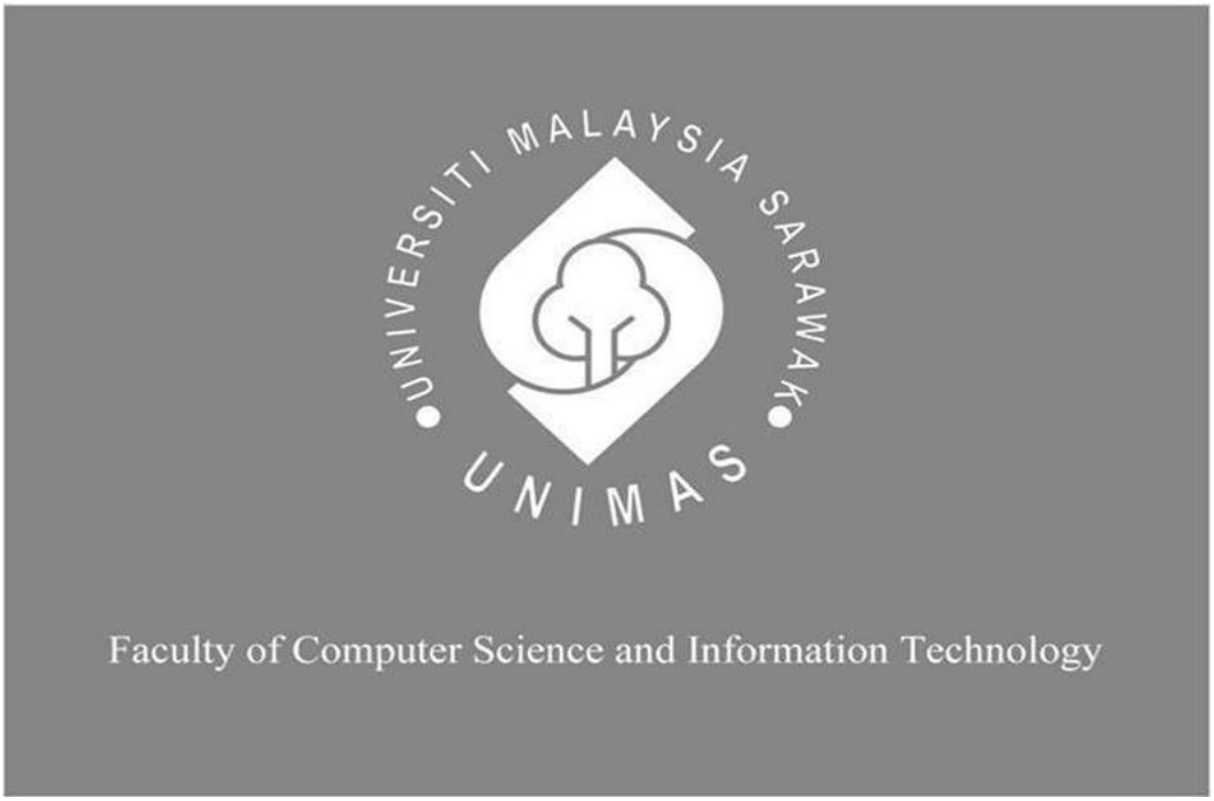

Anger Detection in Monitoring Drivers' Facial Expression using Mobile App

EE MIN JIE

Bachelor of Computer Science with Honours

(Computational Science)

2019

UNIVERSITI MALAYSIA SARAWAK

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This project is submitted in partial fulfillment of the
requirements for the degree of
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(Computational Science)

Faculty of Computer Science and Information Technology
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2019

Declaration

I hereby declare that this thesis is based on my original work except for quotations and citations, which have been duly acknowledged. This thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Ee Min Jie

_____

Name of the student: Ee Min Jie

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LIST OF ABBREVIATION

AI – Artificial Intelligence

API – Application Programming Interface

CNN - Convolutional Neural Network

FYP - Final Year Project

GPS – Global Positioning System

MSD - Mass Spring Damper

PCA - Principle Component Analysis

ABSTRACT

Current facial detection requires experimental set-up which includes usage of variety of camera equipment behind the steering-wheel. This is highly impractical in real-world environment as the set-up might cause annoyance or inconvenience to the driver. Next, steering wheel vibration might induce confusion in drivers. This is because vibrating steering wheel can be caused by faulty brakes, wheel alignment and punctured tires.

