DEVELOPMENT OF AN IOT-BASED CAR IGNITION INTERLOCK SYSTEM WITH ALCOHOL DETECTOR USING MICROCONTROLLER

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAN KAI SXUAN

This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours

Faculty of Electronics and Computer Technology and Engineering
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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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DEDICATION

To my beloved mother, LAU HUEY SUAN, and father, TAN SIAK KOI,

and

To my dearest sister, TAN JING WEN

ABSTRACT

Drunk driving is generally one of the most problematic things that most countries in the world will face. According to police report statistics, from 2018 to May 2020, there are about 70 accidents are caused by drunk driving in Malaysia, with more than 20 cases that were fatal. Thus, our country needs an efficient system to reduce the incidence of drunk driving. The project title is the development of an IoT-based car ignition interlock system with alcohol detector using microcontroller. The first objective of this project is to design and develop an IoT-based car ignition interlock system with alcohol detector using microcontroller. Then, the second objective is to analyze efficiency of an IoT-based car ignition interlock system with alcohol detector using microcontroller. In this project, a system will be implemented where if a drunk person wants to start their car, they must use the MQ3 Alcohol Sensor to check the alcohol level of the driver. The sensor will be connected to an ESP8266 Microcontroller. With some testing, experiments, and adjustment, if the driver is drunk, the system will lock the car ignition system and at the same time alert the driver's emergency contact by sending them a message about the driver condition and the location of the driver to ease the driver's emergency contact located the driver. The results of the test will also be sent to an IoT software.

ABSTRAK

Pemanduan dalam keadaan mabuk secara amnya merupakan salah satu perkara yang paling bermasalah yang dihadapi oleh kebanyakan negara di dunia. Menurut statistik laporan polis, dari tahun 2018 hingga Mei 2020, terdapat kira-kira 70 kes kemalangan disebabkan oleh pemanduan dalam keadaan mabuk di Malaysia, dengan lebih 20 kes yang mengakibatkan maut. Justeru, Malaysia memerlukan sistem yang cekap untuk mengurangkan kejadian kemalangan disebabkan pemanduan dalam keadaan mabuk. Tajuk projek ini ialah pembangunan sistem interlock penghidup kereta berasaskan IoT dengan pengesan alkohol menggunakan mikropengawal. Objektif utama projek ini adalah untuk mereka bentuk dan membangunkan sistem interlock penghidup kereta berasaskan IoT dengan pengesan alkohol menggunakan mikropengawal. Objektif kedua adalah untuk menganalisis keberkesanan sistem interlock penghidup kereta berasaskan IoT dengan pengesan alkohol menggunakan mikropengawal. Projek ini akan melaksanakan sistem di mana apabila seseorang yang mabuk ingin menghidupkan kereta mereka, mereka mesti menggunakan Sensor Alkohol MQ3 untuk memeriksa tahap alkohol pemandu. Sensor ini akan disambung ke Mikropengawal ESP8266. Jika pemandu mabuk, sistem akan mengunci sistem penghidup kereta dan pada masa yang sama memaklumkan kenalan kecemasan pemandu dengan menghantar mesej tentang keadaan pemandu dan lokasi pemandu untuk memudahkan kenalan kecemasan pemandu mencari pemandu tersebut. Hasil ujian juga akan dihantar kepada perisian IoT.

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I am also indebted to University Technical Malaysia Melaka (UTeM) for the financial support throughout the development of my project which enabled me to accomplish the project. Not forgetting my fellow BERC course mates for their willingness of sharing their thoughts and ideas regarding my project.

My highest appreciation goes to my parents and family members for their love and support during the period of my study. An honourable mention also goes to my lecturers for all the advice and insights during this project.

