UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AUTOMATIC ABLUTION MACHINE BASED ON IMAGE PROCESSING

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotic and Automation) (Hons.)

by

NUR RAMIZA BINTI MOHD RAZALI

B051110179

920112-11-5534

FACULTY OF MANUFACTURING ENGINEERING

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ABSTRACT

In today's era of well developing infrastructure, demands in modern and new technology growth rapidly since it contributes a significant contribution in much kind of aspects. One of the most important and frequently used is the machine vision technology. In machine vision technology, there are many application used image processing technique such as inspection, face recognition, sorting, video surveillance, sign language systems, fingerprint recognition and hand gesture recognition to control some devices likes computer, cell phones, and TV which allowing the process run faster. The main objective of this project is to develop an ablution system based on skin detection**.** This project will apply image processing technique to detect the human skin. The structure for this project divided into two main parts which is hardware and software. In hardware parts, the Logitech Quick Cam E-3500 Plus PC Camera and Arduino UNO controller will be used in order to actuate the servo motor to open or close the tap according to the skin detected. This project will activate the tap automatically when there is a present of skin instead of manually opened the tap when performing ablution. This machine also saving the water consumption during perform an ablution compare to perform an ablution manually. The cost of water consumption when perform an ablution using automatic ablution machine is lower compare to perform an ablution manually.

ABSTRAK

Dalam era yang canggih serta pesat membangun, permintaan dalam teknologi yang baru dan moden meningkat dengan cepat kerana ia menyumbang sumbangan yang penting dalam pelbagai aspek. Antara sumbangan yang terpenting dan selalu digunakan adalah teknologi penglihatan. Dalam teknologi penglihatan, terdapat banyak teknik pemprosesan imej digunakan seperti pemeriksaan, pengiktirafan muka, menyusun, pengawasan video, sistem bahasa isyarat, pengiktirafan cap jari dan pengecaman pergerakan tangan untuk mengawal sesetengah komputer, telefon bimbit, dan televisyen yang membolehkan proses berjalan dengan lebih cepat. Tujuan utama projek ini adalah untuk membina sistem wudhu yang boleh mengesan permukaan kulit manusia. Projek ini akan menggunakan teknik pemprosesan imej untuk mengesan kulit manusia. Struktur untuk projek ini dibahagikan kepada dua bahagian utama iaitu perkakasan dan perisian. Dalam bahagian perkakasan, Logitech Quick Cam E-3500 Plus PC kamera and Arduino UNO akan digunakan untuk menggerakkan motor servo untuk membuka atau menutup pili mengikut kulit yang dikesan. Projek ini akan mengaktifkan pili secara automatik apabila kulit dikesan dan bukannya membuka pili air secara manual ketika hendak berwuduk. Dengan menggunakan mesin wudhu automatik untuk berwudhu, penggunaan air dapat dikurangkan berbanding berwudhu secara biasa. Kos penggunaan air menggunakan mesin wudhu automatik juga lebih rendah berbanding berwudhu secara biasa.

DEDICATION

Specially dedicated to my beloved parents, Mohd Razali bin Omar and Wan Rokiah binti Wan Muda and to my supervisor, Encik Ruzaidi bin Zamri, and all my friends who have encouraged, guided, and inspired me throughout the study process.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMECLATURES

UTeM	-	Universiti Teknikal Malaysia Melaka
PBUH	-	Peach Be Upon Him
ROI	-	Region Of Interest
AWW	-	Automatic Wudhu Washer
HOG	-	Histogram of Oriented Gradient
SVM	-	Support Vector Machine
HCI	-	Human-Computer Interaction
HSV	-	Hue Saturation Value
GL	-	Grey Level
BL	-	Back Ground Luminance
HSI	-	Hue, Saturation And Intensity
RGB	-	Red, Green and Blue
YCrCb	-	Luminance (Y) and chrominance components (CrCb)
MLP	-	Multi Layer Perceptron
AC	-	Alternating Current
DC	-	Direct Current
FKP	-	Fakulti Kejuruteraan Pembuatan
FTMK	-	Fakulti Teknologi Maklumat dan Komputer

