THE DEVELOPMENT OF OBJECT MEASURING SYSTEM USING IMAGE PROCESSING TECHNIQUE

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering

by

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DECLARATION

I hereby, declared this report entitled "The Development of Object Measuring System Using Image Processing Technique" is the result of my own research except as cited in references.

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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 (Engineering Materials) (Hons). The members of the supervisory committee are as follow:

……………………..................................

(Dr. Ruzaidi Bin Zamri)

……………………….................

(Dr. Mohd Sukor Bin Salleh)

ABSTRAK

Sistem ukuran secara manual telah digunakan dalam bidang pertanian, pakaian, perubatan, antropometrik dan pembinaan. Sistem ini memerlukan ketepatan yang sangat tinggi dalam unit tertentu untuk mengelakkan masalah produk tidak boleh muat. Walau bagaimanapun, system ukuran secara manual tidak berfungsi seperti yang disangka kerana cara ukuran ini memerlukan masa yang banyak, keputusannya tidak tepat dan orang yang melakukan ukuran perlukan penglihatan yang tajam. Dalam automasi era, semua progress termasuk sistem ukuran dijangka tamat dalam masa yang lebih singkat dan memperoleh ukuran ketepatan yang tinggi. Oleh sedemikian, banyak penyelidik melakukan pengajian berkaitan dengan system ukuran. Pengukuran manual semakin diganti dengan kaedah pengukuran baru yang dikenali sebagai pengukuran penglihatan. Dalam era automasi sekarang, data antropometrik juga amat penting dalam gaya hidup harian manusia disebabkan oleh perluasan penggunaannya dari penggunaan tentera, industri pakaian kepada peranti elektronik seperti telefon pintar. Oleh itu, matlamat utama projek ini adalah untuk membangunkan sistem pengukuran penglihatan untuk mengukur lingkar tangan. Gabungan sistem perkakasan dan perisian dapat mengotomatisi kaedah ukuran lingkar tangan untuk menggantikan pengukuran manual. Sistem perkakasan termasuk kamera, papan induk dan komputer riba manakala sistem perisian merujuk kepada sistem pengaturcaraan. Biasanya, pengekodan untuk sistem pengukuran penglihatan tidak akan didedahkan. Sehubungan dengan itu, sumber terbuka Python digunakan sebagai bahasa pengaturcaraan untuk projek ini. Kadar berjaya untuk pengukuran penglihatan mencapai 80% dan pengukuran secara manual mencapai 100%. Perbandingan kaedah ini dalam penggunaan masa telah membuktikan pengukuran penglihatan lebih cepat. Analisis dan perbandingan antara kaedah ini mengesahkan bahawa pengukuran penglihatan boleh menggantikan pngukuran manual kerana hanya subjek number lapan bermasalah. Projek ini dijangka memperkenalkan cara automatik menggunakan pengukuran penglihatan untuk menggantikan pengukuran manual dalam usaha mendapatkan data antropometrik.

ABSTRACT

Measuring system has been used in agriculture, apparel, medicine, anthropometry and construction since the born of the manual measurement. It requires high quality of accuracy to reduce the error of unfit in the finish product. However, manual measurement is not very practical because it has been proved to be time consuming, lack of accuracy and it requires good eyesight. Due to the drive of the high demand in accuracy and shorter time in the automation era, a larger and deeper research in improving measuring data has been done. Manual measurement slowly replaced by a new method of measuring system, which is known as vision measurement. In this current automation era, anthropometric data also becomes critical in the daily lifestyle of human beings. This is because its usage has been widened from the military used, apparel industry to electronic device such as smartphone. Therefore, the main objective of this project is to develop a vision measurement system to measure hand palm. A combination of hardware and software system will fully automate in getting the measurement data to replace manual measurement. Hardware system includes a camera, a mother board and a laptop while software system refers to the programming developing system. Normally, the coding for the well-developed vision measurement system will not reveal. Hence, open source Python is used as the programming language for this project to demonstrate the automation in measurement. Finally, data collection for both methods is done and the successful rate for vison and manual are 80% and 100% respectively. Comparison in terms of time consumption proved that vison method is faster than manual method. Lastly, analyzed and compared these two type of measuring system concluded that vision method can replace manual method because only data subject number eight has error. An improvement and further analysis in future can minimise and eliminate this problem. Therefore, this project is expected to introduce an automatic way using vision measurement to replace manual measurement to get anthropometric data.