In order to detect driver's angry facial expression, image processing algorithm will be applied and implemented in this project. Besides that, an audio feedback feature through mobile application will be implemented as well. With the help of phone camera, driver's facial expression data can be collected then further analysed via image processing under Microsoft Azure platform.

In the end of this project, a working Mobile App should be able to be implemented that can detect angry drivers through monitoring their facial expression. Whenever an angry face is detected, pop-up alert messages and audio feedback will keep reminding drivers to drive calm and safe until drivers manage to handle their emotions where anger is no longer detected.

ABSTRAK

Pengesanan wajah semasa memerlukan susunan eksperimen yang merangkumi penggunaan pelbagai peralatan kamera di belakang stereng. Ini sangat tidak praktikal dalam persekitaran dunia nyata kerana penyediaannya boleh menyebabkan gangguan atau ketidakselesaan kepada pemandu. Seterusnya, getaran roda stereng dapat menimbulkan kekeliruan pada pemandu. Ini adalah kerana roda kemudi yang bergetar boleh disebabkan oleh brek yang salah, penjajaran roda dan tayar yang berlubang.

Untuk mengesan ekspresi wajah marah pemandu, algoritma pemprosesan gambar akan diterapkan dan dilaksanakan dalam projek ini. Selain itu, fitur maklum balas audio melalui aplikasi mudah alih juga akan dilaksanakan. Dengan bantuan kamera telefon, data ekspresi wajah pemandu dapat dikumpulkan kemudian dianalisis lebih lanjut melalui pemprosesan gambar di bawah platform Microsoft Azure.

Pada akhir projek ini, Aplikasi Mudah Alih yang berfungsi seharusnya dapat dilaksanakan yang dapat mengesan pemandu yang marah dengan memantau ekspresi wajah mereka. Setiap kali wajah marah dikesan, mesej amaran timbul dan maklum balas audio akan terus mengingatkan pemandu untuk memandu dengan tenang dan selamat sehingga pemandu berjaya menangani emosi mereka di mana kemarahan tidak lagi dapat dikesan.

CHAPTER 1: INTRODUCTION

1.1 Introduction/Background

Road rage related cases is becoming a norm in Malaysia. According to Malaysian Institute of Road Safety Research, 18% of registered drivers are involved in road rage and road bullying (Austin, 2019). Getting trapped in a heavy traffic jam for a long period of time may trigger drivers to lose their patience. Impatience contribute to higher stress level that might affect drivers' mood or emotions such as anger, aggressiveness and anxiety. With such emotions, drivers may not have a conscious mind to make rational judgements on the road.

Showing disrespectful gestures to other drives such as obscene hand gesture may be offensive and increase the emotion level of anger of the driver (Forbes, 2015). Drivers that do not want to subdue to such offensive remark or not tolerating will take revenge back on the road. When both drivers competing each other on the road, they underestimated the risk of accidents and being too confident in their driving skills. Accidents happen anytime not only because of drivers' behaviour but also considering environmental factors which is not under both drivers control. Damages can be done to other drivers, buildings or whoever that uses the road.

Distracted driving like messaging or talking on the phone is one of the factors causing road rage. Matt Gillespie once stated, "messaging while driving was an instance where we saw a high proportion, nearly 60% of people who considered it to be aggressive". Drivers tend to drive furiously and aggressively by moving or changing lane without giving any signals and honking as they wish. According to the National Safety Council, 1.6 million accidents happened every year due to usage of cell phone while driving and 390,000 were caused by texting on the phone (Nikola, 2019).

In 2018, there were no hardware introduced in the project where only algorithms and measurement on the muscle movement of the arms that affects the turning degree of the steering wheel. With only a few turns, the stress level of the driver can be detected through the muscle tension. It is then proved that such method, also known as, mass spring damper (MSD) model can help to determine the stress level of a driver by measuring the muscle movement from turning degree of steering wheel of a vehicle.