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CHAPTER 1
INTRODUCTION

1.1 Background of study

Islam is a religion in which people being obeyed to their credence to the sole One God and accept Prophet Muhammad Peace Be Upon Him (PBUH) while the herald of God. People with this submission is referred as Muslim. The religion of Islam is predicated on five pillars. The five pillars of Islam are the basic of Muslim life which by means have faith and belief in the one and only God and finally of the Prophethood of Muhammad, besides pray five times each day, concern for and by helping a hand to the needy, refinement through fasting and the pilgrimage to Makkah for those who are able. One of the pillars is by achieve daily prayers. It is a must for a Muslims who mature to perform the prayers. The individual must brace their self with ablution before execute a prayer. The one who is without an ablution is prohibited to execute prayer.

Ablution is purified procedures that have an essential role within the teachings of Islam. Ablution or Wudhu is washing ritual that involves both of physical and spiritual. Ablution can be recommended because of body hygiene in term of physical and in terms of spiritual, the purity of the soul can be able to be protect. Ablution is a process of using water to being adapted on a certain parts of body in order to cleanse someone from a tiny dust or impurity before performing the prayers. The Wudhu term is indicated from basic Arabic's words called Al-wadhaah which means clean and bright. Al-wudhu is really a verb to explain the cleaning activity using water. The Al-wudhu in English translation is ablution. In Islamic, the acts that start with the intention, and then accompanied by washing on certain body followed by washing both of hands, face, sweep the top of head and both of feet.

Before executed the prayers, Muslims must be clean from any dirt and must wear a clean and tidy clothes. Besides, based on hadith that quoted by The Prophet Muhammad , said 'cleanliness is 50% of faith'. The Prophet also said "If there was a river at the entranceway of anyone of you and he took a tub inside five times per day could you notice any dirt on him?" His companions said, "Not a trace of dirt could be left." The Prophet added, "That's the exemplary case of the five prayers with which Allah blots out evil deeds" (Bukhari). In addition, the ablution or wudhu should be executed according to order starting with washing the hand, take water into mouth, inhale water into nose, washing the face, washing the fore-arms, wiping of the head, both ears and wash both feet including ankles. Each order must be reoccur for three times. From the Islamic prospective, it can be said that there are four necessary acts of washing which by washing the face, washing the fore-arms, wiping of the head, wash both feet including ankles.

Based on research, wudhu' process must need about six to nine litres of water eventhough there are only two litres of water is used for the whole ritual. (Rachmat et al., n.d.). Despite, the clumsy person will used more water for executed the ablution. From the Islamic prospective, the energy saving of water is highly being can be reduced. In Islam, the conservation of water is highly highlighted as be said by Prophet Muhammad PBUH. After all, this machine is user friendly and does not pollute the air and permitted Muslims to perform the ablution without wasting the water. This sensor and the servo motor can be said as actuator that is comprised on crane to turn and open it regards on the object under the crane**.** Not just in that case, the rate of water that Muslim needs in order to do the ritual also being detected in this machine. In this new era, many persons invented the previous automatic ablution machine but the price is increased due to it has been commercialized (Rachmat et al., n.d.). Due to that, automatic ablution system based on image processing technique that easy, cheap and environmental friendly are invented.

N.H. Johari have proposed a supposed framework based the usage of wudhu' tub through design development which being same with product fabrication. But the conserving of water during wudhu' is very demand as a result of human behavior. This behavior is distinctive from person to person.

Ablution ritual is an important for those who want to perform prayers (Hassan and M. F. Kamaruzaman,2013). Prayers are not complete without this cleansing ritual unless in an emergency with replacing ablution with tayammum ritual. The Muslims introduced a certain place to execute this ritual when involves the usage of water, to facilitate Muslims to execute ablution. An ablution station has many designs variations. Figure 1.1 below show several kinds of performed ablution station. The benefit of automatic ablution system enable Muslims to save a lot of water whenever they execute the pre-prayer cleansing ceremony and able to save this life-sustaining resource.

Figure 1.1: The variation of ablution station.