Finally, I would like to thank all fellow classmates, faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

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%	-	Percentage
	-	
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LIST OF ABBREVIATIONS

IoT	-	Internet of Things
ESP	-	Espressif
BAC	-	Blood Alcohol Concentration
GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communication
BC	-	Before Christ
IPA	-	Isopropyl Alcohol
COVID-19	-	Coronavirus Disease of 2019
IR	-	Infrared
LAN	-	Local Area Network
TCP/IP	-	Transmission Control Protocol/Internet Protocol
Wi-fi	-	Wireless Fidelity
DoD	-	Department of Defense
IDE	-	Integrated Development Environment
LCD	-	Liquid-Crystal Display
LED	-	Light Emitting Diode
MOS	-	Metal Oxide Semiconductor

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CHAPTER 1

INTRODUCTION

1.1 Background

Alcohol holds a complex yet often controversial role in human culture across many societies. Its misuse has led to significant health, social, and economic repercussions, notably in the form of alcohol-related accidents. According to the road crash data tracking and collection from the Ministry of Transportation, the number of road accidents in Malaysia has increased during the last ten years, with the year 2019 being the highest with 567516 accidents. Driving under the influence is believed to play a major factor in the increase in accidents, as alcohol can start to have side effects in the body that impair driving abilities with a BAC as low as 0.01 percent. Drunk drivers are more likely to be involved in traffic accidents compared to sober drivers with the odds of the incident resulting in serious injury or death 3.5 times higher for drunk drivers.

A study published on PubMed Central examines the effect of alcohol intoxication on driving performance, confidence in driving ability and psychomotor function. Findings suggest that at a BAC as low as 0.021 percent, a driver's ability to maintain a steady lateral position within their lane may be compromised, heightening the risk of accidents. Further research by Fillmore indicates that hand stability and operation precision are affected at a BAC of 0.06 percent, while motor steering and braking control are impaired within the range of 0.05 percent to 0.10 percent BAC. Based on the investigations, alcohol has a significant influence on steering and braking control, which in turn affects the driver’s performance, such as lane crossings, speed, lane deviation and decision making.

To address these issues, various countries have implemented measures to combat driving under the influence, including public awareness campaigns, restrictions on alcohol purchases, and increased law enforcement efforts such as roadside checkpoints.

The system developed in the project aims to reduce the deaths caused by driving under the influence. The project system works by checking the alcohol level of the driver, the vehicle's ignition system will be locked if the driver is drunk and contacts the driver's emergency contact immediately. If the driver is not drunk and the vehicle starts, the results of the readings are recorded for the reference of law enforcers.

1.2 Problem Statement

With the improvement of safety features on vehicles and the increased law enforcements, accidents caused by driving under influence has declined steadily over the years. However, despite these efforts, such accidents persist, bringing severe consequences that can deeply affect the families of victims, both emotionally and financially.

When a driver is under the influence of alcohol, they may be unaware that they are intoxication and continue to drive regardless of the legal alcohol limits while driving, which is may be a fatal error made by the driver. Alcohol, functioning as a depressant dulls one's senses and impairs cognitive functions, which affects our reaction time, attention span and decision-making abilities. These impairmentss are fatal when driving, as it requires the full attention, quick thinking and rapid reaction speed so that the driver can react accordingly should an emergency or incident occurs.

Even a small a dose of alcohol can affect the driver's judgement and concentration, drivers must be able to constantly pay attention to the surrounding environment and vehicles, if an emergency such as an animal running accross the road, a drunken driver with dulled reaction speed and judgement may fail to react appropriately and may cause fatalities not only to the animal, but also to the driver, their passengers and potentially others, including pedestrians and wildlife.

When there is an increase in accidents related to alcohol, authorities are required to take action, such as setting up roadblocks to check for drivers who are driving under the influence using breathalyzers. However,this process of stopping vehicles, requesting drivers to inhale the breathalyzer and waiting for the results may take up significant time, and the slow pace of roadblocks can cause traffic congestion, inconveniencing all drivers on the road.

The consumption of alcohol causes many problems such as massive accidents and law enforcements. To solve these issues, the project that had been developed will be implemented into vehicles so that vehicle's ignition system will be locked if the driver exceed the legal alcohol limits and alerts the driver's emergency contact immediately with information such as the location of the vehicle. Then during a roadblock, the law enforcers can quickly access the results of alcohol tests conducted by these systems, streamlining procedures and minimizing traffic congestion caused by roadblocks.

