UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ROBOT'S FACIAL MOVEMENTS TO EXPRESS BASIC HUMAN EMOTION

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honors.

by

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DECLARATION

I hereby, declared this report entitled "Robot's Facial Movements to Express Basic Human Emotion" is the result of my own research except as cited in references.

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Date : 26th DECEMBER 2018

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honors. The member of the supervisory is as follow:

……..

(DR ALIZA BINTI CHE AMRAN)

ABSTRAK

Muka Robot ini dereka dengan tujuan untuk menyelesaikan masalah sosial seperti penuaan masyarakat dan kemurungan. Projek ini adalah kombinasi rekaan elektronik dan mekanikal. Untuk bahagian elektronik, Arduino UNO digunakan dalam projek ini. Arduino UNO ini menerima pengekodan dan perintah daripada komputer pengguna untuk menguasai servo motor yang sambungkan dengan bahagian muka robot. Untuk bahagian mekanikal, reka bentuk diilhamkan oleh beberapa humanoid robot, like Sophia, SAYA and MIRAE. Reka bentuk robot ini biarkan struktur bahagian muka menjadi tidak begitu rumit dan mudah dikawal. Muka robot ini direka untuk membuat perhubungan tanpa percakapan dengan orang lain melalui ekspresi wajah.

ABSTRACT

The Robot face is designed with the purpose to deal with social problem like aging society and depression. This project is a combination of electronic and mechanical design. For the electronic part, an Arduino UNO board is used in this project. The Arduino UNO board received the coding and signal from the computer to control the servo motor that attached to face parts. For the mechanical part, the design is inspired by several humanoid robot, like Sophia, SAYA and MIRAE. The mechanical design made the robot face become simple and easy to control. The robot face is design to do non-verbal communication with others human by using facial expression.

DEDICATION

To my beloved parents, I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout my life. Their sacrifice had inspired me from the day I learned how to read and write until what I have become now. I cannot find the appropriate words to describe my appreciation for their devotion, support and faith in my ability to achieve my dreams.

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First of all, I would like to express my special thanks to my supervisor, Dr Aliza Binti Che Amran who gave me the golden opportunity, encouragement, guidance, and advice to do this excellent project on the topic of Robot's Facial Movements to Express Basic Human Emotion. Beside that, I really appreciate my supervisor Dr Aliza who helps me in doing a lot of research and guide me along this project. This project might be impossible to complete without her help. Last but not least, I would like to thank everyone that directly and indirectly involved in helping me finishing this Final Year Project report. Thank you very much.

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LIST OF ABBREVIATIONS

3D	Three Dimensions
OS	Operating System
DC	Direct Current
CAD	Computer Aided Design
C++	A type of programming language
PC	Personal Computer
DOF	Degree of Freedom
AUs	Action Units
PWM	Pulse Width Modulation

CHAPTER 1: INTRODUCTION

This chapter describes about the basic idea of this report. It briefly explains about the Robot's Facial Movement to express human emotion. The topics include background of the project, problem statement, objective, and project scope. Every topic in this chapter lead to the basic idea of this project.

1.1 Background

Nowadays, the world facing a problem which is aging society. As the advancing of the technology, the quality of life is highly improved. As the result the average age in this society has become higher, this might be good, but it also brings some side effect to the society which is those young people less interest in have children. This is because the young people want to enjoy their own personal life which will not be bound to the responsible and the cost of raising children. Hence, in some high-developed country like Japan and Singapore facing the problem of aging society. Human, they need communication with other people to express their feelings and ideas. Otherwise, they will easily be facing mental problem or sickness. To avoid this issue, android robots were invented. Android-robots are the robots with human-like appearance, to realize a smooth communication both verbal and non-verbal communications. Both have the same importance. Non-verbal communication is the way to transfer information to the other through body language such as a glance, a nod and gestures. In non-verbal communication, facial expression was playing the most important role. Hence, many engineers were trying to generate natural behaviours and motions of the robot. They want to bring human-robot communication close to human-human communication which is the main aim for the android robot.

1.2 Problem statement

In this era, the distance between people's heart has become further and further although the technology of communication is more and more advance. Therefore, there are many people suffer in depression because they have no one to share their worries and feeling. An android robot can solve this, the greatest asset of android robots is they can give us the strong feeling of presence as if we communicate with real human but a robot with mechanical appearance will immediately be recognized as robot. Therefore, it is important to design a humanoid robot face that could express basic human feelings. This is very important because if the expressions are wrongly interpreted by human, then the objective of the humanoid robot to communicate with human cannot be achieved.

