RFID-BASED VEHICLE SPEED MONITORING AND ENFORCEMENT SYSTEM

BY

TAN KAI XIAN

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION TECHNOLOGY (HONS)

COMMUNICATIONS AND NETWORKING

Faculty of Information and Communication Technology

(Perak Campus)

MAY 2018

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I declare that this report entitled "**RFID-BASED VEHICLE SPEED MONITORING AND ENFORCEMENT SYSTEM**" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

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I would like to express my sincere thanks and appreciation to my supervisors, Dr. Vasaki a/p Ponnusamyasaki who has given me this bright opportunity to engage in a RFID based project, while advise me alongside with the development of this project. A million thanks to you.

The other person I want to thank for is Calvin who always care about my project, without you my progress will be much slower. Finally, I must convey my thanks to both of my parents and my family for their love and support.

ABSTRACT

Speeding violation is one of the factors that contribute to car crashes in Malaysia. In this project, a vehicle speed monitoring and enforcement system which using RFID technology is proposed in order to reduce the speeding violation. In Malaysia, AES cameras are installed at fixed locations to capture the vehicles which violating speed limits. After certain time, the drivers will come in mind the locations of the AES cameras. This may lead to a very dangerous situation. For example, when the drivers approaching the enforcement zone, they will suddenly decelerate the vehicle speed and only to accelerate again after passed through the enforcement zone. RFID reader which uses ultra-high frequency (UHF) can easily to scan the tag for maximum 100 meter. Therefore, the RFID reader can install far away from the roadside and make the drivers hard to aware the enforcement zone. This is the reason why preferring RFID technology over others after discussed and studied. In this project, method on how to collect data from the RFID reader every time the vehicle pass through the RFID reader will be shown. The time count will start when the vehicle pass through the start RFID reader and stop when the vehicle pass through the stop RFID reader. The speed of the vehicle will calculate based on the time difference. If the calculated speed exceeds the speed limit, a buzzer will sound up and a message will send to the driver.

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LIST OF ABBREVIATIONS

AES	Automated Enforcement System
CCU	Central Control Unit
BAP	Battery-Assisted Passive
CCTV	Closed Circuit Television
VLPR	Vehicle License Plate Recognition
OS	Operating System
RFID	Radio Frequency Identification
MFRC522	Mifare RC522
RST	Reset
GND	Ground
MISO	Master Input, Slave Output
MOSI	Master Output, Slave Input
SCK	Serial Clock
SDA	Serial Data
SPI	Serial Peripheral Interface
UHF	Ultra High Frequency
LCD	Liquid Crystal Display
GSM	Global System for Mobile communication

IDE	Integrated Development Environment
ID	Identity
SIM	Subscriber Identity Module
UID	Unique Identity
IoT	Internet of Things
SS	Slave Select

CHAPTER 1: INTRODUCTION

1-1: Problem Statement and Motivation

Road plays an important role in the transportation field in Malaysia. At the same time, the field of transportation has an irreplaceable role in coordinating all countries ' development plan. In fact, the increase in human activities indirectly increases the need of human beings for various kinds of vehicles. Simultaneously, the demand for various kinds of vehicles caused the number of vehicles on the road increased. The rise in the number of vehicles in Malaysia directly led to various kinds of traffic issues especially in road crashes. Excessive speed when driving on the road is one of the factors that led to a car accident.

In Malaysia, AES system is implemented in order to capture the picture of vehicles which violating the speed limits. These AES cameras are usually installed on the roadside so the daily user of these roads can easily to aware them. After certain time, the drivers will come in mind the locations of the AES cameras. This may lead to a very dangerous traffic situation. For example, when the drivers approaching the enforcement zone, they will suddenly decelerate the vehicle speed and only to accelerate again after passed through the enforcement zone and the problem remains as it is. Besides, the drivers that aware the locations of the fixed cameras may use the other roads in order to prevent the cameras, which may lead to traffic accident on the other roads.

In this project, radio frequency identification (RFID) technology is proposed to solve the speeding violations issue. The main reason for choosing the RFID technology is because RFID technology is more difficult to aware by the drivers and this will cause the drivers to reduce the vehicle speed in order to avoid being fined.

CHAPTER 1: INTRODUCTION

1-2: Project Scope

This project develops a system that could monitor the speeds of vehicles through the use of RFID technology and able to inform who exceeds the speed limit by sending a message to the owner of the vehicle. The monitoring system station consists of two RFID readers and a Central Control Unit, which is Arduino Uno. Each car has its RFID tag. Two RFID readers are connected to the Central Control Unit, which is collecting data from them. The RFID reader will scan all the vehicles which are passing through it even the vehicle speed is lower than the speed limit. The time count will start when the vehicle pass through the start RFID reader and stop when the vehicle pass through the stop RFID reader. The time difference for a vehicle to pass through two consecutive readers are calculated. With the calculated time difference and pre stored constant distance the speed of the vehicle is calculated. A buzzer will sound up to alert the driver and a text message will send to the driver if the vehicle exceeds the speed limit.

1-3: Project Objectives

There are three primary objectives for this project. And they are listed as follows:

1. One of the objectives of this project is to setup a connection between the two RFID readers and Arduino Uno. The project will start off with connecting the two RFID readers to the Arduino Uno by using jumper wire. The two consecutive RFID readers must install below the road at determined distance. The determined distance in this project is 100cm. Each vehicle has its own RFID tag. After successfully connected, the two RFID readers will able to scan all the vehicles.

2. Besides, this project aims to create and upload a script to Arduino Uno in order to calculate the speed of the vehicle. This script will create by using C++ language. A running algorithm is used to calculate the time required for a vehicle to pass through two

consecutive readers. With the calculated time difference and pre stored constant distance, the speed of the vehicle is calculated.

3. Last but not least, this project also aims sound up a buzzer to alert the driver and send a text message to the driver to inform them about the speed violation.

1-4: Proposed Approach

In this project we are going to develop a vehicle speed monitoring and enforcement system by using RFID technology. This system not only can calculate the vehicle speed and compare the calculated speed with the pre stored speed but also manage to send a text message to the driver mobile phone if the value of calculated speed is higher than the pre stored speed to inform them about the speeding violation. The idea of this system make the driver hard to recognize the enforcement zone and cause the driver to reduce the vehicle speed to avoid being fined. By using this system, the speeding violations issue in Malaysia would decrease significantly.

CHAPTER 1: INTRODUCTION

1-5: Background Information

Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purpose of automatically identifying and tracking tags attached to objects. The RFID system is composed of two main components, which are the RFID reader and RFID tag. The tag is composed of a microchip connected to an antenna, the microchip can store a maximum of two kilobyte of data, which can include the information of the product, destination of the product and the manufacturing date. RFID tags can be either passive, active or battery-assisted passive. An active tag has an on board battery and periodically transmits its ID signal. A battery-assisted passive (BAP) has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery.

In order to retrieve data from the tags, RFID reader is needed. The RFID reader can be either passive or active. The passive reader can only receive radio signals from the active tags. Active reader can transmit interrogator signals and also receives authentication replies from the tags.

RFID technology is progressing every day and has proven its importance. RFID is widely using in pharmaceuticals industry, healthcare industry, agriculture, livestock tracking, human identification and lot more area. RFID isn't a new technology, but people are beginning to pay attention to this technology which can directly benefit their daily life in unexpected ways.

In this project, two active readers and multiple passive tags are used to monitor the vehicle speed. The RFID readers transmit radio waves and received by the tag. These radio waves activate the microchip of the tag and then the data get transmitted. This system once completed can be installed on demand in high accident zones to monitor the vehicle speed.

CHAPTER 1: INTRODUCTION

1-6: Report Organization

There will be total of 6 chapters in this report. Chapter 1 introduce about the background information, problem statement and motivation, project scope, objective and proposed approach also included. In chapter two, there will be 5 different types of solutions to compare in the literature review.

While there is also the system architecture, block diagram, schematic diagram, screenshot for the completed project and system flowchart inside the chapter 3. Next chapter 4 will determine about the tools to develop the project and the methodology of this project. Besides, in chapter 5 there is the implementation and testing part for the real project. Finally, the chapter 6 conclusion which include is the conclusion, impact, significance, contribution and future work of this project.

CHAPTER 2: LITERATURE REVIEW

There are several solutions have been proposed to monitor the vehicle speed and reduce the speeding violation issue.

2-1: Review of the Existing Systems/Applications

2-1-1: Manned Speed Traps

In order to reduce the number of speeding violation, many traffic regulators use speed trap devices which act as manual patrolling methods (Kevin Ransom, 2016). Speed trap systems have been implemented on demand in high accident zones in many countries as a way to control the vehicles speed. In Malaysia, manned speed trap is one of the methods that used to arrest the speeding drivers. A manned speed trap is a method that one or more police officers intentionally hiding themselves in any place in order to catch the speeding drivers. For example, the police officers can hide themselves in a low ditch, behind the billboard, a place which next to a sharp turn or anywhere that the drivers cannot see them. This action may help to reduce the presence of the police officers so that they can easily to arrest the speeding drivers. In this case, when the police officers believe that the car is speeding, they will flip on the Doppler gun that transmits radio waves at particular frequencies. The waves will bounce off the vehicle and then picked up by the receiver. The police officers can know how fast the car is driving, according to the shift of frequencies. The strength of manned speed traps is that drivers are less aware where exactly police officers will appeared. The limitation is that they require more manpower.

2-1-2: Doppler Gun

The Doppler gun is a device used to measure the speed of moving vehicles and has been widely used by police officers to arrest the speeding drivers by detecting the shift of frequencies which caused by Doppler Effect. The Doppler Effect can be described as the

change in frequency or wavelength of a wave caused by the motion of the observer relative to the wave source. When the target is approaching, the reflected frequency will be higher than the transmitted frequency. Conversely, when the target is receding, the reflected frequency will be lower than the transmitted frequency. Doppler gun has been widely used within the country because the size of the Doppler gun is smaller and convenient to move from one location to another location. Besides, the price of the Doppler gun is only RM2600 and is cheaper compare to the other devices which used to monitor the vehicle speed.

The Doppler radar may cause innocent people to be arrested due to some technical problems. The technicalities include the cosine error, calibration errors, ghosting errors and lack of target specificity (Goodson, 1985). There are some limitations to the use of the Doppler speed gun. For example, Doppler gun can only capture one vehicle at a time. This may cause some drivers to drive behind the speeding car because they know that only the car in front of them will be stopped and arrested. Besides, when two cars are in parallel, the Doppler radar cannot differentiate which car is the speeding car. An arrested driver may argue that his or her car does not exceed the speed limit because the device only captures the speed of the vehicle.

2-1-3: Vehicle License Plate Recognition

Vehicle License Plate Recognition (VLPR) is a technology that can detect the vehicles on monitored roads and automatically extract vehicle license plate information for processing. VLPR technology is one of the important aspects in the intelligent traffic system and it is widely been used. By using image processing, pattern recognition, computer vision and other technologies, it analyzes the images or video sequences of the vehicles captured by the camera to obtain the unique license plate number of each vehicle, thus completing the recognition process. Through some subsequent processing means, it can be implementing into different sectors such as parking management, traffic flow measurement, vehicle positioning, red light enforcement, highway toll station, vehicle speed monitoring, and so on. The license plate number is the only "identity" of the vehicle.