1.3 Project Objective

The main aim of this project is the development of an IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller. Specifically, the objectives are as follows:

a) To design and develop an IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller.

b) To analyze efficiency of an IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller

1.4 Scope of Project

The scope of this project are as follows:

a) The project uses NodeMCU which is a microcontroller to ultilize the system of the project.

b) The project uses MQ3 alcohol sensor to ultilize the detection of the driver's alcohol consumption.

c) The project uses the NEO-6M GPS and SIM900A GSM modules to identify the driver's location and send messages to a preset emergency contact should the driver have consumed alcohol above the predetermined level.

d) Law-enforcement officers uses an application to quickly identify the alcohol level of the driver to increase the efficiency of a roadblock.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review is a critical overview of assessment of the body of work (books, academic articles, dissertations, conference papers, journal articles and many more) that has already been published on a given subject or research question. It consists of reading, evaluating, and synthesizing pertinent materials to present a summary of information and knowledge in a specific field or topic area.

In this chapter, reviews on past studies, definitions and projects regarding the development of an IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller and all of the components that are used in the system will be explained. The information will be used to determine the suitability of the equipment used and further enhance the project's understanding to select the most suitable design from the approved theory and factors in order to finalize the design based on the scopes.

2.2 Alcohol

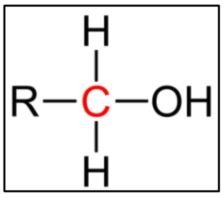

Figure 2.1 Alcohol Functional Group

An alcohol is a type of organic compound that carries at least one hydroxyl (−OH) functional group bound to carbon. Some examples of alcohol include methanol, glycerol, ethylene glycol and many more.

2.2.1 History of Alcohol

Alcohol beverages made by humans can be traced back about 7000 BC, or nine millennia ago in China, but it is almost certain that prehistoric humans consumed alcohol in fruits and berries many thousands of years earlier than that. When fruits and berries start to decay, wild yeast would begin to consume the sugars naturally contained in the fruits and berries, which produces alcohol by a spontaneous process of fermentation. The alcohol produced from the flesh and juice of rotting fruits often reaches levels of 3 or 4 percent, which similar to that of many modern beers [1].

Figure 2.2 Standard of Ur

The Standard of Ur, shown in Figure 2.1 is a Sumerian artefact dating back to around 2500 BC. The artifact is a rectangular wood box covered with a mosaic of shell, red limestone and lapis lazuli. The box is divided into two panels, one depicting a victorious military campaign and the other portraying a peaceful banquet scene. The latter shows a group of people, including what appears to be a king, sitting at a table and being served by attendants. The scene includes a variety of food and wine, as wine was the appointed drink for king and leaders of the Sumerians.

A large portion of early societal development is considered to have been fueled by alcohol. James Breasted [2], an archeologist claims that beer was developed before bread in 1877, this might be an indicate that the sole reason humanity ever settled into farming was to produce enough wheat for beer. According to Roach [3], this was approximately the time that the Middle East began producing barley beer and grape wine. During the Middle Ages, beer which is low in alcohol content, was a popular drink among people of all classes and ages across Europe. According to Richard W. Unger, estate production remained important not only in the Middle Ages and Renaissance but up to and through the nineteenth century. The large country houses of aristocrats, as well as religious foundations, generally had their own breweries and often reached levels of output which far exceeded those of many commercial brewers [4].

In the 15th century, when the Europeans arrived in America, some native tribes had already developed alcoholic drinks. According to a post-conquest Aztec record written by Charlton [5], the use of the local “wine” (pulque) was primarily restricted to religious ceremonies but was open to anybody to the age of 70. Cassava or maize, which had to be chewed before fermentation to convert the starch to sugar, was used by South American tribes to make a beer-like beverage.

