UPPER AND LOWER TORSO CONTACTLESS BODY SIZE MEASUREMENT SYSTEM USING RANGING SENSORS AND CAMERA

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DECLARATION

I declare that this thesis entitled "UPPER AND LOWER TORSO CONTACTLESS BODY SIZE MEASUREMENT SYSTEM USING RANGING SENSORS AND 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 report entitled "UPPER AND LOWER TORSO CONTACTLESS BODY SIZE MEASUREMENT SYSTEM USING RANGING SENSORS AND CAMERA and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours.

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DEDICATIONS

To my beloved mother and father

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All effort in making this report, I would like to give my pleasure to everyone that involved to excel my final year report and project. That I want to please everyone who always reminds my heart.

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Finally, I would like to apologize for all the mistakes made from the beginning of this writing to the end of my writing and I hope all readers pray for my success in the future.

ABSTRACT

Contactless body size measurement system is not an extremely new topic nowadays as the era of technology revolution accelerate quickly in a short period of time. However, there are a lot of way to measure human body size using a contactless system. From the view of way to measure human body size and evalute its performance compare to other existing system, this project is to create and design a contactless body size measurement system by using ranging sensors and camera. The criteria of this contactless body size measurement system such as type of sensor, hardware requirements, distance bietween sensor and human, sample sizes and accuracy were taken to measure to have the most efficient contactless body size measurement system. To take the human body size measurement, human are required to stand exactly two metres away from the sensor after starting the program. All the further methods to take human body size measurement will be discuss in the metodolgy of this project. Besides, the results of this system will be compared to other existing system to assess system performance and efficiency. This contactless body size measurement system has an accuracy of 98.35% compared to other existing system. This shows the system can operate perfectly even its manufacturing cost is a lot cheaper than other existing system. Thus, this project is expected to contribute in fashion industries locally and perhaps globally.

ABSTRAK

Dalam mendepani era revolusi yang kian pesat dalam jangka masa yang singkat, sistem pengukuran saiz badan tanpa sentuhan bukanlah suatu topik yang baharu. Walau bagaimanapun, terdapat banyak cara untuk mengukur ukuran badan manusia dengan menggunakan sistem tanpa sentuh. Dari pandangan cara mengukur ukuran badan manusia dan menilai kebolehannya berbanding dengan sistem lain yang sedia ada, projek ini adalah untuk membuat dan merekacipta sistem pengukuran ukuran badan tanpa sentuhan dengan menggunakan sensor jarak jauh dan kamera. Kriteria sistem pengukuran ukuran badan tanpa sentuhan ini seperti jenis sensor, keperluan perkakasan, jarak antara sensor dan manusia, ukuran dan ketepatan sampel diambil untuk mengukur agar sistem pengukuran ukuran badan tanpa sentuhan yang paling efisien. Untuk mengambil ukuran badan manusia, mereka hendaklah berdiri sekurang-kurangnya dua meter dari sistem tersebut selepas sistem ini dimulakan. Selain itu, seluruh teknik untuk mengambil bacaan akan dibincangkan dalam bahagian metodologi projek ini. Selain itu, keputusan antara sistem ini akan dibandingkan dengan sistem lain yang sedia ada untuk menilai prestasi dan kecekapan sistem. Sistem pengukur badan tanpa sentuhan ini memperoleh ketepatan sebanyak 98.35% berbanding sistem-sistem pengukur badan sedia ada. Ini menunjukkan sistem ini boleh berfungsi dengan baik walaupun ianya lebih jimat dari segi kos pembuatan berbanding sistem sedia ada. Oleh itu, projek ini diharapkan dapat memberi sumbangan dalam industri fesyen di peringkat tempatan dan seterusnya di peringkat global.

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cm	-	centimeters
IR	-	Infrared

CHAPTER 1

INTRODUCTION

1.1 Background

Fashion industries is the basic industry on which the other industries rely upon. It is the most significant industries that contributes to economic activities takes place around the world. Nowadays, everyone wants to stand out from the crowd and that can be done by looking from their outfits. By looking at someone qualities, the first impression comes from clothing and accessories someone is carrying. Hence, fashion industry plays an important role in every nation's economy. In the simplest terms, the fashion industry can be described as a garment-making business, but that would eliminate the important differences between fashion and clothing. Clothing is functional clothing, one of the basic human needs, but fashion combines prejudice of style, individual taste, and cultural evolution.