1.3 objective

This project is aimed to achieve these three objectives:

- To design a robot face that can perform basic facial expression by moving face parts.
- To build a controller that move parts of the robot face to express four basic human facial expressions.
- To perform recognition rate test to each facial expression.

1.4 project scope

This project will focus at the designing of a robot face that can express four basic emotions such as angry, happy, sad and surprise. A microcontroller is used to control the movement of the parts of robot face. A recognition rate test will be performed for each facial expression.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Facial expression is important in the life in society. it is a form of non-verbal communication method. Facial expression in generate by the movement of face muscle which can differ into uncontrollable reaction and controllable reaction as it is controlling by neural mechanisms. Facial expression is knowing as the sign language which conveying social information between humans. It can represent the emotion and how the people feel at that time. Through these other people can easily know about their personal preferences which will help a lot in interaction with each other. Knowing how to read others emotion will become an advantage in deal negotiation and social life. Besides that, emotion also can be transferred to the people around like a smile of the shop assistant can make customer more comfortable, an angry face will make the atmosphere in the room become serious and so on. This mean that emotion can affect the others feeling and the space atmosphere without a single word. There are seven emotion which knowing as universal expressions show in Figure 2.1. They are anger, contempt, disgust, fear, joy, sadness, and surprise.

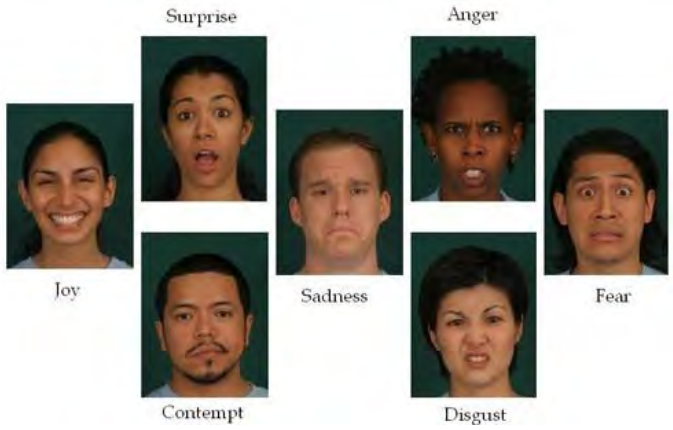

Figure 2.1 The basic seven emotion

The following explain about the important face parts that need to be controlled and manipulated during expressing a human's emotion. The face has been separated into two part which is upper face part and lower face part. Upper face part consists of eyelids, eyebrows and eyeballs. The lower face part consists of lips and jaw.

2.0.0 Upper Face Part

People often say that eyes are the windows to the soul. These sentences reveal that the eyes do provide lots of information about another person's emotional state. A person's eyes show how they feel or what they think, like the blink rate can reveal how tension and relax of a person, the angle of the eyebrows reveal the person is feeling sad or surprise. A fake smile can be made by curving the mouth, but the eyes never lie. Eyes communicate more data than a person aspect. By covering the other part of the people's face just left eyes only can also transmit the feeling of attraction or disgust to others.[1]

The eyebrows play the most important part in the facial expression. When the eyebrows lowering to certain degree will lead the whole face expression into negative emotion like angry, sad and disgust. But in opposite when the eyebrows raised up, it may be a submissive move or indicate openness which lead the facial expression into positive emotion like surprise and happy. There are more complex movement of the eyebrows that represent other advance emotion.

The eyelids are a part of the eyes. It is the final layer of protection of the eyeball. For human, eyelid prevents the eyeball direct contact with dust and other object that will harm the eyes by the movement of blinking. The blinking of the eyelids does not only to protect the eyeballs but also show the state of the people feels. Most of the people will have a high blink rate while they are feeling nervous and tension, and the rate will become lower while they feel relax. Moreover, the eyelids can express the feeling of bored by lowering both into the middle of the eyeball. The eyelids help other part of eye to make an emotion expression more complete.[2]