Today, alcohol remains a prevalent psychoactive agent globally, with an estimated 15 million Americans suffering from alcoholism. The modern history of alcohol reflects a complex interplay between cultural norms, religious beliefs, health considerations, and regulatory measures aimed at managing its consumption and impact on society.

2.2.2 Applications of Alcohol

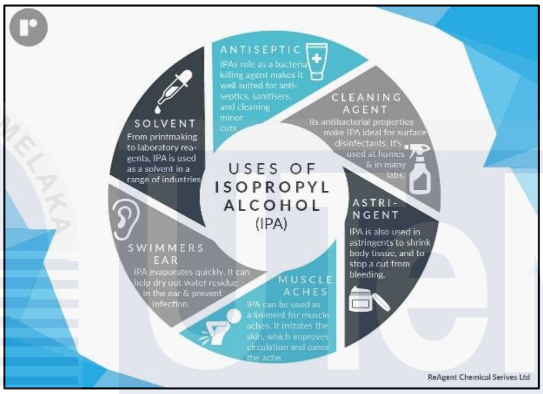

Figure 2.3 The uses of Isopropyl Alcohol (IPA)

The figure above explains some uses of alcohol in our daily lives [6]. One particularly versatile form of alcohol is isopropyl alcohol (IPA), which plays a crucial role in various domains due to its chemical properties. As an antiseptic, IPA is highly effective in killing bacteria, making it suitable for use in sanitizers and cleaning minor cuts. Its rapid evaporation and strong antibacterial properties ensure its function in maintaining hygiene in both healthcare settings and everyday environments.

IPA's antibacterial properties also make it an ideal cleaning agent, widely used for surface disinfectants in homes, offices, and laboratories. This application became especially significant during the COVID-19 pandemic, where maintaining clean and sterile environments was paramount.

In personal care, IPA is utilized as an astringent to shrink body tissue and stop bleeding, making it an essential component in many first aid kits. It is beneficial for treating swimmer's ear by evaporating quickly, drying out water residue, and preventing infection. Additionally, IPA can be used as a liniment for muscle aches. When applied to the skin, it improves circulation and eases discomfort, making it a popular choice for relieving sore muscles and minor aches.

In industrial and laboratory settings, IPA serves as a versatile solvent. It is used in a range of industries, such as printmaking and laboratory reagents, due to its ability to dissolve oils, greases, and other substances. This property makes IPA indispensable in various manufacturing and research processes, ensuring clean and efficient operations.

These varied applications highlight the integral role of isopropyl alcohol in enhancing medical hygiene, personal care, and industrial processes. Its ability to act as an antiseptic, cleaning agent, astringent, and solvent demonstrates its multifaceted utility. The widespread use of IPA across different fields underscores its significance in everyday life, from promoting health and wellness to supporting complex industrial functions.

2.2.3 Effects of Alcohol on Human Body

Alcohol use plays a role in many social activities, from the "business lunch" and parties to special occasions. The benefits to those who drink during social occasions are greatly influenced by culture, the setting in which drinking occurs, and expectations about alcohol's effects [7]. Stress reduction, increased sociability, mood elevation, and relaxation are the most commonly reported psychosocial benefits of drinking alcohol [8].

When we consume alcohol, some of it is absorbed into the bloodstream from the gastrointestinal tract through passive diffusion. Alcohol absorption starts in the stomach, but most of the alcohol is absorbed in the small intestine. Absorption of alcohol is usually at its peak 30 to 45 minutes after consumption.

BAC, or blood alcohol concentration is determined by a number of factors. The most important factors are the dose consumed, gender, and recent food intake. BAC rises to higher levels when large volumes or high-percentage alcoholic beverages are consumed. The alcohol is distributed throughout the body and is mainly found in blood and other bodily fluids.