CHAPTER 2: LITERATURE REVIEW

The automatic license plate recognition technology can automatically register and verify the "identity" of the car without causing any changes to the car. The strength of this technology is real time monitoring and surveillance. The limitation is that bad weather or hindrance can make vehicle license plate recognition systems ineffective.

The license plate recognition technology combined with the speed measuring device can be used for monitoring the speeding violations of vehicles. The specific applications are divided into six steps as follows:

1. Setting speed monitoring points on the road.
2. Capturing speeding vehicles and identifying license plate numbers.
3. Sending license plate numbers and pictures of illegal vehicles to various exits.
4. Setting penalty point at each exit.
5. Using the license plate recognition device to identify the passing vehicle and compare the number with the number of the speeding vehicle that has been received.
6. Once the numbers are the same, an alert device is activated to notify the police officer to stop and arrest the speeding driver.

2-1-4: Image Processing

Image processing is a technology that can convert an image into digital form and perform various image processing techniques such as image enhancement and restoration, noise removal, image histogram, image compression, image segmentation, image difference, image classification and image transformation to extract useful information from the image (Ekta Saxena and Mrs. Neha Goswami, 2015). Image processing is a type of signal disbursement in which input is an image, like video frame or photograph and output may be image or characteristics associated with that image.

The image processing technology combined with the vehicle license plate recognition technology can be used to monitoring the speeding violations and obtained the information of speeding car such as license plate number and illegal video image. The specific applications are divided into five steps as follows:

1. Using CCTV to capture video images on highways and then digitizing the images.
2. The digitalized image is preprocessed.
3. Determining the presence of vehicle in the field of view according to the pre-processed image and determining the motion track and the speed of the vehicle.
4. Identifying the vehicle's license plate which appeared in step 3.
5. If the vehicle exceeds the speed limit, the number plate and video image will send to the monitoring center.

This solution depends on implementing a large number of CCTV cameras within the country in order to monitor the vehicle speed. The limitation is that the CCTV may be interfered by the bad weather or any kind of hindrances and caused the system become ineffective. Besides, this system also required some time to preprocessing the video image. There is a lot of redundant data for image processing in an image. The more data for image processing, the more time is needed for preprocessing it.

2-1-5: Radio Frequency Identification (RFID)

Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purpose of automatically identifying and tracking tags attached to objects. Farrukh Hafeez, Mohammad Al Shammrani, Omar Al Shammary (2015) have proposed a system which using RFID technology to calculate the vehicle speed and charge them fine for speeding violation. Two RFID readers and tags are included in this system. The two RFID readers are installed at a specific distance and the RFID tags are attached to each vehicles. The two RFID readers are connected to the Central Control Unit which collecting data from them. The vehicle speed can be calculated by using Speed - Time – Distance formula. If the vehicle speed is exceeds the speed limit, the owner of the speeding vehicle will be fined. By implementing this technology, the drivers will become more difficult to aware the enforcement zone and this will cause them to reduce the vehicles speed in order to avoid being fined. The limitation of this method is speeding driver may argue that his or her car does not exceed

the speed limit because this system only scan the tag of the vehicle but does not provide other evidence such as picture or video to prove their crime.

2-2: Critical Remarks of previous works

Existing System	Advantages	Disadvantages	Critical Comments
Manned Speed Traps	• Less aware where exactly police officers will appeared.	• Require more manpower.	This method requires many police officers to patrol manually in different areas which can easily aware by the drivers.
Doppler Gun	• Smaller and convenient to move to other location.	• Can only capture one vehicle at a time. • Cannot differentiate which car is the speeding car when two cars are in parallel.	Doppler radar may cause innocent people to be arrested due to some technical problems.
Vehicle License Plate Recognition	• Support real time monitoring	• Bad weather or any hindrance	Drivers can easily aware the presence of the camera and

	and surveillance	will affect the system.	may use the other roads.
Image Processing	• Support real time monitoring and surveillance	• Required some time to preprocessing the video image.	Drivers can easily aware the presence of the camera and may use the other roads.
Radio Frequency Identification	• Difficult to aware the enforcement zone.	• Does not provide enough evidence such as picture or video.	RFID technology is very suitable for this project as drivers become hard to aware the enforcement zone.

Table 2-2: Critical Remarks of previous works

CHAPTER 3: SYSTEM DESIGN

3-1: System Architecture

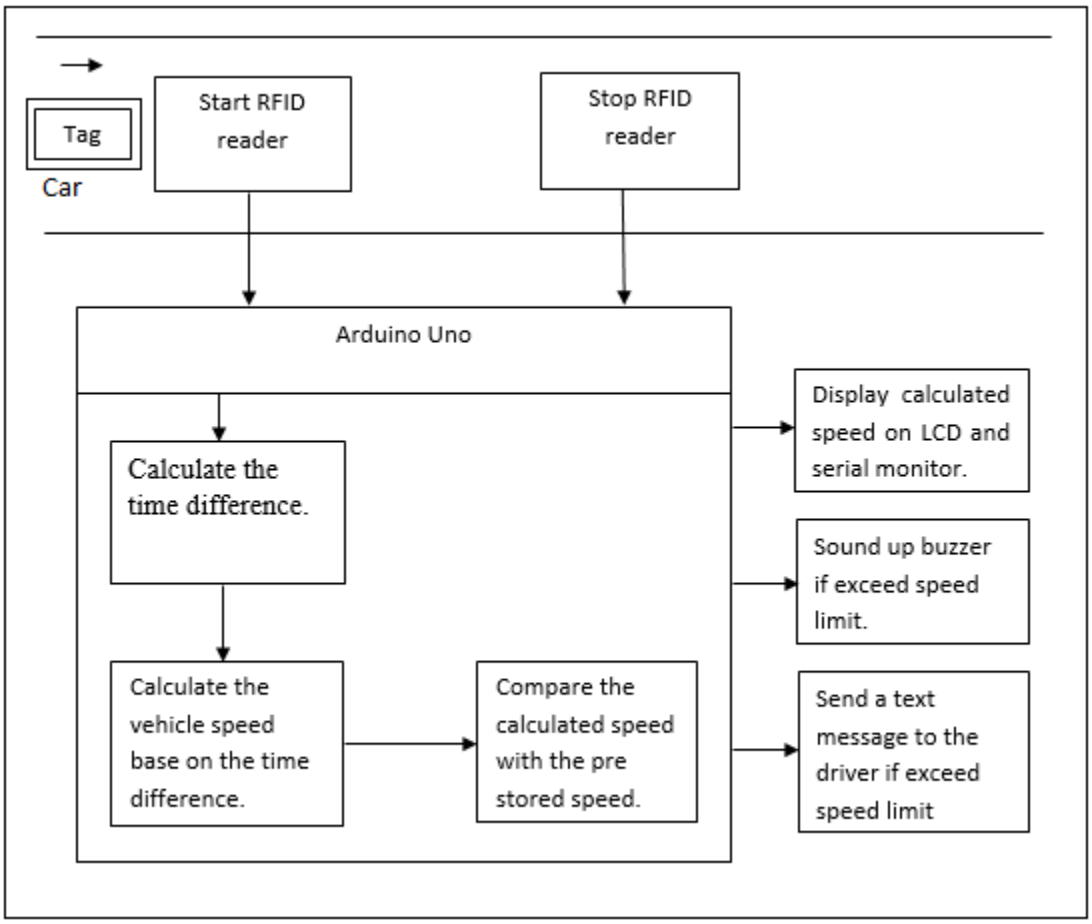

Figure 3-1-F1: System architecture

System architecture is a conceptual model that defines a system. It allows the reader to understand and clear of how the system actually works. Based on figure 3-1-F1, the Arduino Uno will be the heart of the system which will be controlling the two RFID readers, LCD, buzzer and GSM modem. The two RFID readers will scan the tag and the Arduino Uno will collect the data from RFID readers. The time count will start when the vehicle pass through the start RFID reader and stop when the vehicle pass through the stop RFID reader. The time difference for a vehicle to pass through two consecutive readers are calculated. With the calculated time difference and pre stored constant distance the speed

of the vehicle is calculated. Then, the calculated speed will compare with the pre stored speed and the result will display on the LCD and serial monitor. A buzzer will sound up to alert the driver and a text message will send to the driver if the vehicle exceeds the speed limit.