The cleansing ceremony has been stated in the Holy Al-Quran and it is called Sunnah or Hadith. Since 14 centuries ago, the basic method of wudhu' have been specified in the Al-Quran. (R. Anwar,2012).

As in article from i.islam, ablution is a simple command from God to test our obedience and God loves those who make themselves clean and pure. Who are performed the prayer are having "one on one" time with God. They are having a spiritual connection directly with God at that moment. So, ablution is compulsory before performing prayers and before having "one on one" time with the Creator.

1.2 Problem statement

Regarding to the previous studies, it is states that there are an issue based on the water consumption and by 2025, more than 2.8 billion people in 48 countries will lack access to water supplies (O. H. Hassan and M. F. Kamaruzaman,2013). There are a few activities that can lead to water demand which are ablution, irrigation, service shower, kitchen, and toilet cleaning.

Recently, individuals have invented the first automatic ablution machine, but when it's commercialized the price is indeed expensive and targeted on specific market segment. On that reason, there is a need to develop automatic ablution machine that is easy and cheap.

1.3 Objective

The specific objective that need to be achieved is:

i. To develop Matlab coding for skin detection.
ii. To analyze cost and water saving of automatic ablution machine.

1.4 Scope

The purpose of this project is to develop an automatic ablution machine for reduce water consumption during perform ablution.

The scope for this project is:

i. This machine is only for ablution purposes.

1.5 Report Structure

This research project can be categorized into three main chapters which are introduction, literature review and methodology. There are some short description for the related chapters. Chapter 1 will be comprised into five major titles which are background, problem statement, objective and scope. In the background, it will described about the basic idea about the research project. Then, the problem statement explained about the current problems that need to be justified before solving the related problems. After that, it is objective that need to be obtained throughout this research project. Finally, the scope that will covers the range of what will be focused on throughout this research project.

Meanwhile in Chapter 2 will explained on the literature review which covering the previous research that done by others and study the related data in order to get the best information to do this research project.

Chapter 3 will explained about the methodology that being functioned to achieve the objective and the scope of the project. This chapter illustrates the all activities from the beginning until the end of the research project.

In the Chapter 4, it will be covers about the expected result that need to be achieved throughout this analysis project . Moreover, the problems that are associated with the project is also being mentioned. Finally comes to Chapter 5 that will explained about the product or outcome of this research project.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter will discussed the literature review of three subtopic. The first subtopic is the history of the automatic ablution. The second subtopic is image processing technique from previous study. The previous methods used in image processing techniques which divided into two. First is hand gesture segmentation and the second is hand segmentation used for skin detection.

2.2 Automatic Ablution Machine

Automatic ablution machine is the machine that have the ability to save much water when Muslims wants to do pre-prayer cleansing ceremony called wudhu (ablution). This ablution machine conceded Muslims to do the cleansing ritual without wasting of water and is environment-friendly because it promoted water spillage. R.Anwar (2013) has stated that ablution is the act of usage of water to the specific body parts to cleanse from small impurities.

There are some information about the other machine which is the Auto Wudhu Washer (AWW) (Patent Pending) which is the worlds' first automatic wudhu' that introduced to allow Muslim to execute the ablution in a standing position with an extraordinary with the adequate of water and time and in conformance to Holy Quran teachings. AACE has designed and developed two version of AWW. The very first version is AWW model STD 707 and the second version is AWW model PRM 708. The AWW model STD 707 is produced technically for being functioned in the certain place only such as in mosques, offices and what not.

There are many components of AWW which comprised of intention built ear, mouth, and facial washer unit, a forearm and elbow washing unit and a foot and ankle washing unit all of which are incorporated within a system. By connecting with sensor , the tool is whole computerized and worked. Anthony Gomez, who is the inventor and the Chairman and Managing Director of Australian AACE Worldwide PTY Ltd. Company, said that there are no constant quotation for the machine involved.