Alcoholic beverages are consumed primarily because alcohol alters the drinker's behavior and affects well-being. These changes occur when alcohol reaches the brain and temporarily disrupts signal transduction. The behavioral effects of alcohol are directly correlated with blood alcohol concentration (BAC). At BAC levels up to 0.05 g/dL, individuals may experience increased relaxation and sociability. BAC levels above 0.08 g/dL can impair muscle coordination and driving skills. When BAC exceeds 0.15 g/dL, symptoms such as drowsiness, impaired judgment, vision, and balance are common. At BAC levels over 0.25 g/dL, slurred speech, apathy, and lethargy can occur. BAC levels higher than 0.4 g/dL can lead to unconsciousness, incontinence, and death, with lethality becoming a significant risk at BAC levels exceeding 0.45 g/dL [9].

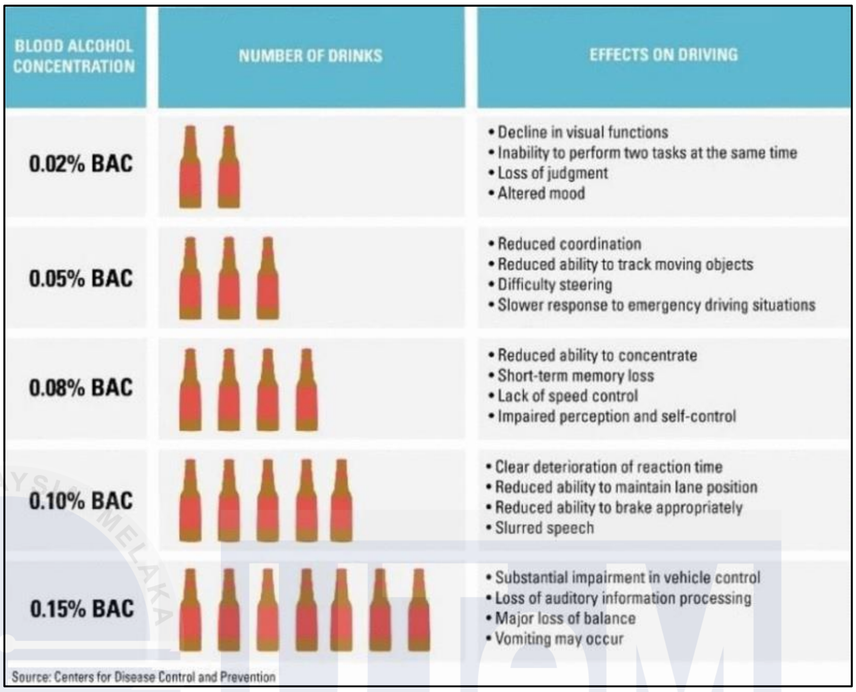

Figure 2.4 Effects of Drinking on Driving

2.3 Analysis of Traffic Accidents caused by Drunk Driving in Malaysia

Drunk driving remains a significant public safety issue globally, and Malaysia is no exception. The problem of driving under the influence is particularly concerning due to its contribution to traffic accidents, which often result in severe injuries and fatalities. The consequences of driving under the influence is analyzed and explained in detail regarding the person's health and the legal consequences.

2.3.1 Traffic Accident Trends Under Alcohol Influence

Drunk driving is extremely dangerous. This is a serious issue that must be taken care of in today's generation because there are many people who lost their lives due to driving under the influence of alcohol. Not only they are putting themselves in danger, they are also putting the people around them, such as the passengers pedestrians at risk too. Due to their reckless behavior, many innocent people may lose their lives without their knowledge.

A study conducted at Universiti Teknologi MARA (UiTM) Perlis analyzed the triggers of road accidents in Malaysia using the Analytical Hierarchy Process (AHP). The research, led by Norpah Mahat, Nurdiyana Jamil, and Siti Sarah Raseli, highlighted the significant factors contributing to road accidents. Among the primary factors identified, human behavior, environment, and vehicle, human behavior was found to be the most influential, the weight of human behavior is the highest value among the factors which is 0.8005 placing it the first. Within this category, drunk driving or driving under the influence emerged as the top subfactor. Drunk driving or driving under the influence becomes the first rank which the weight is 0.5771. This finding underscores that drunk driving is a major cause of road accidents in Malaysia [10].