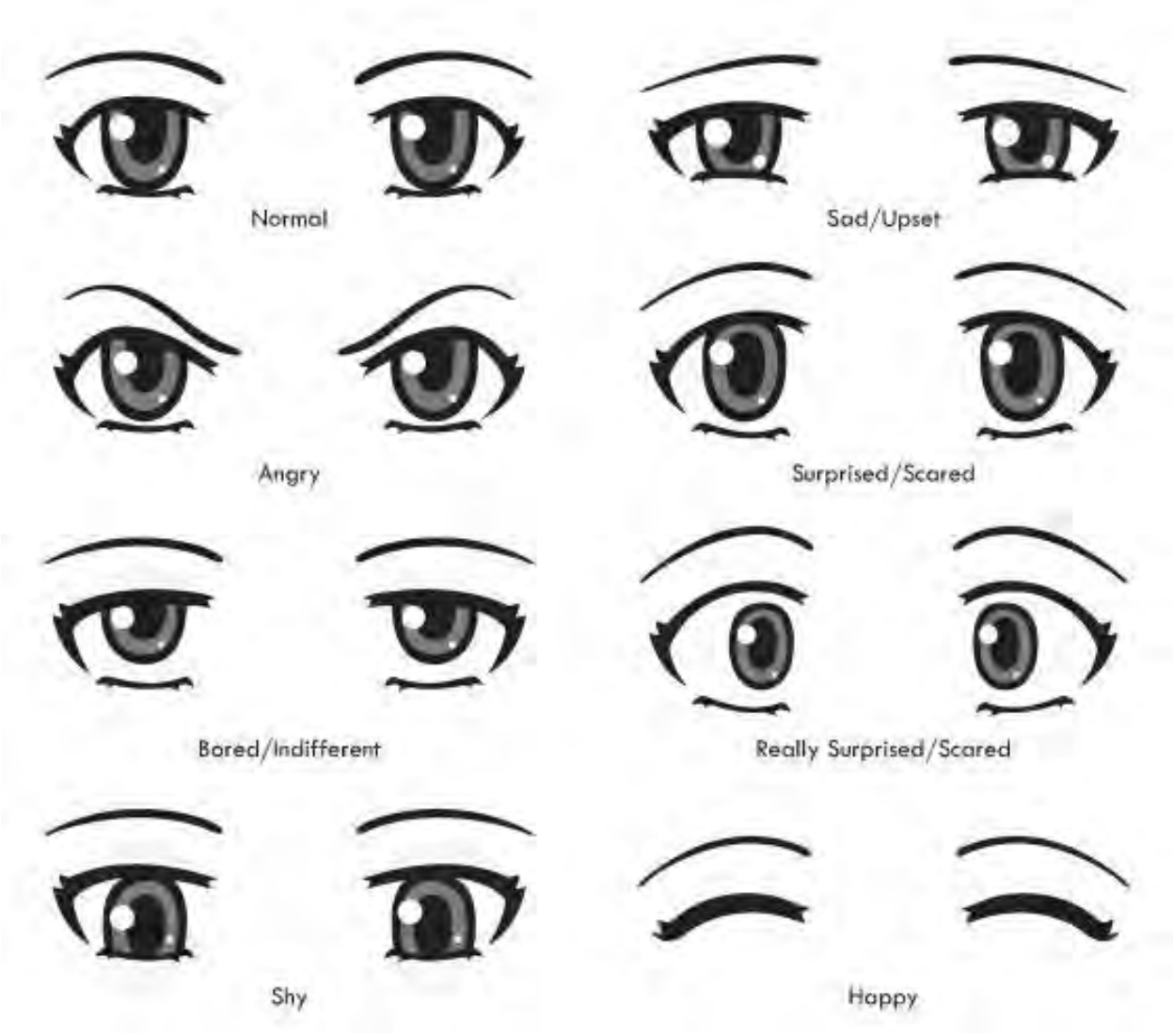

Figure 2.2 The emotion expression of eyes and eyebrows[3]

2.0.1 Lower Face Parts

Lips is a part of the mouth of humans. Lips are made by soft and flexible muscle which can form many different movement. Lips are movable, soft and serve as the opening for food intake and articulation of speech. The lips play important role in facial expressions, mostly it expresses the emotion by curving the muscle of the lips to form an up-open or down-open parabola. The most common visible emotions expression of lips is smile by making a U-shape, surprise with O-shape, and angry with n-shape. With the support of jaw, the expression of lips can become more significant.[2][1]