DEDICATION

Special thanks to my one and the only
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LIST OF ABBREVIATIONS

BC	-	Before christ
SI	-	Système internationale / International system
PSFS	-	Patient-specific functional scale
GUI	-	Graphic user interface
3D	-	3-Dimensional
2D	-	2-Dimensional
ROI	-	Region of interest
RGB	-	Red green blue
BGR	-	Blue green red
TI	-	Thermal index
MRI	-	Magnetic resonance imaging
CT	-	Computer tomography
HSL	-	Hue-saturation-luminance
EMT	-	Edge maximum technique
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
SL	-	Single language
WiFi	-	Wireless fidelity
BLE	-	Bluetooth low energy

GPIO	-	General purpose input/output
USB	-	Universal serial bus
HDMI	-	High definition multimedia interface
CSI	-	Camera serial 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
VS	-	Versus
Jpg	-	Joint photographic expert group
STD	-	Standard deviation
LOA	-	Limit of agreement
LED	-	Light emitting diode
BOM		Bill of material
ECM		Environmental conscious manufacturing
LLL		Long life learning
BE		Basic Entrepreneurship

LIST OF SYMBOLS

BC	-	Before Christ
SI	-	Système Internationale / International System
%	-	Percentage
π	-	Pi
r	-	Radius
mm	-	Millimetre
$\sum$	-	Summation
$\bar{x}$	-	Mean

CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Measurement system provides unit to outline the identity and characteristic of a product. The identity and characteristic include value, size and shape of the product. It is widely used and great contributes in agriculture, education, construction, food and clothes industry. Measurement system was originated in the 3rd millennium BC. This was the period when human beings started to transform from a moving to a nomadic lifestyle. With a replacement of money to trade from exchange system, known as "Barter System", the measurement system became critical. The slowly growing of trading importance between community and across the world elevated the growing of measurement system to a higher accuracy and increasingly diverse set of fields. The first of measurement technique and standard were created during the Egyptians time when Royal Cubit (Figure 1.1) was use as today's length measurement. It was a technique measure from the distance from Pharaoh's elbow to his fingertips (David Flack, October 2012). Today, the science of measurement term is known as metrology. It involves dimensional measurement which defines as a measuring of an artefact. Artefact can be the diameter of a ball, the length of a table and the volume of a bottle. In metric world, the SI unit of length is meter and it is possible to switch to millimeter, centimeter, kilometer and other related measurement (Flack, 2009).

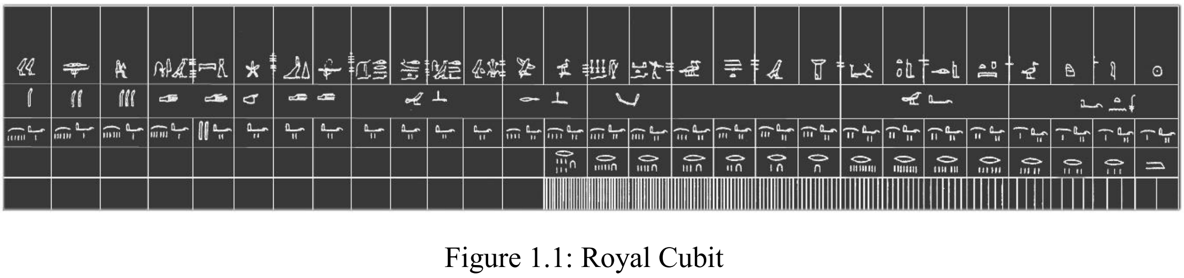

Figure 1.1: Royal Cubit

To study a variety of human's aspects within past and present societies, an anthropologist engages in the practice of anthropology. Human body measurement is collected to complete the anthropometric data of community. The data collected is useful for military database, educational and future research. The future research includes a previous study to investigate the reliability of Patient-Specific Functional Scale (PSFS) by measuring the PSFS with a standard error to justify the reliability of the clinical utility (Wright et al., 2018). There are also plenty of ergonomics researcher seeks to improve the ergonomics data to study deeper on the behavior of specific community. A group of researchers came up with an idea using the hand dimensions and index finger length ratio to determine the gender. They concluded using hand dimensions can detect the gender in forensic identify investigation (Ibrahim et al., 2016). In 2016, researchers measured the hand morphometry at different gestational ages babies. They said the data is important for industrial applications especially in gripping performances of pre-term baby things (Honoré et al., 2016).