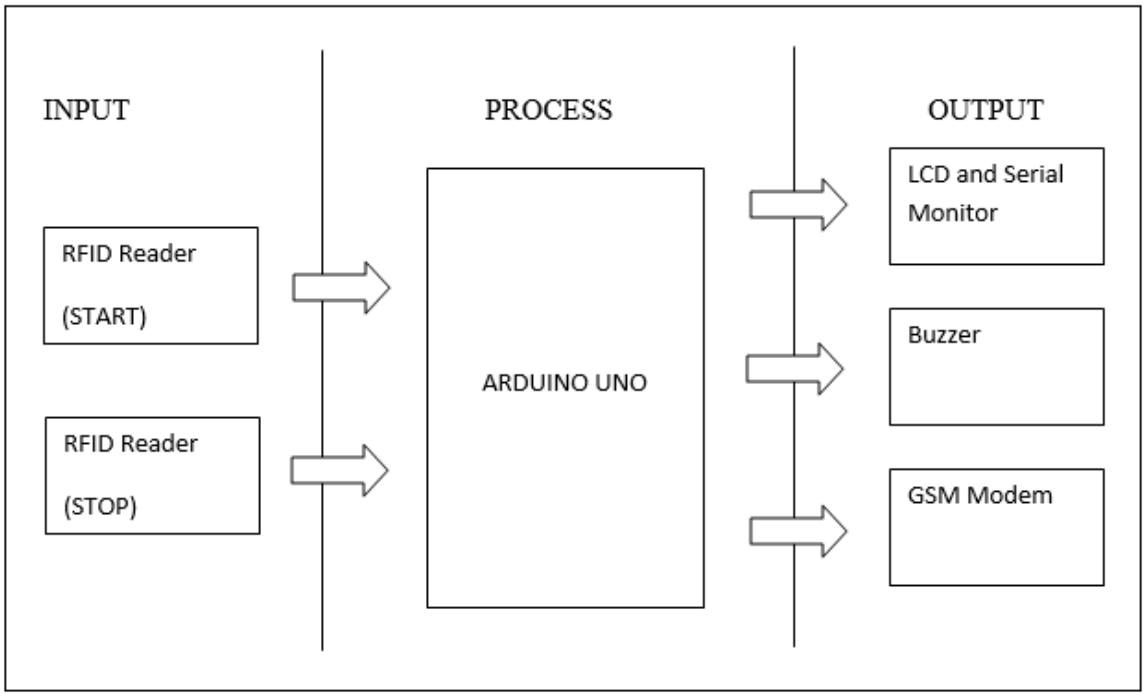

Figure 3-1-F2: Block diagram

CHAPTER 3: SYSTEM DESIGN

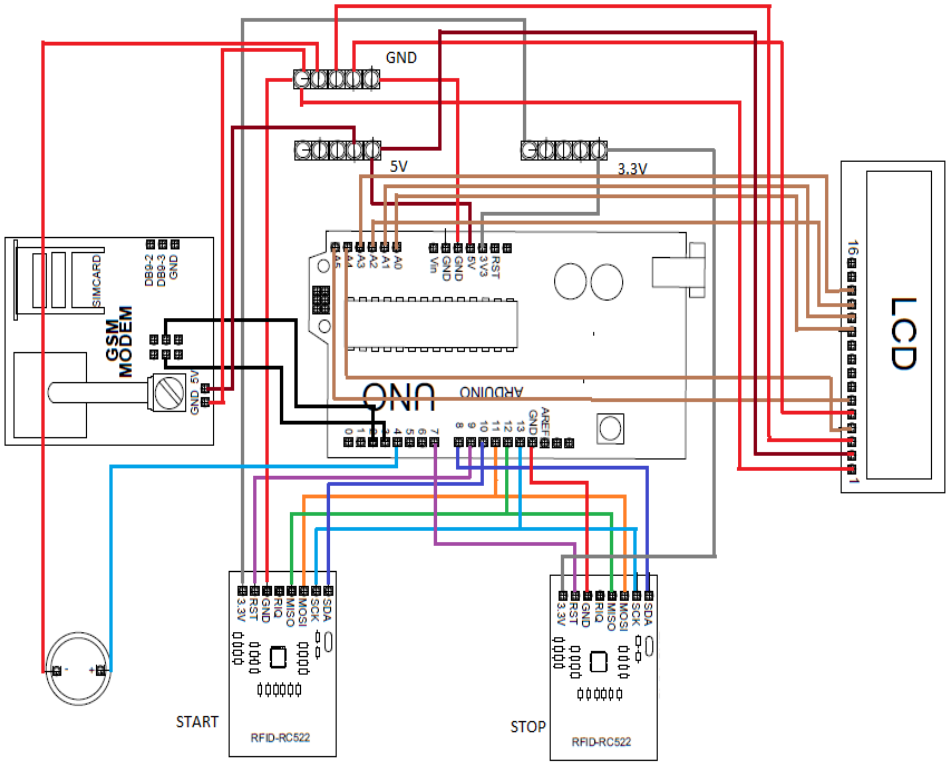

Figure 3-1-F3: Schematic diagram

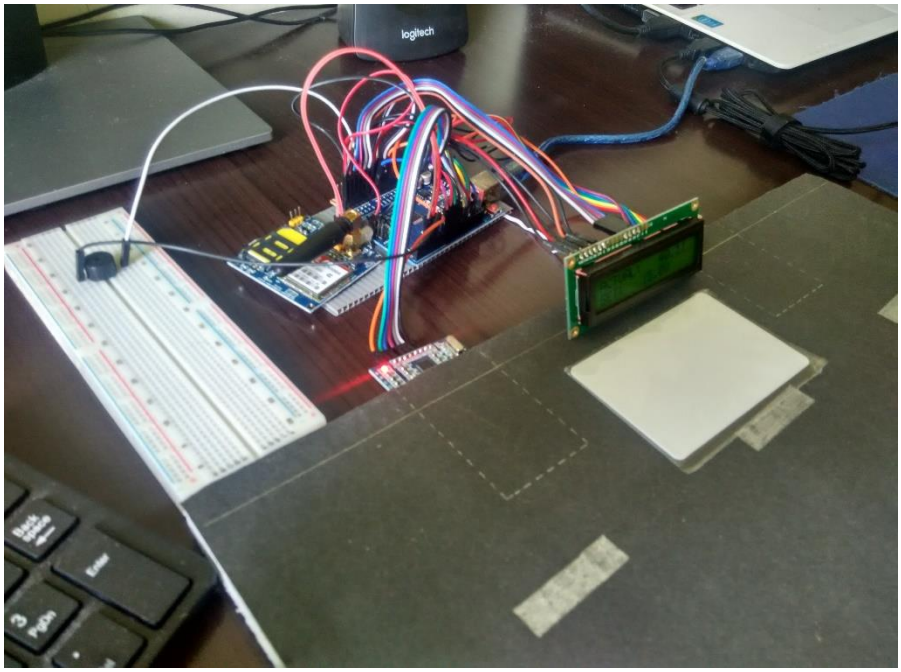

Figure 3-1-F4: Screenshot of the project after launch the program

CHAPTER 3: SYSTEM DESIGN

3-2: Requirement Specification

3-2-1: Functional Requirements

- The program should be able to connect the two RFID readers.
- The program should be able to scan the RFID tags.
- The program should be able to retrieve the unique ID from the RFID readers.
- The program should be able to display the unique ID on the serial monitor.
- The program should be able to calculate the time difference the vehicle pass through consecutive RFID readers.
- The program should be able to calculate the vehicle speed based on the time difference.
- The program should be able to do the comparison between the calculated speed and pre stored speed.
- The program should be able to send a text message to the driver if the vehicle exceeds the speed limit.
- The driver should be able to receive a text message if the vehicle exceeds the speed limit.

3-2-2: Non-functional Requirements

- The program should be able to display the time difference on the serial monitor.
- The program should be able to display the calculated speed and pre stored speed on the LCD screen.
- The program should be able to trigger the buzzer if the vehicle speed exceeds the speed limit.

CHAPTER 3: SYSTEM DESIGN

3-3: Functional Modules in the system

3-3-1: Collect data Module

In this module, all the setting for the RFID reader will be written in C++ code and implemented. This module is responsible for collecting the data from the RFID reader every time the reader scan the vehicle. Each vehicle has its own RFID tag. Basically in this module, when the system runs, the RFID readers will continue to wait for vehicle until the start RFID reader scan the vehicle. The start RFID reader will not able to scan for the other vehicle until the first vehicle pass through the stop RFID reader. If the vehicle choose to pass through the stop RFID reader first, the stop RFID reader will not scan the vehicle. The start RFID reader will continue to wait for vehicle after the previous vehicle passed through the stop RFID reader. In order to communicate and collect data from the RFID readers, the SPI library and RFID library are needed to install in Arduino IDE. The RFID library allows the Arduino Uno to read data from tag by using the two RFID readers. Besides that, the SPI library allows the Arduino Uno to communicate with the SPI device, with the Arduino Uno as a master device.

3-3-2: Calculate speed Module

This module is responsible for calculating the speed of the vehicle. An algorithm which written in C++ language is uploaded to the Arduino Uno board in order to calculate the vehicle speed. Firstly, the time count will start when the vehicle pass through the start RFID reader and the time count will stop when the vehicle pass through the stop RFID reader. The time difference for a vehicle to pass through the two consecutive RFID readers are calculated. With the calculated time difference and pre stored constant distance the speed of the vehicle is calculated. After the vehicle speed is calculated, the calculated speed will compare with the pre stored speed to determine whether the vehicle speed is exceeds the speed limit or not.

3-3-3: Display result Module

This module is responsible for displaying the calculated speed and the pre stored speed on the LCD screen. When the vehicle pass through the RFID readers, the unique ID of the tag, the time difference for the vehicle to pass through the two consecutive RFID readers, the calculated speed and the pre stored speed will display on the serial monitor. Only the calculated speed and the pre stored speed will display on the LCD screen. This LCD is prepared for the situation when the result is unable to display on the serial monitor such as the USB cable which connect the Arduino Uno board with the laptop is unplug from the USB port. After the program is uploaded to the Arduino Uno board, the program can run automatically when there is an external power supply to power up the board. In order to display the calculated speed and pre stored speed on the LCD screen, the LiquidCrystal library is needed to install in the Arduino IDE. This LiquidCrystal library allows the Arduino Uno board to control the LCD based on the Hitachi HD44780 chipset, which is found on most text-based LCD.

3-3-4: Notification Module

This module is responsible for notifying the driver if the vehicle exceeds the speed limit. There are two hardware implement in this module. The first implementation is a buzzer and the second implementation is a GSM modem. When the vehicle is exceeds the speed limit, the buzzer will sound up to alert the driver and a text message will send to the driver to inform them about the speeding violation via GSM modem. GSM modem is a GSM phone without display, keypad and battery. It accepts a SIM card and operates over a subscription to a mobile operator just like a mobile phone. In this project, the GSM modem is controlled by the Arduino Uno to send a text message to the driver when the vehicle exceeds the speed limit. In order to execute this function, the GSM library is needed to install in the Arduino IDE.

CHAPTER 3: SYSTEM DESIGN

3-4: System Flow

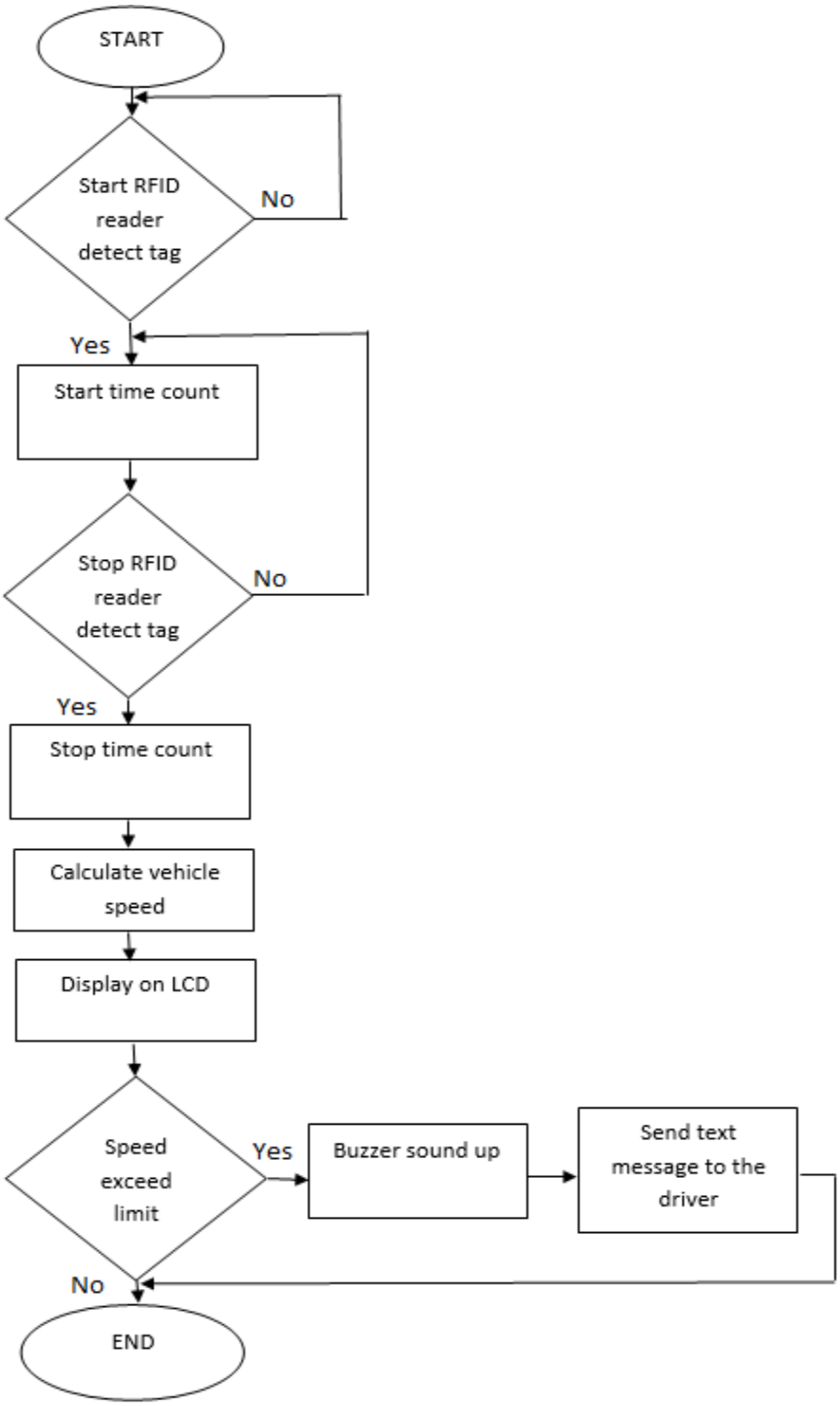

Figure 3-4: Flowchart of system flow

CHAPTER 3: SYSTEM DESIGN

The system flow of this project will be represented in a flowchart form. From the flowchart, it emulates a situation where the start RFID reader will scan the vehicle every time the vehicle pass through it. Then, the time count will start until the vehicle pass through the stop RFID reader. The time count will not stop if the vehicle does not pass through the stop RFID reader. The time difference for a vehicle to pass through two consecutive readers are calculated. With the calculated time difference and pre stored constant distance the speed of the vehicle is calculated. Then, the calculated speed and the pre stored speed will display on the LCD screen. If the vehicle exceeds the speed limit, the buzzer will sound up and a text message will send to the driver to inform them about the speeding violation.