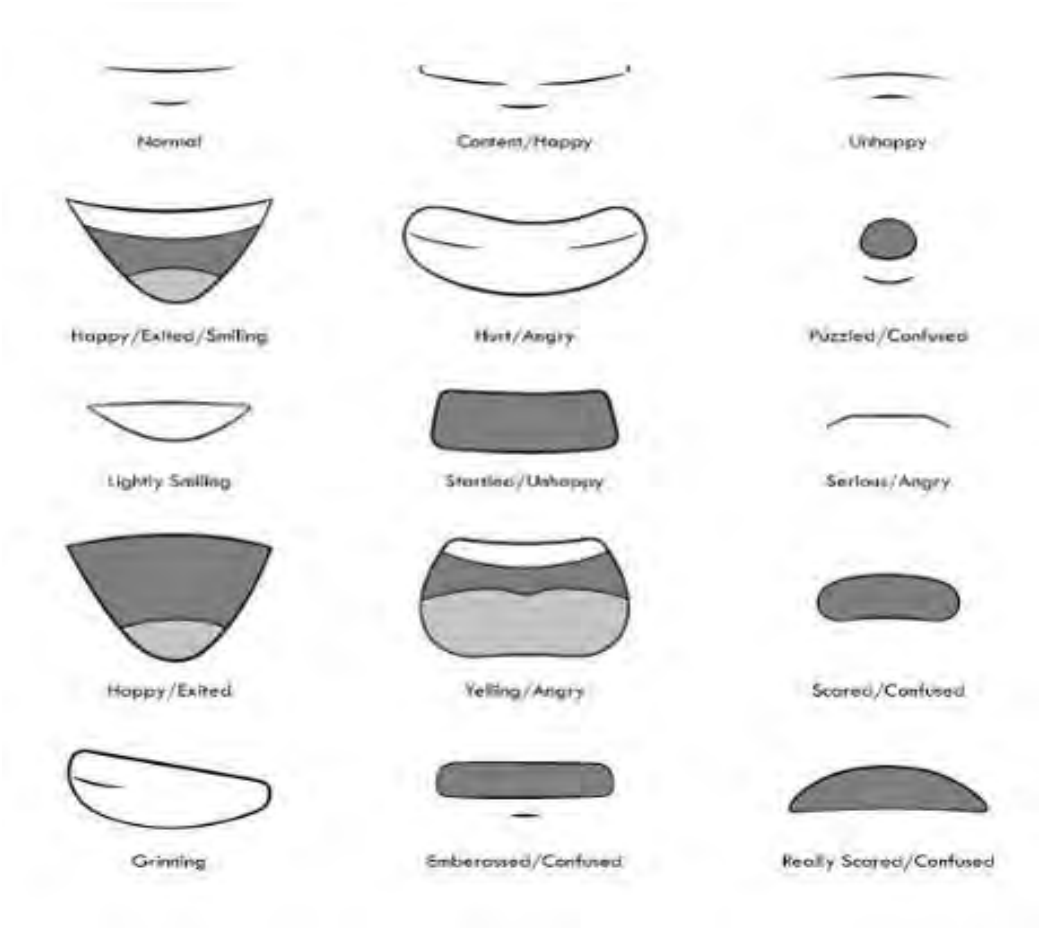

Figure 2.3 The emotion expression of mouth[4]

By combining different type of motion of eyes and mouth, a greater variety of facial expression can be formed. But this project will only focus on four basic emotion expression which is angry, happy, sad and surprise.

2.1 Equipment

Varies type of motor is used to construct robot in the journal. They have been used in different part with their special characteristic. Hence, the study about type of motor and their uses is needed before the construction of the robot. The following explain about three type of motor that frequently used which is DC motor, Servo motor and stepper motor.

2.1.0 DC motor

A DC motor is widely used in our daily life, it is a rotary machine that converts direct current electrical energy into mechanical energy. In a typical DC motor, there is a spinning armature inside which is called as rotor via the rotates of the armature while the DC motor function. There are permanent magnets on the outside which call stator because they are always stationary while the DC motor is being active. The armature usually contains an electromagnet, so when the electricity was pass through the electromagnet, it creates a magnet field who will repels and attracts the permanent magnet in the stator. Through this process, the armature will keep spinning as the poles of the electromagnet keep changing and produce a mechanical energy. Direct current machines are characterized by their versatility. DC motor are two wire system, each wire represents power and ground, unlike servo motor and stepper motor it is a continuous rotation motor. A pulse-width modulation (PWM), a technique of rapidly pulsing the power on and off is being used to control the speed of DC motor. The speed of the motor is determined by the percentage of time spent cycling the on/off ratio, e.g. the motor will spin at half the speed of fully on when the power cycled at 50% which mean it is half on, half off.[5]

By means of various combinations of shunt-, series-, and separately excited field windings that shown in Figure 2.4, DC motor can be designed to display a wide variety of volt-ampere or speed-torque characteristics for both dynamic and steady-state operation.[6]