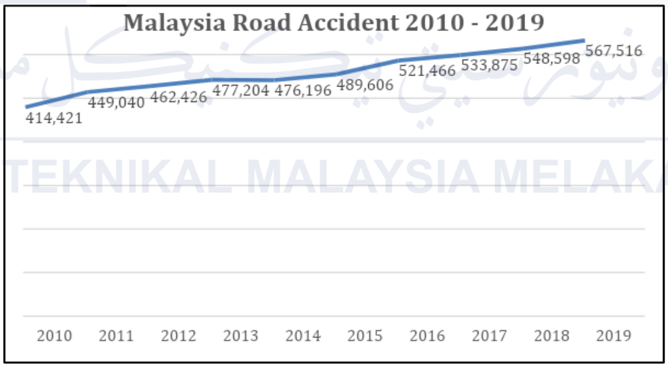

Figure 2.5 Number of Road Accidents in Malaysia from 2010 to 2019

Based on the statistic sourced from the Ministry of Transport Malaysia [11] in Figure 2.4, the number of road accident increased from 414,21 to 567,516 from the year 2010 to 2020. In those accident, some people suffered minor injuries, while some, in the worst case scenario, lost their lives. Every day in Malaysia, around 18 people lose their life in traffic accidents according to data provided from the Ministry of Transport Malaysia [12].

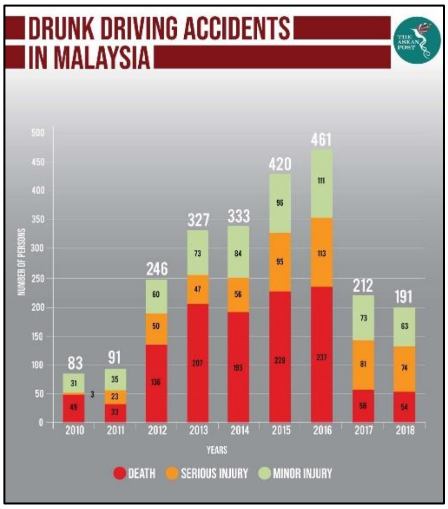

Figure 2.6 Number of Drunk Driving Accidents in Malaysia from 2010 to 2018

Rendering to Malay Mail [13], there are a total of 2281 people involved in drunk driving accident from year 2010 to 2018 in Malaysia. According to Figure 2.5, 539 people suffered from seriously injuries, 595 people suffered from minor injuries and 1147 people died in the drunk driving accidents from the year 2010 to 2018 in Malaysia.

The overall decreasing trend in fatal road accidents in recent years has matched with the overall decline in the yearly mortality index from road accidents since 2011, according to Malaysia's Road Safety Department data. In other words, except for the increase in 2016, the fatality rate has steadily fallen each year apart from that, some individuals have contended, according to Athira Nortajudin [14], that while the long-overdue tougher penalty may help reduce drink- driving accidents in Malaysia, many individuals believe it is not the ultimate solution to the problem. Some people support the death sentence for criminals, while others believe that alcohol should be banned completely.

2.3.2 Legal Consequences of Drunk Driving in Malaysia

In Malaysia, the legal framework governing drunk driving is stringent, with severe penalties outlined under various sections of the law. These provisions are designed to deter individuals from driving under the influence and to enhance road safety. The primary statutes addressing drunk driving offences include sections 44, 45A, and 45 of the Malaysian Road Transport Act [15].

According to Section 44(1) - Causing Death While Under the Influence, driving a vehicle under the influence of alcohol or drugs to the extent that it impairs control and results in causing death is a serious offence. Convictions under this provision can lead to imprisonment for 10 to 15 years and fines ranging from RM50,000 to RM100,000. Additionally, offenders are disqualified from holding a driving license for at least 10 years. For repeat offenders, the penalties increase significantly, with imprisonment ranging from 15 to 20 years, fines between RM100,000 and RM150,000, and a driving ban of 20 years.