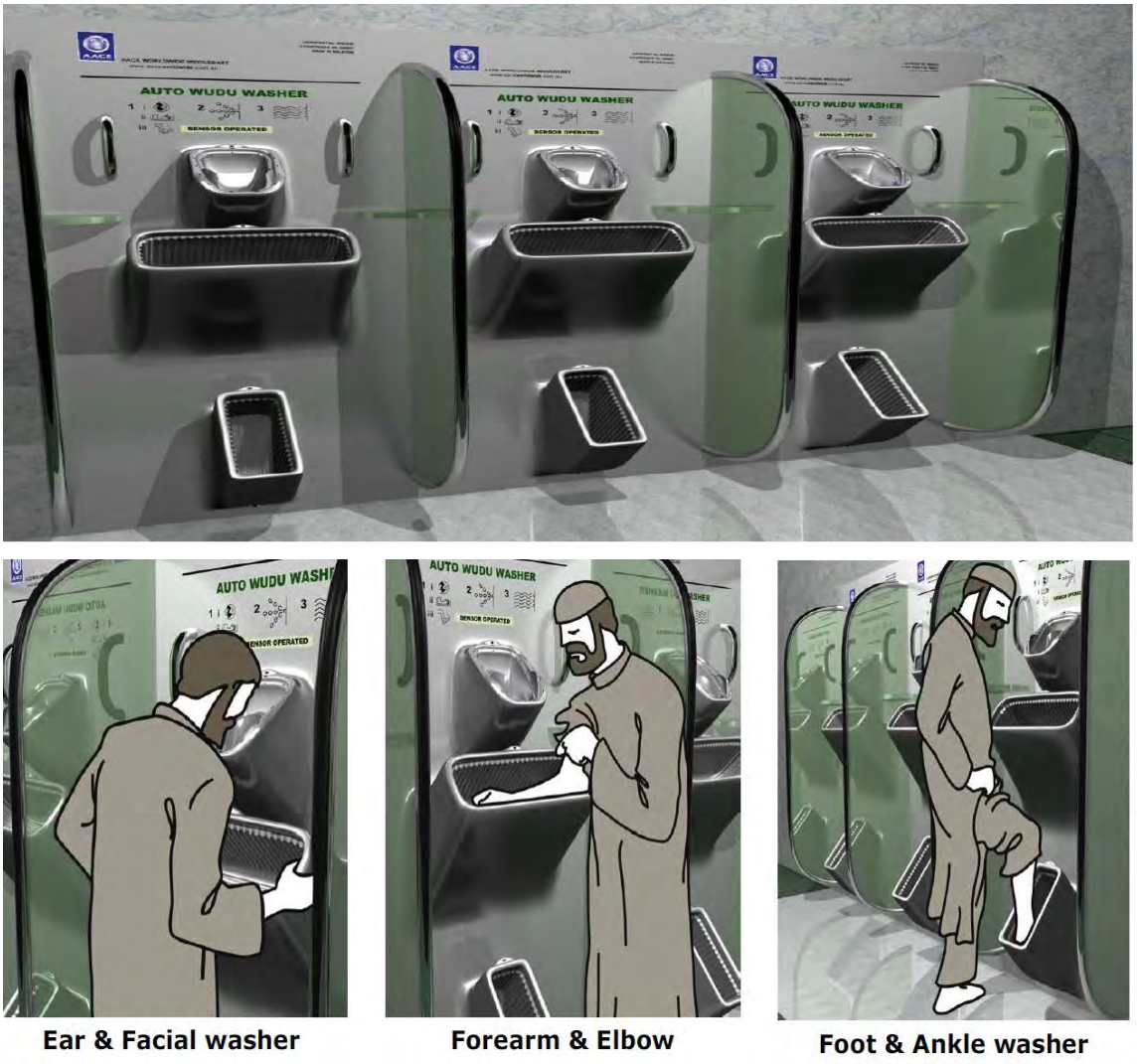

Figure 2.1 : Auto Wudhu Washers (AWW) model STD 707 (Rachmat et al., n.d.)

The important features of this machine is that this machine dries automatically, clean and have no water spillage. Plus it prevents overcrowding in wash rooms, ergonomic design, easy to use, low maintenance, easy installation (Rachmat et al.,

n.d.). The newest machine is (Figure 2.2) fully computerized so it generally does not required a crane.

Figure 2.2 : Auto Wudhu Washers (AWW) model STD 708.

