Table 1.1).

MEASURE	BASE UNIT
Length	Meter (m)
Mass	Kilogram (kg)
Time	Second (s)
Temperature	Kelvin (K)
Amount of substance	Mole (mol)
Electric Current	Ampere (A)
Luminous Intensity	Candela (cd)

Table 1.1 Base units of SI system

The term anthropometry is a study of human body proportion and its measurement. The usage of the anthropometry can be traced back in the ancient civilizations where they making use of anthropometrical measurements for cultural functions to represent beauty, power, and alternative fascinating attributes of the human form. Symmetry was significantly desirable, and units of measurement usually mostly consisted of the width of a person's hand or length of a person's foot. The historical use of anthropometry has been applied to a wide range of applications, including:

- Paleoanthropology and human evolution
- Biological anthropology
- Phylogeographic
- Criminology and Forensics
- Phrenology
- Physiognomy
- Craniometry and craniofacial attributes

The growth of anthropometry studies is growing rapidly towards the 21st century as its used to gather scientific and epidemiological data. It also important in industries that value ergonomics, fashion, and human identification. Anthropometry have its own values in term of going commercialization where the data is really useful and valuable for industrial researcher in the design of high quality custom design clothing, and also in the engineering like designing the ergonomic car seat, suitable ride height of racing bicycle for professional cyclist, layout of airplane cockpit for pilot maneuverer efficiency and many more.

As the world are pursuing into fast phase technologies, where every daily life routine needs to be fast and efficient. Measurement system is also not exempt on this rapid growing of technology where manual measurement tools is being replace with faster, convenience and most importantly it's accuracy and precision of the measurement tools getting better rather than manual measurement. Within medical institutions, manual measurement of body dimensions is common practice and its process is time consuming as it requires different measuring instruments and the skills and knowledge needed to operate them. (Willem et al., 2018). First detailed anthropometric measurements were performed on human cadavers (R. Drills et al., 1964) because of lack of modern body scanning technologies and precise electronic measurement devices, direct measurement on a segment removed from the body was the only option (Stancic et al., 2009).

As the high-technologies taking over the world, errors made by human is possibly eliminate or reduced by applying the technologies thus increasing the efficiency and accuracy of the measurement tools. Nowadays, image analysis technologies have been in applied in measurement segment. Meunier and Yin (2000) make an introduction on anthropometric measurement system where the two-dimensional images can generate a body measurement. Vision measuring method is the current most effective advance method and most of its application use in the field of automation industry to speed up the parameter measuring of components of electronics, appliances or material. It can be very useful especially in anthropometric and clinical categories.

In Asia especially in Malaysia, there's various of anthropometry data that have been taken. Various studies on anthropometry in Malaysia were conducted by Deros et al. (2009), Rosnah and Wong (1996), Karmegam et al. (2011) and Ngeow and Aljunid (2009) focusing on

young adults. Anthropometric for older Malaysian were also reported by Sharifah Norazizan et al. (2006), Rosnah et al. (2006) and Suriah et al. (1998). Most of the anthropometry data are taken using manual measurement method. Studies that being conducted by Deros et al. (2013) stated that, 15 bodily dimensions were measured and recorded using traditional measuring tools such as measuring tape, ruler, Martin's human body measuring kit and anthropometer. The data collection process took a long time but it is not costly, easy to manage, mobile and flexible (Deros et al. 2009).

1.2 PROBLEM STATEMENTS

The method of measuring body parts, which is height of human body and length of human arm is still using the manual measurement method which is called anthropometric using manual measuring equipment such as wall mounted stadiometer (Figure 1.1) to measure height of human body and measuring tape (Figure 1.2) to measure the length of human arm. Every single measurement taken by using that measuring equipment is not clearly or precisely determined. Anthropometry is very sensitive to measurement error (Villamor & Bosch, 2014). Manual anthropometric techniques can present issues related to human measurement errors (Sicotte et al., 2010).

Higher chance of error when using an anthropometric measurement is occurs because of the variability of anthropometry equipment measurement and also various technique to operate the equipment can lead to the error. (Perini et al., 2005). Error appears with the reason of the untreated experimental measuring apparatus intervals (Kretchmer, 2018). The need of professional and trained examiners is important on using anthropometric measurement as its relatively high between-measurement technical errors and mechanical limitations (NYORC, 2006; Haniff et al., 2008). Surveys that involve a large number of samples require a group of skilled and trained people to do the measurement, and this can lead to measurement errors (Ulijaszek & Kerr, 1999).

Figure 1.1 wall mounted stadiometer

Figure 1.2 Measuring tape

The lack of accuracy and time consuming may become main issue in automation era. Hence, there is a need to replace the manual anthropometric method of measuring human body height and length of human arms with a faster, higher precision and practical method. Open source software known as Python are preferable as it always associate with image processing technique. With the aid of Raspberry Pi as a single-board computer to process the coding and with the extension module of CMOS (Complementary Metal-Oxide-Semiconductor) camera that delivers excellent image quality which is crucial in digital image processing.

1.3 OBJECTIVES

The objectives are as follow

(a) To develop an image processing coding for human body height and length of human arms and compute length of human arms span and human body height index using Python programming language.

(b) To validate vision sensor measurement method with manual measurement method in term of time consumption.

(c) To compare vision sensor measurement method with manual anthropometric measurement method. (wall mounted stadiometer and measuring tape) in term of accuracy and precision between these methods.

1.4 SCOPES OF THE RESEARCH

The broad scopes of this research will be narrowed down into three main scopes to tally with the research objectives. First scope is to develop coding using the Python language in digital image processing. Many of the previous researcher regarding into the image processing technique use Python as it has its own open source in the internet that can be referred plus the open source is mostly free

Second, research on vision measurement focusing on height of human body as well the length of human arms. The measurement data will be record and tabulated. Manual measurement method using wall mounted stadiometer and measuring tape are also record and tabulated. Data between these two methods will be compare in term of time consumption taken for each subject sample. Figure 1.3 shows the human height and length of human arm span.

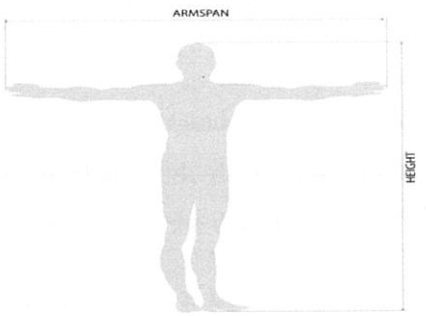

Figure 1.3 Height and arm span

Third, all the data collected only focus on Malaysian people. The Malaysian sampling collected is thirty random Malaysian citizen age range between 22 until 26 years old. Sample need to be in specific to ensure the data gathered is in range. The raw data collected can be used for analysis including comparison in method collected between machine vision and manually measurement.