Nowadays, the design of highly accurate and precise embedded sensors measuring human body size in fashion industry has resulted in efficient fashion industry, improving life essential and reducing time and expenditure to travel to shop. Efficient fashion industry allows for the vision of smart fashion industry, which is about taking human body size measurement through virtual reality without the need of physical human contact.

1.2 Motivation

In this era of modern revolution, everyone is increasingly dependent on technology. The needs of technology in our daily lives has becoming significant towards today generation. Recently, world was shocked by the coronavirus disease, Covid-19 pandemic. The outbreak of Covid-19 has created a global health crisis that has had a profound effect on the way we view the world and our daily lives. The outbreak has not only halted any sense of normalcy, but it also delivered an economic impact. Implications were felt as early as January 2020, when domestic and foreign manufacturers halted operations to curb the spread of the virus.

Fashion retail is one of the worst-hit industries hit by the Covid-19 epidemic, amid a slowing economy. Fashion retailers around the world are trying to survive. Offline sales plummeted as stores closed, e-commerce platforms faced stiff competition and consumer demand weakened with pessimism. From luxury to fast fashion, fashion retailers across all segments are bracing for impact. Lately, Online shopping or shopping through the web is gaining popularity as it saves a lot of valuable time for shoppers and also reduces other hassles. [9] Moreover, online shopping is widely accepted worldwide because of the pandemic that forces us to stay at home unless there are essential needs. Although customers can find all the fabric information through the website, such as design, size, fabric color and other features, they cannot decide whether the fabric suits the style, color, size and other aspects. The clothes delivered may therefore also not suit the consumer.

A number of experts have recently experimented in this area to solve the challenges of online shopping. The researchers came up with the concept of putting on certain clothes or clothing so that customers may not have to try it physically. So, I am motivated to design a system that can help customers to shop cloth online without the need to go to the shop to take body size measurement.

1.3 Problem Statement

The first problem statement of this study is the new norm which limit physical contact between human and a strict order of movement. This is happening to prevent the spreading of Covid-19. As we know, measuring tape was used before to measure human body size such as arm length, waist circumference and chest length. This manual method of taking human body size measurement involves physical human contact when one person needs to apply the measuring tape to the other person which her body size measurement was being taken. Hence, an idea to apply contactless human body size measurement system would be more efficient to prevent physical contact between humans. Although this system may help to reduce physical contact between humans, the accuracy of this contactless system can be questioned. Other than that, this system is saving huge amount of valuable time of the shoppers and also reducing other hassles.

The second problem statement is the capability of data derived from cameras and sensors used in this system to locate the outer side of human body with variety type of sizes and high when performs specific poses. To overcome this, an accurate body size measurement can be obtained by using correct algorithm and method of calculation and the error of this system can be taken to the edge.

1.4 Objectives

1. To design upper and lower torso contactless body size measurement system by using ranging sensors and camera.

2. To calculate human body size measurement such as shoulder width, arm length, waist circumference and leg length.

3. To evaluate the performance and accuracy of this contactless body size measurement system compared to others existing system and manual method.

1.5 Scope

- Raspberry Pi 4 was used as microcontroller to setup the configuration of hardware.

- An algorithm was used to calculate the body size measurement of human.

- Cameras and ranging sensors were used to detect the human outer side of body and shown in computers.

- Human body size must be taken and compare the results between manually method and contactless system to calculate the accuracy and efficiency of the system.

- Compare the results with other existing system (Kinect, magic mirror, depth camera).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays, various type of contactless body size measurement system has been used widely in fashion industries. Based on the research on this particular topic, some hypothesis has been made. While such different hypotheses are included in the literature, this analysis will concentrate on six main themes that appear consistently in the literature reviewed. These themes include type of sensors, hardware requirements, distance between human and sensors, method of calculation, sample sizes and lastly accuracy of the system. While these subjects are explored in the literature in different ways, this article will specifically concentrate on the implementation of the system.