According to Roshan (2019), a road rage detector has been patented by Huawei. The detector uses digital cameras that can trace drivers palm and thermal cameras to observe changes in driver's body temperature. Thermal camera will first detect drivers' faces then convert it into thermal images. With the help of thermal images processing, PCA and eigenfaces, anger detection can be detected. Digital cameras were then used to trace drivers' palm to check on obscene hand gesture such as "middle finger" or fist-shaped hand gesture. Any obscene hand gesture is detected, the car will be decelerated or eventually brake.

The worst drivers per age category are those between 25 to 39 years of age (Swanevelder,2019). This group age of people is believed to own at least one phone each. Today, it is difficult to find someone without a phone. A mobile application to detect angry driver should be implemented as monitoring device that helps to alert drivers to drive calmly and safely.

1.2 Problem Statement

Camera-based system has been developed that watches driver's facial expressions while driving. The current facial detection requires experimental set-up which includes usage of

variety of camera equipment behind the steering-wheel. This is highly impractical in real-world environment as the set-up might cause annoyance or inconvenience to the driver.

Steering wheel vibration has been applied by Huawei patented system which encouraged drivers to relax and calm down in case of road rage. However, using such vibrating technique might induce confusion in drivers. This is because vibrating steering wheel can be caused by faulty brakes, wheel alignment and punctured tires.

1.3 Aims and Objectives

1) Apply an image processing algorithm to detect driver's angry facial expression.
2) Implement an audio feedback feature through mobile application to alert driver on the current emotion status such as pop-up message alerts with warning-like background music.
3) To evaluate the mobile application’s performance based on unit testing.

1.4 Scope

- Every driver is assumed to possess a mobile phone.
- Drivers are mentally and physically healthy. This is to prevent biased results due to mental disorder from the drivers.
- Bright environment. The mobile phone is to be placed on a platform that receive adequate lighting and the facial features of the driver can clearly be seen.

1.5 Brief Methodology

With the help of phone camera, driver's facial expression data can be collected then further analysed via image processing under Microsoft Azure platform. More user-friendly interface will be designed and integrated with Microsoft Azure APIs to develop a mobile application that can detect angry drivers.

1.6 Significance of the Project

Drivers that drive in anger mode can be detected through facial expression and image processing. Alert system that help to remind the drivers to drive calmly and safely after detection has been made. Audio feedback such as "Keep yourself calm and drive safe as we detected you are driving in anger" or "The world will never be the same without you." will be used as a reminder alerting system. Road rage related cases which contributes in number of accidents can be reduced.

1.7 Project Schedule

Research studies (Introduction, Literature Review, Methodology) on this project starts from beginning of this semester, Sem1 19/20, which is from September till December before FYP symposium that falls on the week of 14. Meanwhile for testing, implementation, conclusion and future work will be in Sem 2, 19/20 from February till June.

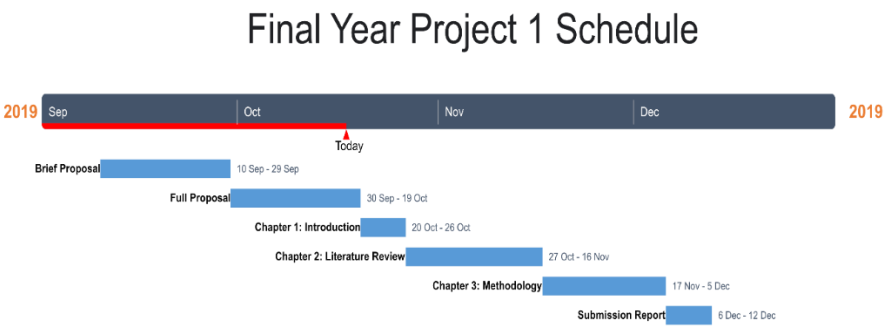

Figure 1.1: FYP 1 Project Schedule

1.8 Expected Outcome

Able to come out with a working Mobile App that can detect angry drivers through monitoring their facial expression. Whenever an angry face is detected, pop-up audio messages alert will keep reminding drivers to drive calm and safe until drivers manage to handle their emotions where anger is no longer detected.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Road rage comes in many different forms such inappropriate hand gestures, tailgating, stuck in a heavy traffic jam, talking on the phone or simply texting can cause road rage. Besides that, road rage may leads to road accidents. Road rage mostly caused by unconscious mind in making rational judgement while driving. Irrational judgement can be made when driver is triggered to lose their patience. Impatience in a person can cause high stress level and might be in a bad mood or angry conditions.