CHAPTER 4: METHODOLOGY AND TOOLS

4-1: Design Specification

In this section the methodologies adopted will be described, while there will be list of tools used for development of the project.

4-1-1: Methodologies

The prototype model refers to a working prototype of the system that should be built before the actual software development. A prototype is an analog implementation of the system and generally has limited functionality, lower reliability, and insufficient performance compared to actual software. Several shortcuts are often used to build prototypes. These shortcuts may include the use of inefficient, imprecise, and virtual functions. A prototype is usually a crude version of the actual system. The prototype model obtains user feedback by providing prototypes to the user so that the developed software can truly reflect the user's needs. By using this model, the client can get an "actual feel" of the system much earlier instead of they have to wait for the final system to be completed. This allow any misunderstanding of requirements, additional features and possible errors to be detected much earlier, before the actually system is finalized. This model is most suitable for projects whose requirements cannot be known in detail ahead of time.

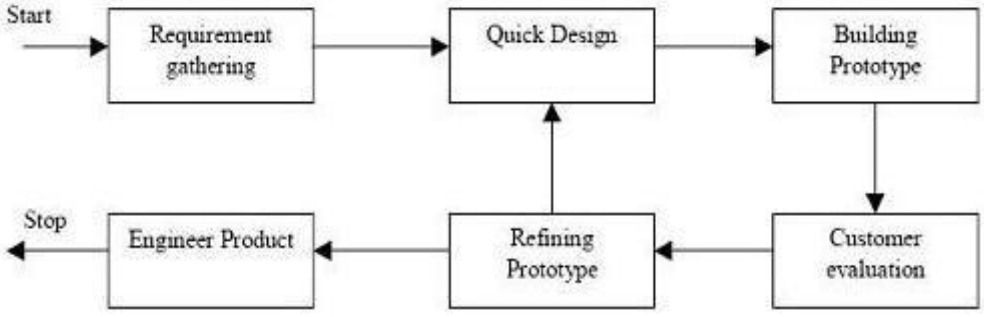

Figure 4-1-1: Prototyping Model (ISTQB Exam Certification, 2018)

CHAPTER 4: METHODOLOGY AND TOOLS

In this project, prototype model was selected after discussed and studied. As this project is not a very large scale project, hence the prototype model is suitable. Besides, user can actually understand more on this system earlier instead of waiting for the final system to be complete by using this model. Furthermore, this model allows any changes or modification to made in order to reduce failure.

4-1-2: Tools to use

This project will be employing an Arduino Uno connected with two RFID readers which are MFRC522 in order to scan the vehicle. Each car has its own RFID tag. A LCD is implemented to display the calculated speed and the pre stored speed. A buzzer and a GSM modem are implemented to notify the drivers when they exceed the speed limit. The software components include Arduino Software (IDE) and C++ language.

4-1-2-1: Hardware

Arduino Uno

The Arduino Uno is the heart of the entire system. It is capable to receive input from the RFID readers and produce result as output after process. Besides, it is reasonable in pricing and easy to get.

Figure 4-1-2-1-F1: Arduino Uno (Inventables, 2018)

Mifare RC522

Mifare RC522 is the high integrated RFID card reader which works on non-contact 13.56mhz communication, is designed by NXP as a low power consumption, low cost and compact size read and write chip, is the best choice in the development of this project.

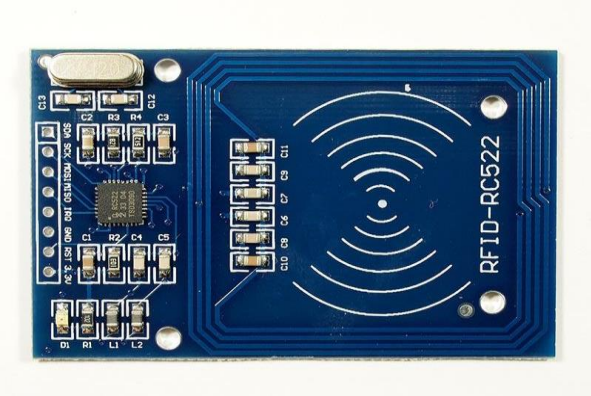

Figure 4-1-2-1-F2: Mifare RC522 RFID Card Reader (HAOYU electronics, 2018)

ISO14443A smart IC cards

The MIFARE Classic® family is the most widely used contactless smart card ICs operating in the 13.56 MHz frequency range with read/write capability and ISO/IEC 14443A compliance.

Figure 4-1-2-1-F3: ISO14443A smart IC cards (HAOYU electronics, 2018)

Standard LCD 16x2 Display

A standard LCD 16x2 display is use to display the calculated speed and the pre stored speed for this project. This standard LCD 16x2 display is connected to the Arduino Uno by using jumper cable.

Figure 4-1-2-1-F4: Standard LCD 16x2 Display (thingbits, 2018)

Buzzer

A buzzer will sound up when the vehicle exceeds the speed limit in order to alert the driver about the speeding violation.

Figure 4-1-2-1-F5: Buzzer (Banggood, 2018)

GSM SIM900A Modem

GSM modem is a GSM phone without display, keypad and battery. It accepts a SIM card and operates over a subscription to a mobile operator just like a mobile phone. In this project, the GSM modem is controlled by the Arduino Uno to send a text message to the driver when the vehicle exceeds the speed limit.

Figure 4-1-2-1-F6: GSM SIM900A Modem (Microsolution 2018)

Other Components (Jumper Cable, Breadboard, SIM Card)

Jumper wire is an electrical wire where it use to connect between the RFID readers and Arduino Uno. The types of jumper cable that use in this project are male-to-female jumper cable and female-to-female jumper cable. Breadboard is a construction base for prototyping where it use to connect buzzer and Arduino Uno to form a basic circuit. A SIM card is placed in the SIM900A GSM modem in order to send a text message when the vehicle exceeds the speed limit.

Personal Computer (Laptop)

Windows based operating system laptop was use to run the Arduino Software (IDE). The code is create on Arduino IDE and then upload to the Arduino Uno board.

4-1-2-2: Software

Arduino Software (IDE)

Figure 4-1-2-2: Arduino IDE (Arduino, 2018)

Arduino IDE is an open-source cross-platform application that make user easy to write code and upload the code to the Arduino board. This application is written in java language but the script that write to run this project is C++ language.

C++ language

C++ is a middle-level language and is an extension of the C language. C++ language support multiple platform such as Windows, MAC OS and various versions of UNIX. In this project, a C++ script is created and uploaded to the Arduino Uno board through Arduino IDE.

CHAPTER 4: METHODOLOGY AND TOOLS

Libraries Used

There is a list of libraries that used in this project.

RFID library allows the Arduino Uno to read data from tag by using the two RFID readers.

SPI library allows the Arduino Uno to communicate with the SPI device, with the Arduino Uno as a master device.

LiquidCrystal library allows the Arduino Uno board to control LCD.

GSM library allows the Arduino Uno board to send message to the mobile phone.

4-2: Expected Challenge

The challenge to be expected in this project will be the number of vehicle that can enter the enforcement zone at one time. When a vehicle pass through the start RFID reader, the start RFID reader will scan the first vehicle and then will become unable to scan for the other vehicle until the first vehicle pass through the stop RFID reader. This method will increase the accuracy when calculate the speed for each vehicle but also limit the number of vehicle that can enter the enforcement zone at one time.

4-3: Timeline

Task	Project Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Data Collection	■	■												
Define project objective and scope			■											
Analysis for literature review				■	■									
Define technologies involved					■									
Determine system development model						■								
Determine system and functional requirements							■	■	■					
Outline system architecture										■				
Outline system flow										■				
Create database and insert all the information of the tag.											■	■		
Presentation														■
Documentation	■	■	■	■	■	■	■	■	■	■				

Table 4-3-T1: Gantt chart showing the project timeline (FYP 1)

Task	Project Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Calculate time difference														
Calculate vehicle speed														
Set the speed limit														
Add a LCD to display the calculated speed and pre stored speed.														
Add a function which can send a text message to inform the vehicle owner about the speeding violation.														
Add a buzzer which will sound up if the vehicle exceeds the speed limit.														
Finalizing the functional requirement, system architecture and system flow														
Finalizing system for presentation														
System testing and performance														
Presentation														
Documentation														

Table 4-3-T2: Gantt chart showing the project timeline (FYP 2)

4-4: Estimated Cost

Items	For Final Year Project Development	For Commercialization
Arduino Uno	RM0	RM45.00
MFRC522 readers and tags	RM0	RM60.00
GSM Modem	RM0	RM130.00
Standard LCD 16x2 display	RM0	RM20.00
Jumper wire	RM0	RM27.00
Breadboard	RM0	RM20.90
Buzzer	RM0	RM3.50
Arduino Software (IDE)	RM0	--
C++ language	RM0	--
	RM0	RM306.40

Table 4-4: Estimated Cost

Based on the table above, there will be no spending needed as the required items are mostly personal belonging of mine. As for commercialization, Arduino Uno, MFRC522 readers and tags, GSM Modem, Standard LCD 16x2 display, jumper wire, breadboard and buzzer will cost RM45.00, RM60.00, RM130.00, RM20.00, RM27.00, RM20.90 and RM3.50 respectively.

CHAPTER 5: IMPLEMENTATION AND TESTING

5-1: Hardware Setup

5-1-1: Arduino Uno with RFID readers

The entire system of this project generally involves Arduino Uno. The two RFID readers (MFRC522) were connected to Arduino Uno by using jumper cable to perform read function for the system. The wire connection for start RFID reader is as table 5-1-1-T1. The wire connection for stop RFID reader is as table 5-1-1-T2. Besides that, a figure of Arduino Uno pin diagram and the actual setup with RFID readers are also shown.