Sensor activated taps is used to control and dispensed electronically the water flow for Auto Wudhu Washers (AWW) model STD 708.

2.3 Image Processing Technique

There are several technique of image processing which can be used in this machine which it can detect the signal operating for which data is in visual such as in video type. The expected result of the output image processing will be connected to the image. It is describes the digital image processing or analog image processing. The acquisition of images is referred to as imaging. Gabriele Moser (2009) has stated that image processing technique is for creating a first array of pixels corresponding to an input image and each pixel having an address and a data value and for creating a second array of data values at addresses corresponding to the location of features in said image.

2.4 Skin colour classification

The aim of the skin colour classification is to figure out the colour pixel of the non coloured or colour image (Phung, Bouzerdoum, Member, & Chai, 2005). A better skin colour pixel should achieved the range of all different in all skin (blackish, yellowish, brownish, whitish, etc.) and promote many lightning situation as possible (Nallaperumal et al., 2007). This part indicated the colour area and the algorithms based on the classification that has been examined in the previous study. This section describes the colour spaces and the classification algorithms which is investigated in this study. Skin detection method is the image processing technique consists of image acquisition or capturing the image, image pre-processing to remove unwanted noise and image enhancement to enhance and contrast the image. For hand skin detection consists of two type of method which are dynamic hand gesture segmentation and static hand segmentation. Dynamic hand gesture segmentation means the rate of the separate hand gestures from continuous image order consisting the gestures (Shu Mo, Shihai Cheng, Xiaofen Xing, 2011). Static hand segmentation is examined from image that comprising the gesture that have been extracted from the video visualization.

2.4.1 Dynamic hand gesture segmentation

Bao Hong Zhao Xinggui (2010) defines that the gesture segmentation is the way to examine and comparing the grade of the gesture segmentation that will be consequences to the rate of recognition. Jisu Kim (2013) has suggested 4 ways in proposed procedures which are head detection, back projection, hand rotation, and hand detection.

Xiaoming Yin and Ming Xie (2001) have constructed a 3D reconstruction technique to focused 3D hand gestures to examine the concept of matrix between cameras from stereo hand images. M.W. Krueger was firstly proposed gesture-based interaction as a new form of Human-Computer Interaction (HCI) in the middle of the seventies. A real-time gesture system which can be used in place of the mouse to resize and move the windows are presented by Kjelden and Kender.

The neutral network and segmented from background can be categorized based on skin colour detection. Kahn constructed the Perseus system and it functioned to differentiate the pointing gesture in a variety of characteristic Figure 2.3 shows the classical image processing pipeline used for hand gesture recognition.