Based on statistics, the number of cases on road rage has become synonymous with the number of road accidents in many parts of the world (Intan, 2019). Such worrying trend has prompted many researchers to provide solutions to the ever-growing trend. From industry leaders to governmental organisation, every domain has started funding the research in this field. Giving rise to numerous new techniques and technologies tailored specifically for monitoring driver's temper throughout the entire journey. Hence, this has become a reason for this research to be carried out.

Moreover, the general approach for driver temper monitoring system is as described. Driver's facial expression is monitored continuously while driving. In that case, when anger emotion has been detected, driver should be notified that he/she is driving aggressively which may lead to road rage (Paredes et al., 2018). Anger detection has been done by few researchers but there are only a handful of mobile application that has been created to monitor driver's facial expression.

The architecture for mobile devices is different from traditional computer architecture in terms of memory management and processing algorithms. Hence, it is such difference that

challenges many researches into exploring the mobile platform. Besides, traditional facial detection algorithm requires huge amount of processing power in order to yield accurate results. Different angles of the camera from mobile devices also poses a challenge for researchers to formulate an algorithm that works perfectly under extreme real-life environment.

With the use of cloud computing and advancement in hardware technologies, it has given researchers an optimistic future in developing a holistic and sustainable mobile application to detect road rage. As such, this project discusses the advantages and disadvantages of different approach and finding the best-fit approach in combating road rage using modern-day technologies. Figure 2.1 below shows the general overview of how an anger detection system should be.

Figure 2.1: Overview of anger detection system.

2.2 Driver's Emotion Detection

Figure 2.2: Basic emotions of a human.

As shown in Figure 2.2, there are 7 universal facial expressions such as happiness, sadness, fear, disgust, anger, contempt and surprise (Harry,2018). Anger can affect the performance of the drivers. Hence, the main facial expression focused is the anger emotions. It is believed that whenever someone is angry, they tend to firmly close their upper and lower lips together, lower down the eyebrows and enlarge their eyes with glare (Nelson, 2018). Figure 2.3 shows how an angry face looks like.

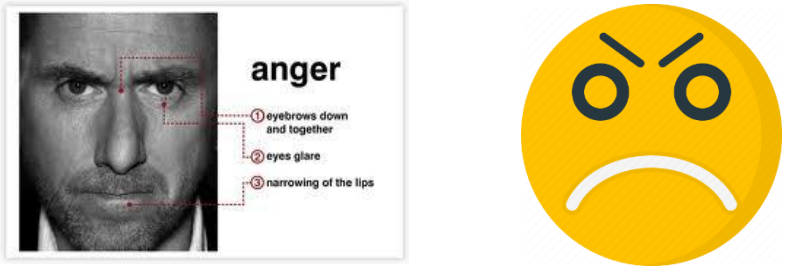

Figure 2.3: Anger Facial Expression.

2.2.1 Using Road rage detection system

Huawei has patented a road rage detector system (Roshan, 2019). This system involves numbers of cameras such as digital camera and thermal camera. Anger emotions can be detected via thermal camera. Thermal camera will firstly detect changes in blood pressure. Thermal camera can also detect drivers' faces then convert it into thermal images. With the help of thermal images processing, PCA, Support Vector Machine (SVM) approach and eigenfaces, anger detection can be detected (Basu, et al., 2015). Faces that has been detected will then be filtered and sharpened before 6 facial patches been divided. SVM approach is used to classify facial emotions as shown in the Figure 2.4 below.