With the rapid growing of technology in modern era, the manual measuring instrument slowly replaced by digital measuring instrument and now vision measuring instrument. Two-dimensional (2D) photogrammetry was served as the primary sources for craniofacial measurement data to covered the inaccuracy of direct anthropometry and it was then transformed to three-dimensional (3D) imaging technique such as laser surface scanner and stereo-photogrammetry for craniofacial investigation (Weinberg et al., 2004). A hand anthropometry survey was carried out and electronics digital caliper with an accuracy of 0.01mm was used to measure twenty-four hand dimensions (Mandahawi et al., 2008). Vision sensing and image processing compile with machine visual identification technology is largely used in automation industry due to its fast speed and high accuracy (Min & Principle, 2015). It must comply with the application of digital image processing and a computer to transfer an image or video from the camera and then using algorithms to measure the subject parameter or track the motion of an object in the image. Using a combine method of photogrammetry and digital image processing can make real time traffic measurement to adjust the timings of traffic lights (Zhu et al., 2015). Jing Min mentioned that a new detection technology using machine vision can replace traditional techniques of detecting screw thread (Min & Principle, 2015).

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. For example, digital image processing technique measured the torsion from eye multitemporal based on the eye image (Parker et al., 1985).

1.2 PROBLEM STATEMENT

The method of measuring 3 selective parts of hand, which are palm breadth, palm length and finger length is still using Vernier caliper (Figure1.2) or digital caliper (Figure 1.3). It is not surprised that every single measurement is subject to uncertainly (Paolo et al., 2017). There are many type of errors occurred proven by previous research stated that direct measurement is not reliable. According to the authors of Fundamentals of Dimensional Metrology book, caliper is difficult to follow Abbe's Law to achieve high accuracy because there are always errors (Flack, 2009). Errors appears with the reason of the untreated experimental measuring apparatus intervals (Krechmer, 2018) In measurement, risk of human error is associated with operator error which includes physical and mental stress state that lead to observational error and wrong formal procedures as well as response options (Paolo et al., 2017). Reading the calliper requires good eyesight and skill to avoid misreading (Flack, 2009). The manufacturers can only manipulate the error to minimum but they cannot eliminate the error (Dotson, 2016).

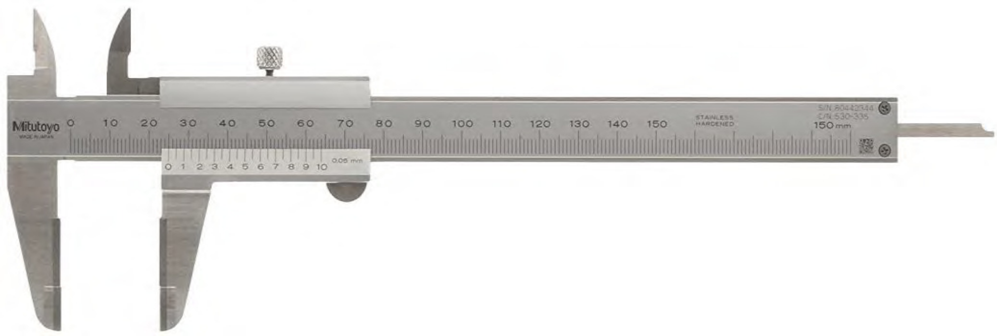

Figure 1.2: Vernier caliper

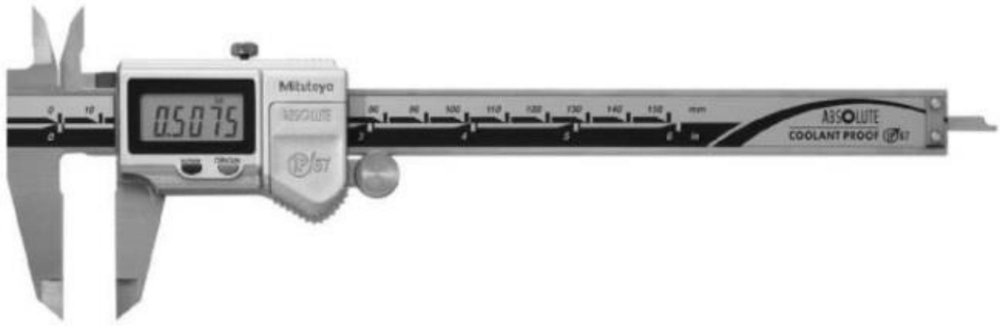

Figure 1.3: Digital caliper

Besides, proceeding a measurement using caliper is very time consuming (Kohnen, 2002). The lack of accuracy and time consuming may become main issue in automation era. Hence, there is a need to replace this traditional manually measuring hand method with a faster, higher accuracy and easier method. Not only that, many researchers do not reveal their measurement coding. Therefore, that is a need to demonstrate automation in measurement. Coding is developed with the used of open source software known as Python.

1.3 OBJECTIVES

The objectives are as follows:

(a) To develop an image processing coding for hand breadth, hand palm and finger length measurement and compute finger vs palm (shape) index.

(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 measurement method.