RFID reader (Start)	Arduino Uno
3.3V	3.3V
RST	Arduino Pin 9
GND	GND
MISO	Arduino Pin 12
MOSI	Arduino Pin 11
SCK	Arduino Pin 13
SDA (SS)	Arduino Pin 10

Table 5-1-1-T1: Wire Connection for start RFID reader

RFID reader (Stop)	Arduino Uno
3.3V	3.3V
RST	Arduino Pin 7
GND	GND
MISO	Arduino Pin 12
MOSI	Arduino Pin 11
SCK	Arduino Pin 13
SDA (SS)	Arduino Pin 8

Table 5-1-1-T2: Wire Connection for stop RFID reader

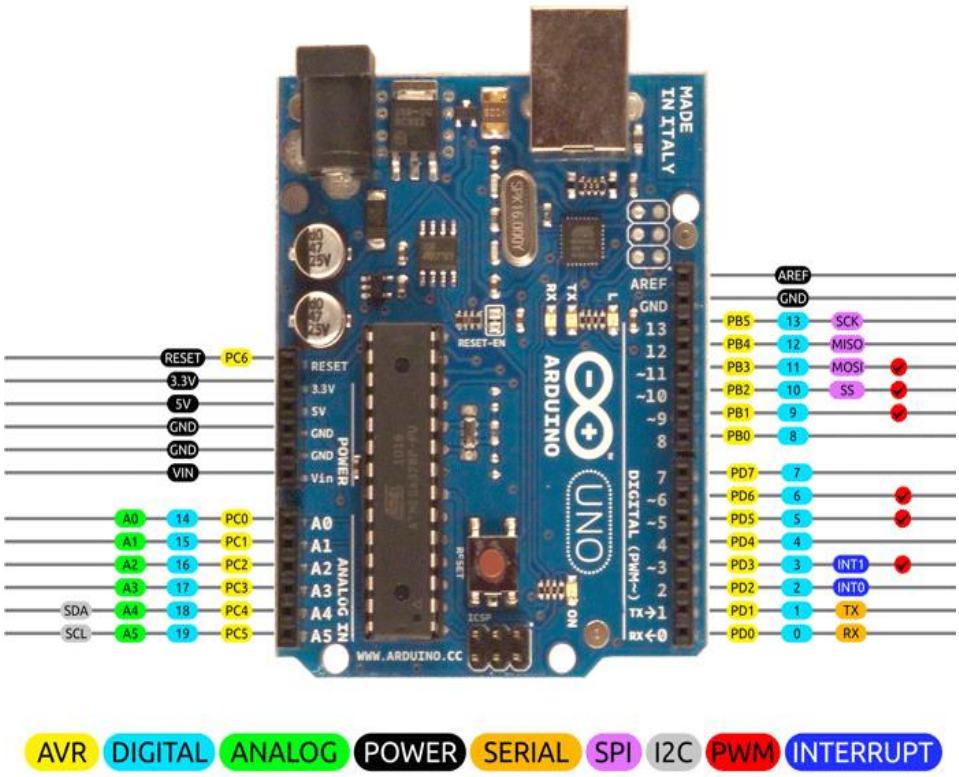

Figure 5-1-1-F1: Arduino Uno pin diagram (Component101, 2018)

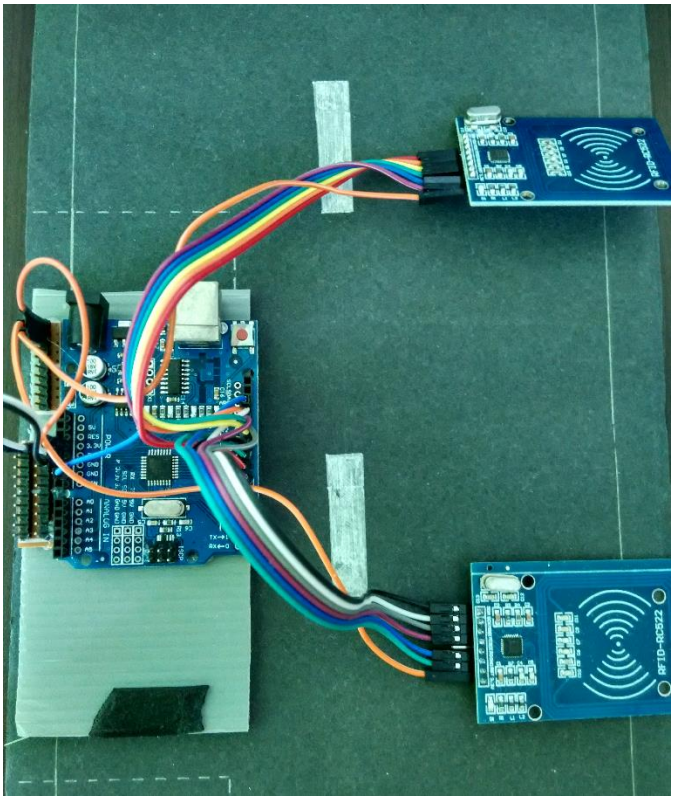

Figure 5-1-1-F2: Actual setup with RFID readers

5-1-2: Arduino Uno with standard LCD 16x2 display

The standard LCD 16x2 display was connected to Arduino Uno by using jumper cable in order to display the calculated speed and pre stored speed. The wire connection is as table 5-1-2. Besides that, the actual setup with standard LCD 16x2 display is also shown.

LCD	Arduino Uno
D7	Arduino Pin A3
D6	Arduino Pin A2

D5	Arduino Pin A1
D4	Arduino Pin A0
E	Arduino Pin A5
RW	GND
RS	Arduino Pin A4
V0	GND
VDD	5V
VSS	GND

Table 5-1-2: Wire Connection for standard LCD 16x2 display

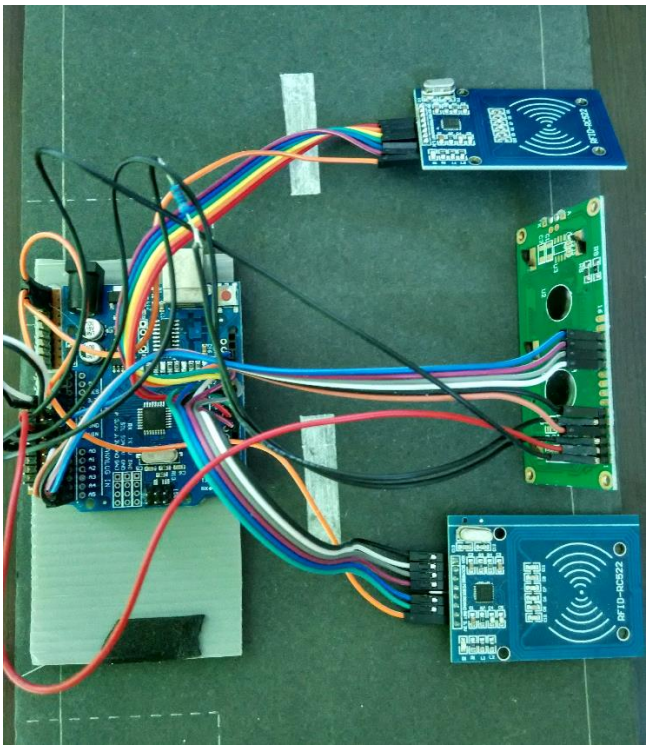

Figure 5-1-2: Actual setup with standard LCD 16x2 display

5-1-3: Arduino Uno with GSM modem

In this project, GSM modem is controlled by Arduino Uno to send message to the mobile phone if the vehicle exceeds the speed limit. This GSM modem was connected to the Arduino Uno by using jumper cable. The wire connection for the GSM modem is as table 5-1-3. Besides, the actual implementation of the GSM modem is also shown.

GSM modem	Arduino Uno
GSM Rx	Arduino Pin 2
GSM Tx	Arduino Pin 3
GND	GND
5V	5V

Table 5-1-3: Wire Connection for GSM modem

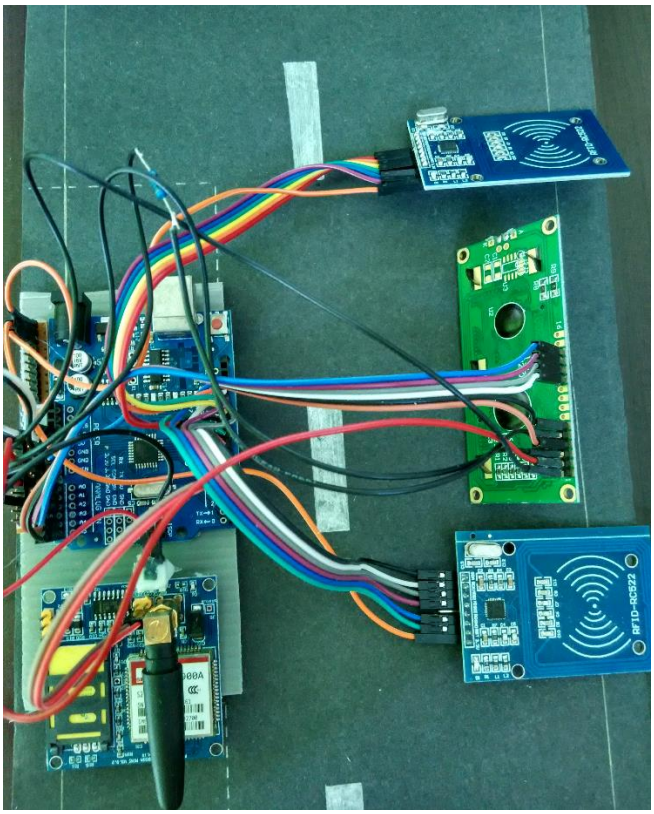

Figure 5-1-3: Actual setup with standard GSM modem

5-1-4: Arduino Uno with buzzer

In this project, a buzzer is implemented to alert the driver if the vehicle exceeds the speed limit. The buzzer was connected to the Arduino Uno by using jumper cable. The wire connection for the buzzer is as table 5-1-4 and the actual setup with buzzer is also shown.