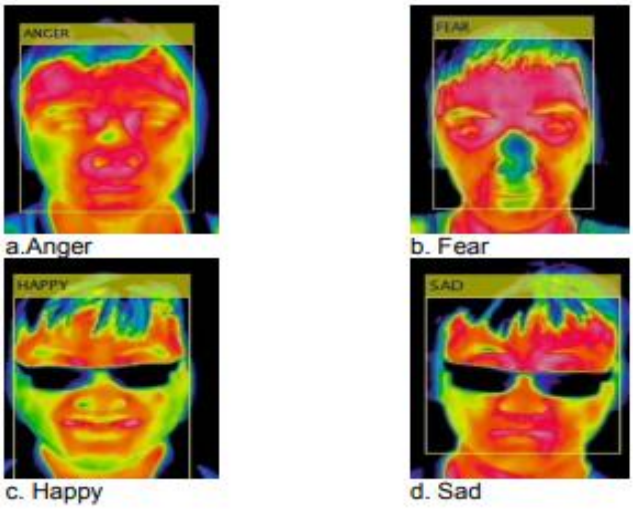

Figure 2.4: Example of thermal images.

Next, digital camera is then used to trace drivers' palm. This is to check on the inappropriate hand sign such as "middle finger" or fist-shaped hand gesture. Driver is also classified as angry driver whenever obscene hand sign is detected. The algorithm used in detecting hand algorithm is by using Haar Classifier (Sadman, 2017). Figure 2.5 shows the example of palm detection that uses hand algorithm. If any inappropriate hand sign is detected, the car will be automatically decelerate and eventually brakes by the anger detector system patented by Huawei.

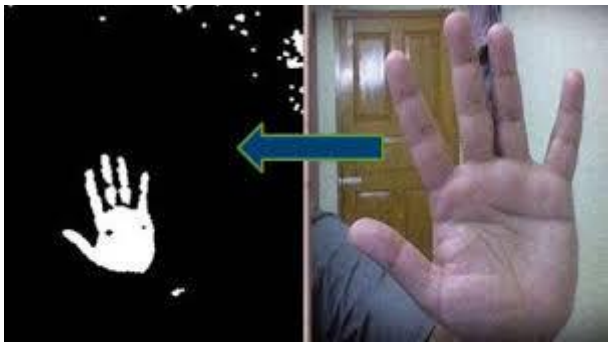

Figure 2.5: Example of palm detection.

Another way to detect if driver is under anger emotion which is by detection system of Huawei via speech-recognition. If driver was detected in shouting or swearing inappropriate

words, driver will be detected as an angry driver. Therefore, an alerting system has been introduced where the steering wheel of the vehicle will vibrate. Vibration of the steering wheel helps to remind and alert driver that anger emotion has been detected. Besides that, it is believed that vibration can calms down an angry driver and helps to relax them.

2.2.2 Detecting stress with a car steering wheel

Mass Spring Damper model is used to detect stress level of a driver (James, 2018). With such model, muscle movement will be measured from the turning degree of the steering wheel. None of the hardware has been introduced but only requires signal processing of the steering wheel and data obtaining. Besides that, muscle movement measurement and also calculations are introduced. With only few tests taken, stress level can be detected which also proves the relationship between muscle tension caused stress level and MSD model is directly proportional. Whenever stress is detected, driver can conduct breathing exercises or stretch their body. This may help them reduce or lower their stress and able to pay more attention to the road. Besides that, playing favourite music or light songs can also help to reduce stress level of a driver.

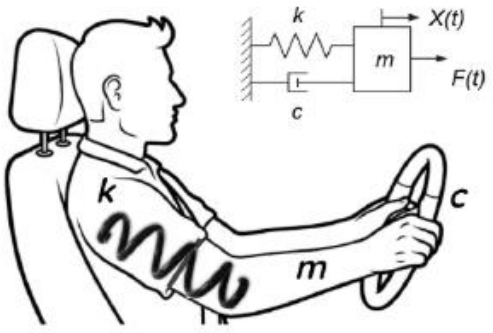

Figure 2.6: Muscle movement measurement.