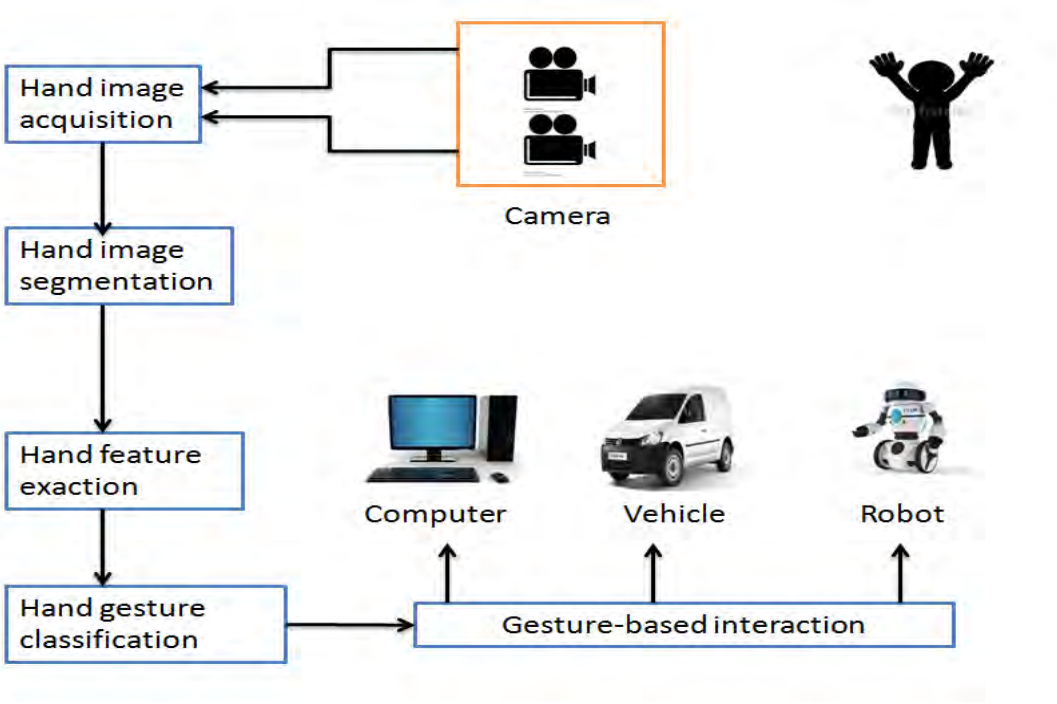

Figure 2.3 : Process of hand gesture recognition.

Qiu-yu Zhang (2008) has come with 3σ -principle of normal distribution for hand gesture detection to suit with the problems. The with 3σ –principle is a method of maximal between-class variable can be used to calculate the threshold value. Extracting hand contour or shape based a specific threshold value is a process of hand gesture segmentation. The maximal between-class variance is one of the method in global threshold technology on the basis of the statistical theory.

Figure 2.4 : Example of an initial image.

Figure 2.5 : Example of using '3σ -principle' of normal distribution for hand gesture detection.

Mo-yi Zhang (2008) have come with a way of hand gesture segmentation and tracking with appearance predicated on probability model. The statistical frame difference method is used to obtain the data after the dividing of the image. Jian-qiang Hu (2008) defined that the motion of the object will move in small scale in order to modify the result in the segmentation . If somebody that poses the gestures has moved a little bit, the image will remain fixed and steady. In Figure 2.5, grey scale image is the statistic moving information image. The more the moving information, the whiter it will be.

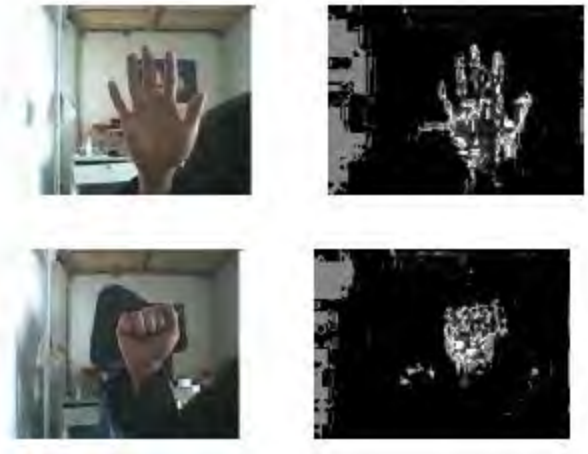

Figure 2.6 : Original hand images and skin probability distribution images.

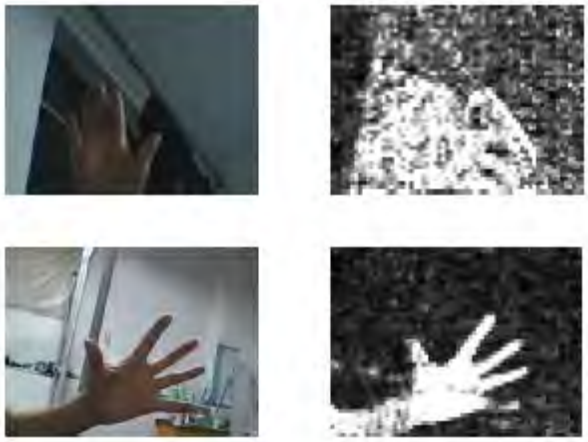

Figure 2.7: Original hand images and statistic moving information.

The rate how much the current frame search window it will be examined by the region's growth (Jian-qiang Hu,2008). For example if the region of the hand are much greater than previous region, it must have a skin color noise. Figure 2.8 shows caused by the region's growth.