Buzzer	Arduino Uno
Positive	Arduino Pin 4
Negative	GND

Table 5-1-4: Wire Connection for buzzer

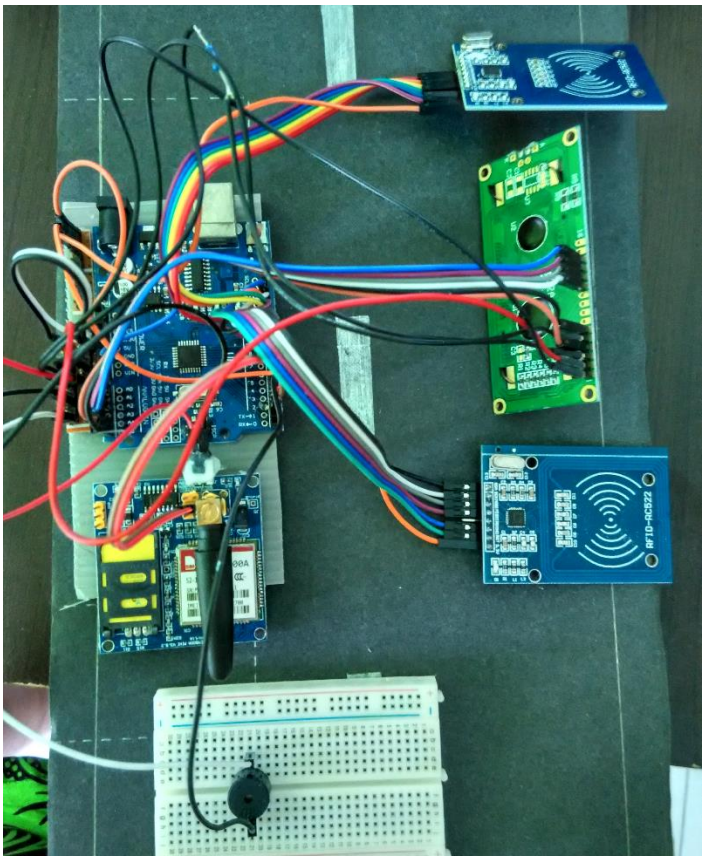

Figure 5-1-4: Actual setup with buzzer

CHAPTER 5: IMPLEMENTATION AND TESTING

5-2: Software Setup

5-2-1: Arduino Software (IDE)

In this project, Arduino Software (IDE) need to be installed in the laptop in order to write the code and upload the code to the Arduino Uno board. Arduino IDE is written in programming language JAVA and is a cross platform application which can make the user easy to write code and upload the code to the Arduino Uno board. The installation of the Arduino Software (IDE) is short and the guide is easy to find online. The Arduino Software (IDE) that we used in this project is the latest version which is Arduino 1.8.5. The available installation guide for Arduino Software (IDE) can be find in the following link: (https://www.arduino.cc/en/Guide/Windows). There are total of 7 mechanisms we can install the Arduino Software (IDE):

- Windows Installer
- Windows ZIP file
- Windows app
- Mac OS X
- Linux 32 bits
- Linux 64 bits
- Linux ARM

In this project, we are installing the Arduino Software (IDE) Windows Installer. Windows Installer can install directly everything we need to use in the Arduino Software (IDE), including the drivers. After the installation is completed, we can start to install the libraries and run the program.

5-2-2: RFID library

RFID library need to be installed in the Arduino Software (IDE) in order to read the data from the tag. The RFID library can be download from this link: (https://github.com/song940/RFID-RC522). After downloaded, unzip the RFID-RC522-master.zip file and install it in the Arduino Software (IDE).

5-2-3: SPI library

In this project, SPI library also need to be installed in the Arduino Software (IDE) in order to allow the Arduino Uno to communicate with the SPI device, with the Arduino Uno as the master device. The SPI library can be download from the following link: (https://github.com/PaulStoffregen/SPI). After the library is downloaded, unzip and install the library in the Arduino Software (IDE).

5-2-4: LiquidCrystal library and GSM library

In this project, LiquidCrystal library is installed to allow the calculated speed and pre stored speed to display on the LCD screen. Besides that, GSM library is installed to allow Arduino Uno to control the GSM modem in order to send message to the mobile phone. These two libraries will install automatically when the Arduino Software (IDE) is installed.

5-3: System Operation

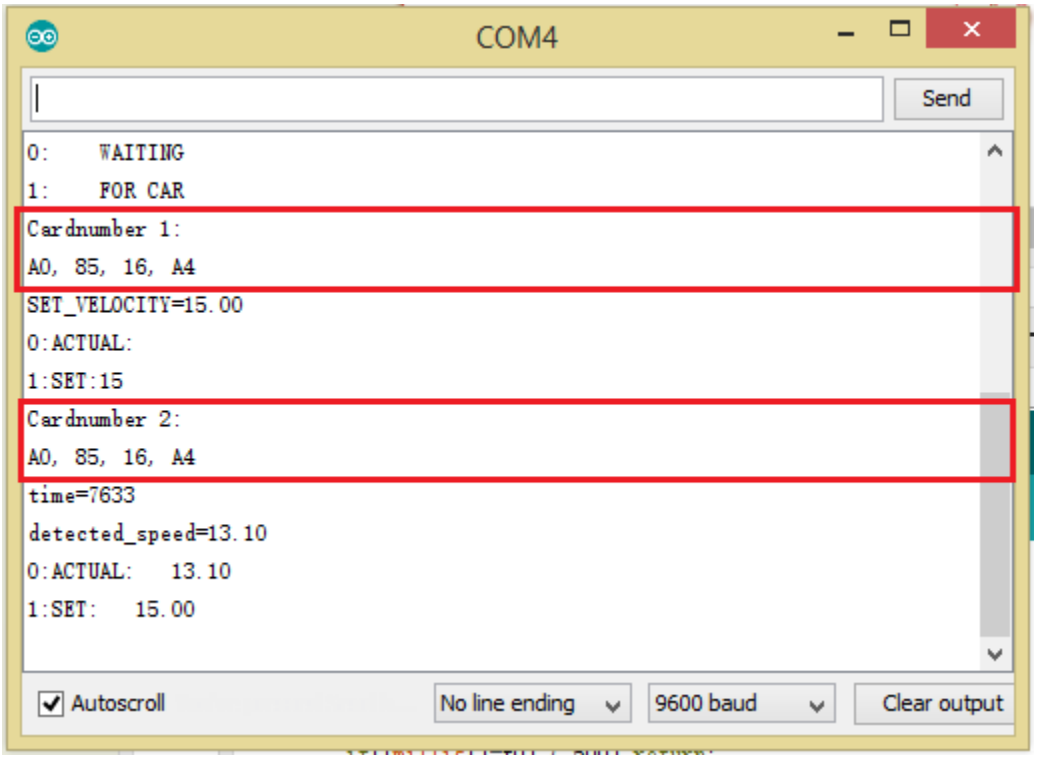

Figure 5-3-F1: Screenshot for retrieve UID from RFID readers

Once all the components are connected to the Arduino Uno board and the required libraries are installed in the Arduino Software (IDE), the system is able to run according to the C++ script which uploaded to the Arduino Uno board. The first function in this project is collecting data from the two RFID readers. Based on the figure 5-1-F1 above, when the vehicle pass through the start RFID reader, the unique ID of the tag will retrieve from the start RFID reader and display on the serial monitor. When the vehicle pass through the stop RFID reader, the unique ID of the tag will retrieve from the stop RFID reader and display on the serial monitor.

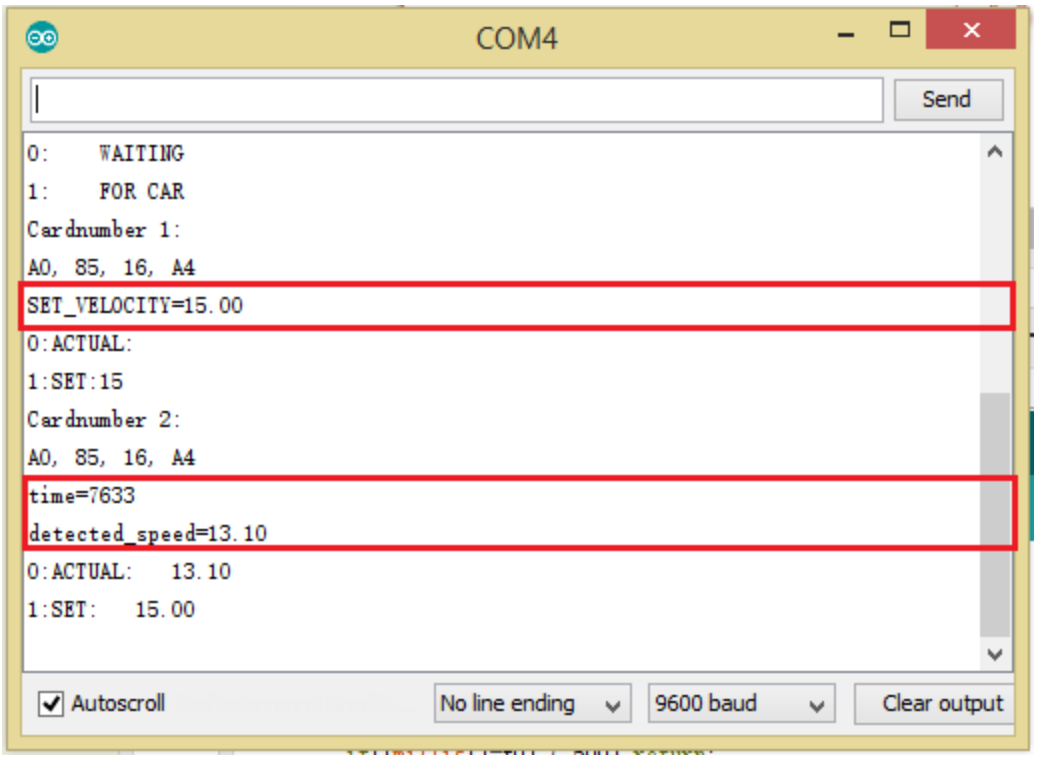

Figure 5-3-F2: Screenshot for vehicle which does not exceeds the speed limit

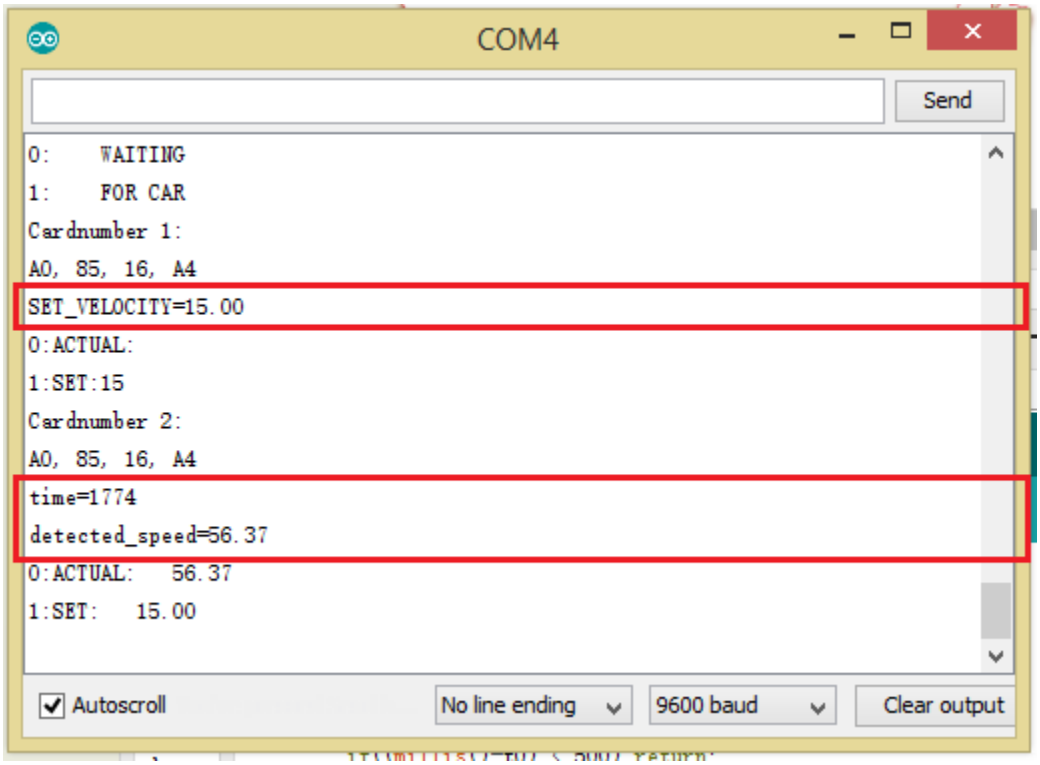

Figure 5-3-F3: Screenshot for vehicle which exceeds the speed limit

The second function in this project is calculating the vehicle speed. Every time the vehicle pass through the start RFID reader, the pre stored speed which is 15cm/s will display on the serial monitor. At the same time, the time count will start. The start RFID reader will become unable to scan for the other vehicle until the first vehicle pass through the stop RFID reader. When the vehicle pass through the stop RFID reader, the time difference for a vehicle to pass through the two consecutive readers in milliseconds will display on the serial monitor. The pre stored distant in this project is 100cm. The formula to calculate the speed is detected speed = distant / ((time stop - time start) / 1000.0). The reason that divided the time difference by 1000.0 is because 1 second is equal to 1000 milliseconds. By using this formula, the vehicle speed is calculated. After that, the calculated speed will compare with the pre stored speed to determine whether the vehicle exceeds the speed limit or not.