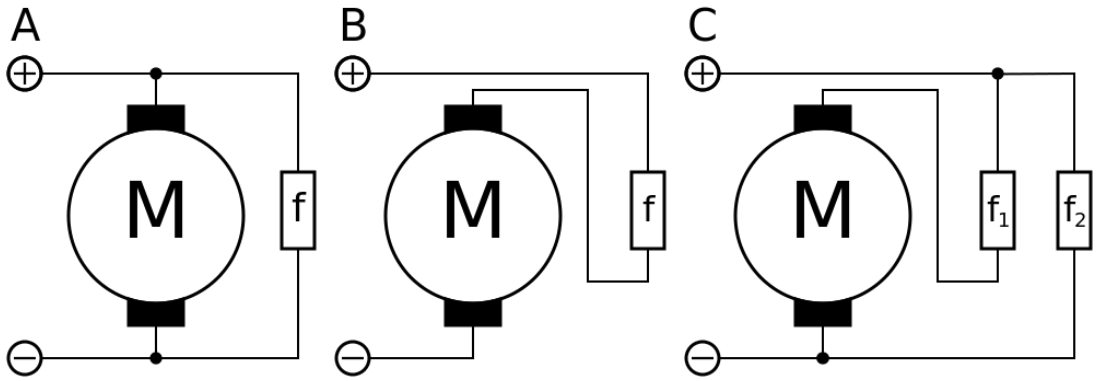

Figure 2.4 Connection of shunt-, series- and separately-excited motor[6]

2.1.1 Servo motor

Servo motor also called as Control motor, it mostly used as output actuators in feedback control system and it does not use for continuous energy conversion. The functioning principle of Servo motor is similar as other electromagnetic motor, but the operation and construction are different. Servo motor operate at very low speed and sometimes even at zero speed due to its long length and smaller diameter rotor of the motor. Hence, the servo motor has low rotor inertia and high-speed response. Due to this special characteristic, servo motor is widely use in radar system, process controller, computer, robotics and guidance system. Servo motor are generally construct by four things: DC motor, gearing set, control circuit and position-sensor. This make servo motor has a more precisely position control compare with standard DC motors. Servo motor is three wire system which known as power, ground, and control. Power to servo motor is supplying constantly and the servo control circuit regulating the draw to

drive the motor. PWM is used for the control signal of servo motor, but it is not the same use as DC motors. Unlike DC motors use PWM to control the speed, servo motor use its duration of positive pulse to determine the position of the servo shaft.[7] The equivalent circuit of servo motor is shown in Figure 2.5.

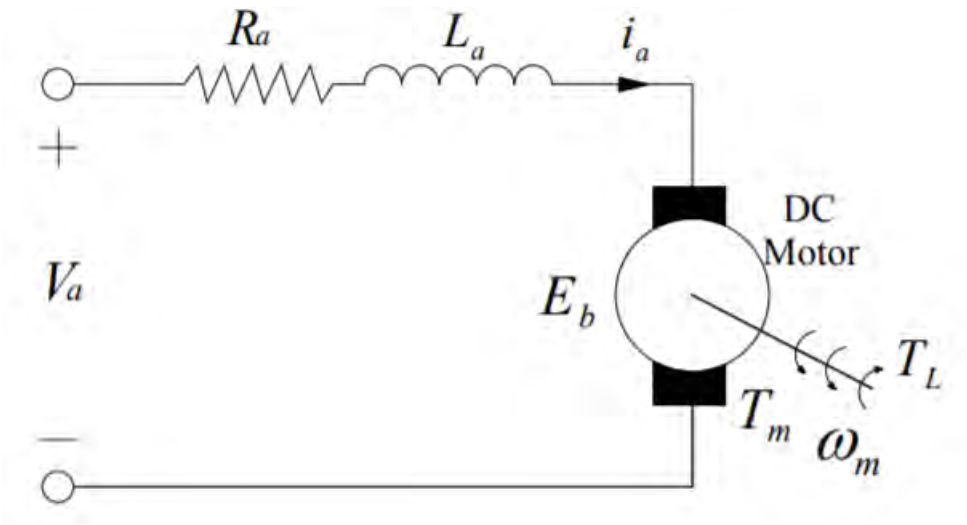

Figure 2.5 Equivalent circuit of servo motor[7]

The servo motor is basically a DC motor which does not run continuously for a longer period. Servo motor has a feedback system inside its circuit which allow it to rotate at specific angle with greater precision and accuracy.