2.2 Type of Sensors

The basis for creating a range of items is measurements characterizing human body posture and shadow. The largest range of measurement data includes clothing items that include silhouettes [2]. Genetic determination is influenced by various forms of body structure, but we only inherit the ability to acquire characteristics. External environmental factors also impact the composition of the body, such as climate, lifestyle, diet and physical activity. Characteristics of the body system, which are closely related to genetic determination, in particular body measurements and shadows[2].

A sensor is a device which, from its environment, detects and transforms physical information into data that can either be interpreted by a human or a computer. Much of the sensors are electronic, but there are simpler ones, such as glass thermometers, which present visual data. To measure temperature, measure distance, detect smoke, control pressure and various other uses, people use sensors. There are many types of sensors that can be used in designing contactless body size measurement

system. Some of them are using 3D sensor as the main component to scan the whole-body measurement and some of them are using Kinect and depth sensor to locate the skeleton point on body before simulating it to get the body size measurement as in Figure 2-1 below:

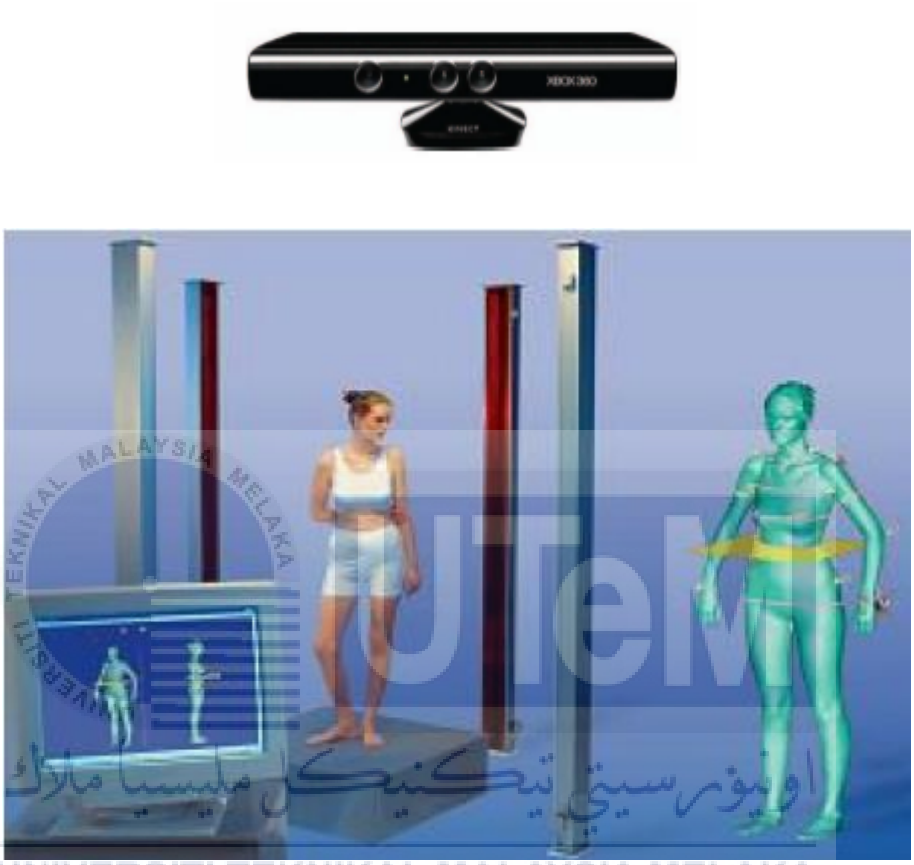

Figure 2-1 The Comparison between Kinect Sensor and 3D Scanner [2].

2.2.1 3D Body Scanners

In patent making and measurement determination, body measurement plays a significant role. Traditionally, body measurements were measured using tape measures. Using tape measures to capture body size takes time. Nowadays, the clothing industry often uses 3D whole body scanners to collect body measurements. Performance, validity, and reliability are well achieved by the stationary scanner. However, owing to its high price, it is not suitable for home use.