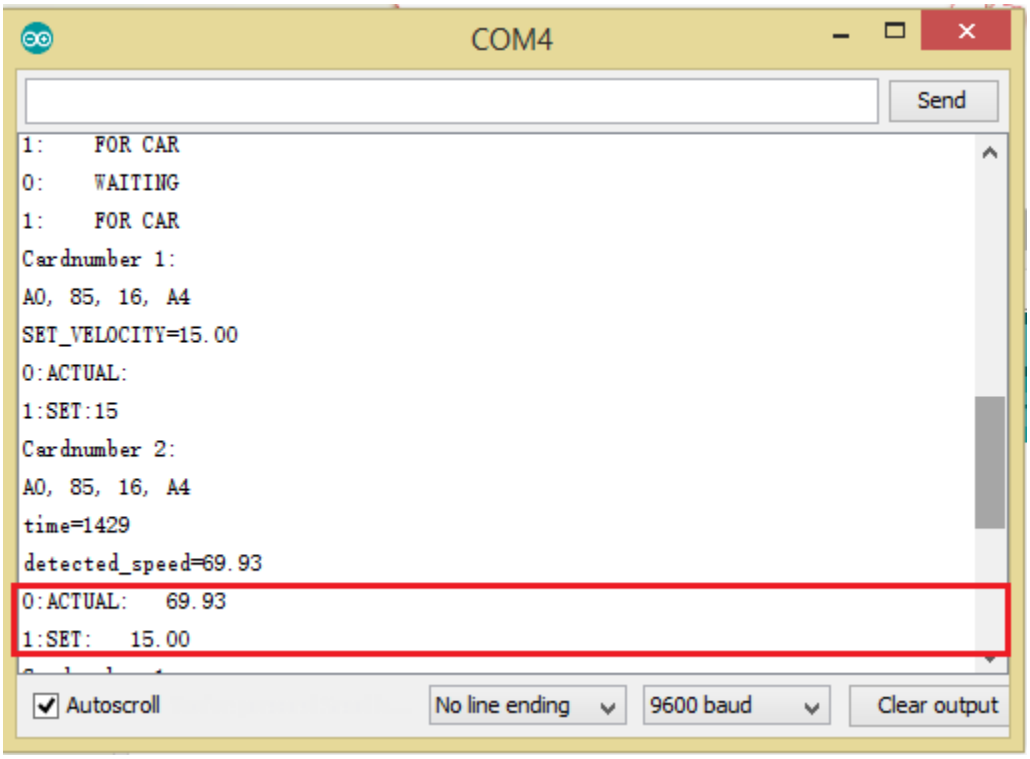

Figure 5-3-F4: Screenshot for serial monitor

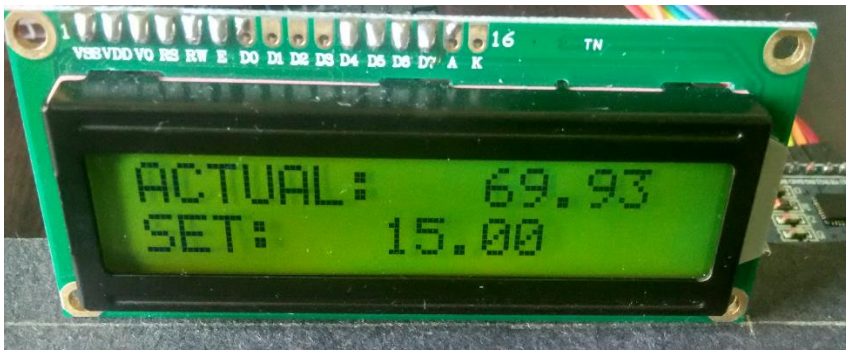

Figure 5-3-F5: LCD screen which display the calculated and pre stored speed

The calculated speed and the pre stored speed are displayed on the serial monitor and the LCD screen. After compiled and uploaded the program to Arduino Uno board, the program can run automatically without the support from the Arduino Software (IDE). If there is an external power supply for the Arduino Uno board, the USB cable that connect the laptop and the Arduino Uno board can unplug from the USB port and the board still can execute the program loaded on it. In this situation, the result will not able to display on the serial monitor. A 16x2 LCD screen is suitable in this situation to display the calculated speed and the pre stored speed.

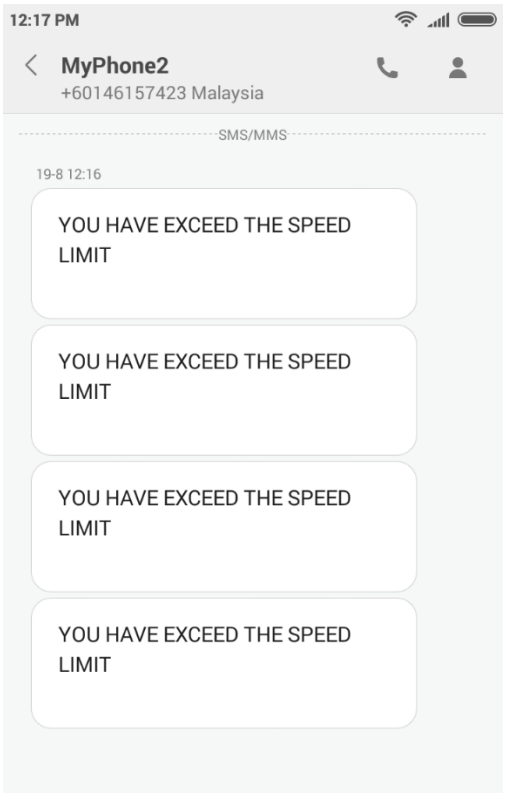

Figure 5-3-F6: Screenshot of phone message

When the vehicle exceed the speed limit, a buzzer will sound up and a text message will send to the driver to inform them about the speeding violation. In this project, a GSM modem is controlled by the Arduino Uno to send a text message to the driver who exceeds the speed limit. Figure 5-3-F6 above shows the screenshot of phone message when the vehicle exceeds the speed limit.

CHAPTER 5: IMPLEMENTATION AND TESTING

5-4: Setting and Configuration

The CD contains three folders which is called rfid_speedtrap, RFID and SPI. These folders contain all the necessary source codes and libraries to run this project. To set up the whole system for demonstration, these are the following instructions:

1. First, connect the Arduino Uno with all the components required in this project based on the wire connection table and schematic diagram.
2. Install the latest Arduino Software (IDE) Windows Installer in personal laptop.
3. Unzip the RFID library and SPI library.
4. Copy and paste these libraries into the Arduino Software (IDE) libraries.
5. Start the Arduino Software (IDE).
6. Open the rfid_speedtrap.ino and compile it.
7. If no error then can upload this program to the Arduino Uno board.
8. Finally, wait for the system to execute.

5-5: System testing

Case	Action	Test Result	Status
1	Vehicle pass from the stop RFID reader to the start RFID reader.	Stop RFID reader will not scan the vehicle.	Pass
2	Vehicle pass from the start RFID reader to the stop RFID reader.	Display the unique ID of tag on serial monitor.	Pass
3	Vehicle pass from the start RFID reader to the stop RFID reader.	Time difference is calculated and show on the serial monitor.	Pass
4	Vehicle pass from the start RFID reader to the stop RFID reader.	Speed is calculated based on the time difference and display on serial monitor and LCD.	Pass
5	Vehicle pass from the start RFID reader to the stop RFID reader.	Buzzer will sound up if the value of the calculated speed higher than the value of the pre stored speed.	Pass
6	Vehicle pass from the start RFID reader to the stop RFID reader.	A text message will send to the driver if the vehicle exceeds the speed limit.	Pass

Table 5-5: System testing result

CHAPTER 6: CONCLUSION

6.1 Conclusion

At the end of this project, a working full prototype system was developed. In this prototype system, the two RFID readers can scan the vehicle every time it pass through the RFID readers. The RFID readers can scan the vehicle only if the vehicle pass from the start RFID reader to the stop RFID reader. There is impossible for a vehicle to move in an opposite direction on the road. The full prototype system is able to calculate the time difference for the vehicle to pass through the two consecutive RFID readers and able to calculate the speed based on the time difference. Finally, a buzzer will sound up to alert the driver and a text message will send to the driver if the vehicle exceeds the speed limit to inform them about the speeding violation via GSM modem.

Although this project is proven to be difficult but the project objectives are able convert into deliverables such as calculate the vehicle speed using RFID technology, which cause the driver hard to recognize the enforcement zone and the driver will reduce the vehicle speed to avoid being fined.

Nevertheless, the evolution of IoT technologies is growing fast nowadays. The potential of this project is so helpful that it can reduce the speeding violations issue in Malaysia.

CHAPTER 6: CONCLISION

6-2: Impact, Significance and Contribution

This project is going to be helpful in reduce the number of speeding violation and thus reduce the number of car crashes. In Malaysia, the purpose of implementing AES system is to reduce the number of car crashes caused by speed violation by fine the driver who exceeds the speed limit. Unfortunately, the AES system getting a less successful result in reducing the number of car crashes because the size of the AES camera is large and the driver can aware it easily. Besides, the drivers that aware the locations of the fixed cameras may use the other roads in order to prevent the cameras. Therefore, by implementing this project, the drivers will become more difficult to aware the enforcement zone and this will cause them to reduce the vehicles speed in order to avoid being fined.

6-3: Future Work

There are still many improvements and enhancements can be done in this project. Firstly, the number of vehicle that can pass through the enforcement zone at one time. In this project, there is only one vehicle can pass through the enforcement zone at one time. This is to increase the accuracy when calculate the vehicle speed but is impossible to implement in a real situation.

Next, increase the distance that the RFID reader can scan the tag. In this project, MFRC522 is used to scan the tag. The maximum distance of MFRC522 to scan the tag is 3cm. By implement a UHF RFID reader, the distance for the RFID reader to scan the tag will increase and cause the driver hard to recognize the enforcement zone if the RFID reader install far away from the roadside.

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APPENDIX A – BI WEEKLY REPORT

FINAL YEAR PROJECT WEEKLY REPORT

Project II

Trimester, Year: Year 3 Semester 3	**Study week no.:** 2
Student Name & ID: Tan Kai Xian - 1405008	
Supervisor: Dr. Vasaki a/p Ponnusamyasaki	
Project Title: RFID-Based Vehicle Speed Monitoring and Enforcement System	

1. WORK DONE
- Successful to connect the two RFID readers to the Arduino Uno

2. WORK TO BE DONE
- Calculate the time difference the vehicle pass through the two consecutive RFID readers.

3. PROBLEMS ENCOUNTERED
- None.

4. SELF EVALUATION OF THE PROGRESS
- Knowledge about Arduino Uno improving.

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Project II

Trimester, Year: Year 3 Semester 3	**Study week no.:** 4
Student Name & ID: Tan Kai Xian - 1405008	
Supervisor: Dr. Vasaki a/p Ponnusamyasaki	
Project Title: RFID-Based Vehicle Speed Monitoring and Enforcement System	

1. WORK DONE

- Successful to calculate the time difference the vehicle pass through the two consecutive RFID readers.

2. WORK TO BE DONE

- Calculate the vehicle speed based on the time difference and set the speed limit.

3. PROBLEMS ENCOUNTERED

- None.

4. SELF EVALUATION OF THE PROGRESS

- Report was progressing as scheduled

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Project II

Trimester, Year: Year 3 Semester 3	**Study week no.:** 8
Student Name & ID: Tan Kai Xian - 1405008	
Supervisor: Dr. Vasaki a/p Ponnusamyasaki	
Project Title: RFID-Based Vehicle Speed Monitoring and Enforcement System	

1. WORK DONE

-Successful to calculate the vehicle speed and set the speed limit.

2. WORK TO BE DONE

- Display the calculated speed and pre stored speed on LCD screen.

3. PROBLEMS ENCOUNTERED

- None.

4. SELF EVALUATION OF THE PROGRESS

- Knowledge about LCD improving.
- Report was progressing as scheduled

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Project II

Trimester, Year: Year 3 Semester 3	**Study week no.:** 10
Student Name & ID: Tan Kai Xian - 1405008	
Supervisor: Dr. Vasaki a/p Ponnusamyasaki	
Project Title: RFID-Based Vehicle Speed Monitoring and Enforcement System	

1. WORK DONE

- Successful to display the calculated speed and pre stored speed on the LCD screen.

2. WORK TO BE DONE

- Using GSM modem to send a text message to mobile phone if the value of the calculated speed higher than the pre stored speed.

3. PROBLEMS ENCOUNTERED

- None.

4. SELF EVALUATION OF THE PROGRESS

- Knowledge about GSM modem improving.
- Report was progressing as scheduled

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

Project II

Trimester, Year: Year 3 Semester 3	**Study week no.:** 12
Student Name & ID: Tan Kai Xian - 1405008	
Supervisor: Dr. Vasaki a/p Ponnusamyasaki	
Project Title: RFID-Based Vehicle Speed Monitoring and Enforcement System	

1. WORK DONE

- Successful to send a text message to mobile phone if the vehicle exceeds the speed limit.
- Successful to sound up the buzzer if the vehicle exceeds the speed limit.

2. WORK TO BE DONE

- Continue with system testing.
- Finalize the report.
- Prepare presentation slides.

3. PROBLEMS ENCOUNTERED

- None.

4. SELF EVALUATION OF THE PROGRESS

- Confident for demonstration of the final system.

_____ _____

Supervisor's signature Student's signature

APPENDIX B - Poster

RFID-BASED VEHICLE SPEED MONITORING AND ENFORCEMENT SYSTEM

TAN KAI XIAN
UNIVERSITI TUNKU ABDUL RAHMAN

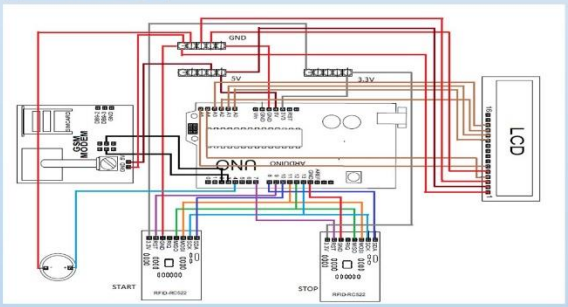
Problem Statement and Motivation

Speeding violation is one of the factors that contribute to car crashes. In Malaysia, AES cameras are installed at fixed locations to capture the vehicles which violating speed limits. After certain time, the drivers will come in mind the locations of the AES cameras. This may lead to a very dangerous situation. For example, when the drivers approaching the enforcement zone, they will suddenly decelerate the vehicle speed and only to accelerate again after passed through the enforcement zone. As a result, a effective solution has to be implemented to overcome this issue.

Objectives

- To setup a connection between two RFID readers and Arduino Uno.
- To calculate the speed of the vehicle.
- To send a text message to the driver if they exceed the speed limit via GSM modem.

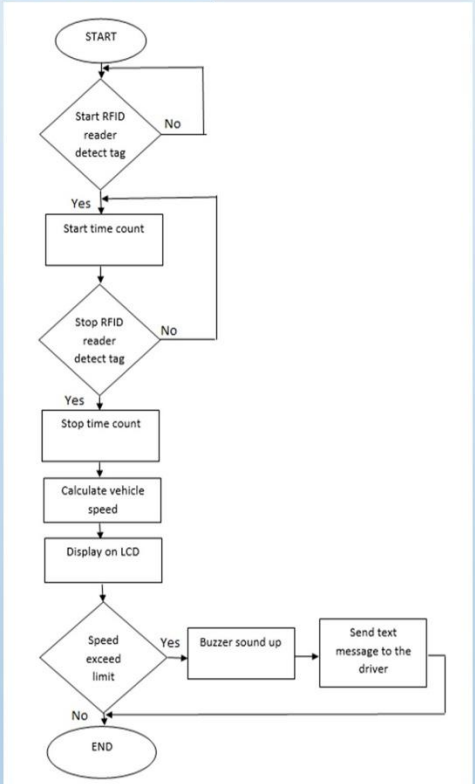
System Design



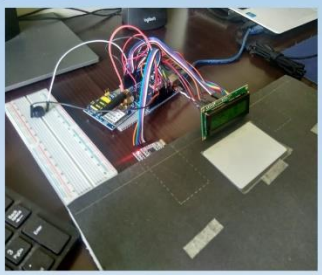
System Description

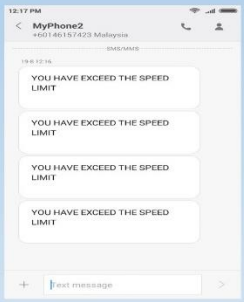
- Vehicle pass through the start RFID reader and stop RFID reader.
- Time difference is calculated.
- Vehicle speed is calculated based on the time difference.
- A buzzer will sound up and a text message will send to the driver if the vehicle exceeds the speed limit.

Overall Flowchart



Result

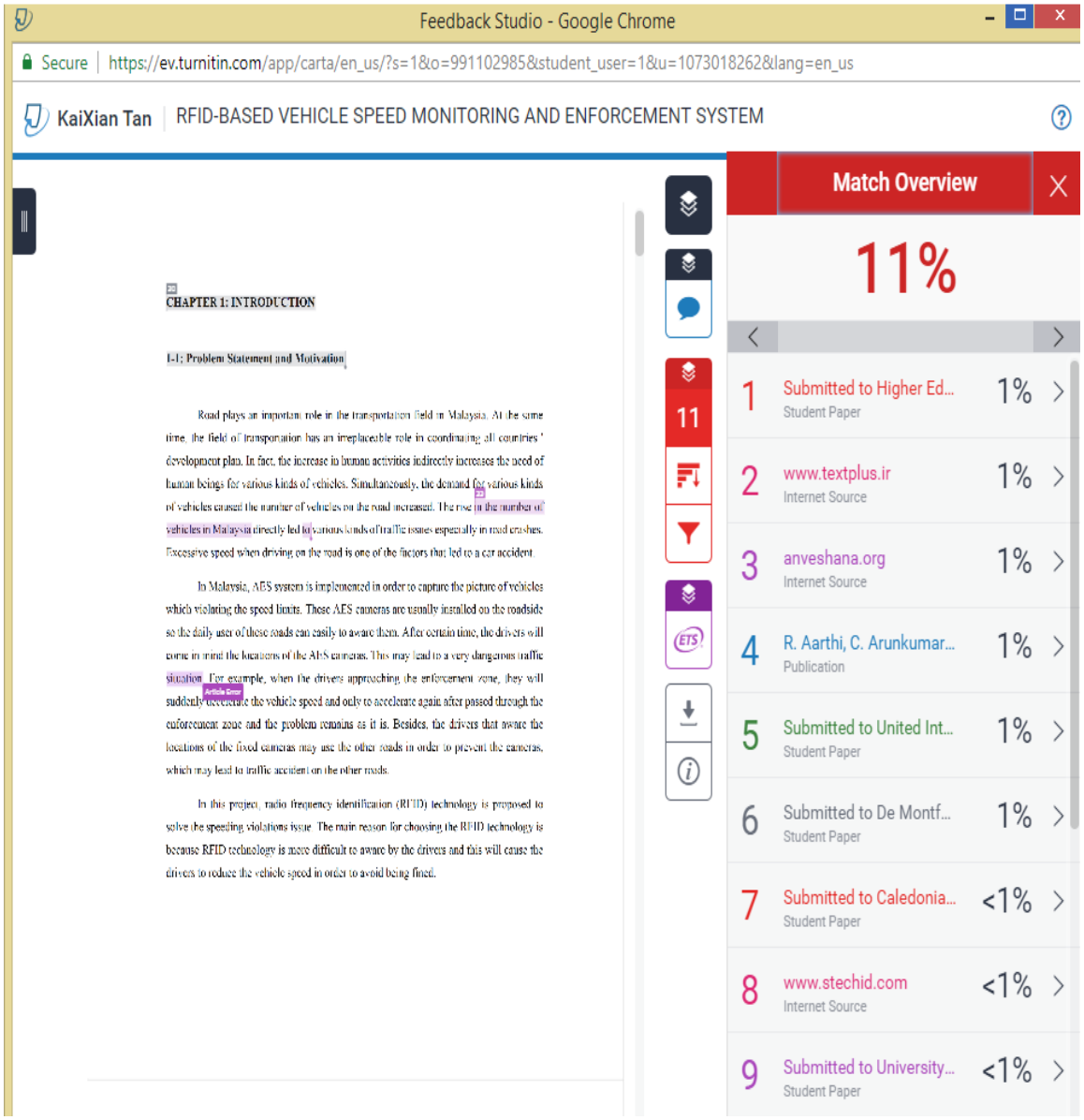




Conclusion

- This project is going to be helpful in reduce the number of speeding violation and thus reduce the number of car crashes.
- Although this project is proven to be difficult but the project objectives are able convert into deliverables such as calculate the vehicle speed using RFID technology.

PLAGIARISM CHECK RESULT



RFID-BASED VEHICLE SPEED MONITORING AND ENFORCEMENT SYSTEM

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Tan Kai Xian
ID Number(s)	1405008
Programme / Course	Bachelor Information Technology (Hons) Communications & Networking
Title of Final Year Project	RFID-Based Vehicle Speed Monitoring and Enforcement System

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Student Name	Tan Kai Xian
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