(Jones et al, 1989) stated that Loughborough was the location of the first 3D scanners used to clone the human body [3]. This is a shadow scanner that is capable of capturing the human body's outline but not curvature. A few years later, in the Hollywood film industry, the Cyberware firm discovered the need for 3D human copies. The stationary scanner performs well on performance, validity, and reliability. It is, however, not appropriate for us at home. Dresser sighed as it was difficult to get access to the actors to test the suitability of the costumes. (Daanen, Hein et al., 2018) state that Cyberware scanners activate a fast copy in seconds that can be milled to fit clothing. At the same time, 3D scanning efforts were performed by Hamamatsu in Japan, Vitronic in Germany and Telmat in France [7]. As well as more recent updates (Daanen and Ter Haar, 2013)[5, 6], detailed reviews of early systems are available (Daanen and Van De Water, 1998).

3D scanners usually have four scanners situated in the corners of the room and computer systems to record more than 100 measurements of the body surface. The default program makes it possible to automatically scan different body positions whether the user is in a standing or sitting position [2]. Figure 2-2 below shows the position of the user while the 3D scanner takes measurements of the user's body measurements.

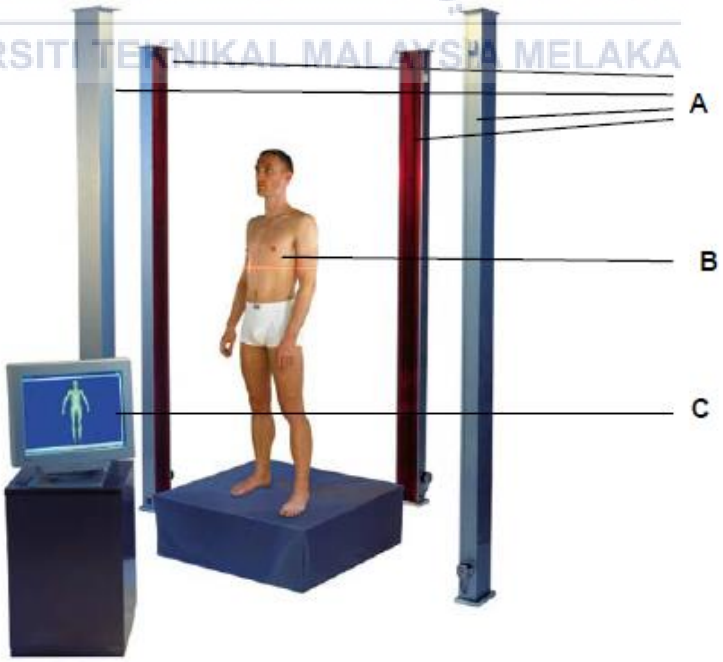

Figure 2- 2 Position of User when Standing between 3D Scanner [3].

An experiment was performed (Sybilska, Wioletta et al., 2010) in which silhouette measurements were taken to determine the quantity of various silhouette forms based on the Wanke method in the young female population group. In relation to the similarities and differences in features, this approach systematizes different kinds and forms of structures of the human body. It existed in the 1950s and was the first conception of Polish typology. First, it only applies to men. Typologically, however, this approach can now assess the entity and evaluate the somatic composition of the entire population or part of the population based on arithmetic values. [2].

2.2.2 Kinect Sensor

Many opportunities for multimedia computing have been generated by recent developments in 3D depth cameras including Microsoft Kinect sensors. Kinect was designed to transform the way people play games and how they consume entertainment. (Zhang and Zhengyou, 2012) state that with Kinect, people can interact with games with their bodies in a natural way [8].

Comprehension of human body language is the key activation technology; before being able to respond, the machine must first understand what the user is doing. This has always been an active computer vision area of quest, but it has proved very difficult with video cameras. The Kinect sensor allows the device to feel the third dimension (depth) of the player and the world directly, simplifying the task [8]. It also understands when users speak, knows who they are when walking, and can interpret and translate their gestures into a format that developers can use to create new experiences [8]. Figure 2-3 below shows the Kinect sensor and its components.