In Section44(1A), Causing Injury While Under the Influence, if an individual causes injury while driving under the influence, they face imprisonment for 7 to 10 years and fines between RM30,000 and RM50,000. The disqualification period for holding a driving license in this case is at least 7 years. For those with previous convictions, the penalties escalate to imprisonment for 10 to 15 years, fines between RM50,000 and RM100,000, and a driving ban of 10 years.

In Section 45A - Exceeding the Prescribed Alcohol Limit, driving or attempting to drive with blood alcohol levels above the legal limit constitutes an offence, irrespective of whether an accident occurs. The penalties include imprisonment for up to 2 years and fines ranging from RM10,000 to RM30,000, along with a minimum 2-year driving ban. Repeat offenders face harsher consequences, including up to 5 years in prison and fines between RM20,000 and RM50,000.

In Section 45 - Being in Charge of a Vehicle While Unfit, even if a person is not actively driving but is in charge of a vehicle while unfit due to alcohol consumption, they can be fined between RM1,000 and RM5,000 and face imprisonment for up to 2 years. They will also be disqualified from driving for at least 2 years. For individuals with prior convictions, the penalties include up to 5 years in prison and fines between RM20,000 and RM50,000, with a driving ban of at least 5 years.

Finally in Section 45C - Refusal to Provide a Sample, if a police officer suspects a drink driving offence and requests a sample of blood, breath, or urine, the individual must comply. Refusal to provide a sample without a reasonable excuse is an offence, punishable by up to 2 years in prison, fines ranging from RM10,000 to RM30,000, and a minimum 2-year driving ban. Subsequent convictions result in increased penalties, including up to 5 years in prison and fines between RM20,000 and RM50,000, with a driving disqualification of at least 5 years.

The legal alcohol limits in Malaysia are 22 micrograms (mcg) of alcohol in 100 milliliters (ml) of breath, 50 milligrams of alcohol in 100ml of blood, and 67 milligrams of alcohol in 100ml of urine. These stringent measures reflect Malaysia's commitment to road safety and the serious view taken of drink driving offences.

By thoroughly outlining these legal provisions and their severe consequences, it is clear that Malaysia enforces stringent measures to curb drunk driving and enhance public safety on its roads.

2.4 Breathalyzers

Figure 2.7 Breathalyzer

Blood Alcohol Concentration (BAC) is the legal term for determining the level of intoxication. Previously, blood testing was employed for this purpose. In today's world, however, collecting blood samples on the field and shipping it to a lab for analysis is impracticable, inefficient, and time-consuming. As a result, law enforcement agents needed a tool to check the driver's intoxicated level without having to examine the suspect's body. It was for this reason that breathalyzers were invented in the first place. In Malaysia, as well as the rest of the globe, breathalyzer are utilized in law enforcements. A police officer can provide a breath test to anybody suspected of driving under the influence of alcohol. According to Eugene Ng [16], the breathalyzer's premise is that when a person consumes alcohol, it is absorbed into the bloodstream via the mouth, throat, and stomach, and then manifests itself in the air.

Alcohol is neither metabolized nor chemically altered in the circulation. As blood flows over and into the lungs, some alcohol passes through the membranes of the lung's air sacs and into the air. The alcohol content in the blood is controlled by the alcohol content in the alveoli's air. The Breathalyzer detects the alcohol-concentrated air as soon as it is exhaled.

2.4.1 Types of breathalyzers

There are several types of Breathalyzers in the market such as Semiconductor Breathalyzer, Fuel Cell Breathalyzer and Infrared Sensor Model that have different specific functions for each of them.

2.4.1.1 Semiconductor Breathalyzers

Figure 2.8 MEMS Sensor Alcohol Tester Digital Breathalyzer AT7000

A semiconductor sensor in the breathalyzer electronically oxidizes alcohol through reacting it with tin-oxide. A redox reaction is carried out in the device through combining alcohol with water and acetic acid and the current that is generated from the reaction will get measured. The measured current acts as an indication of the amount of alcohol that reacted in the individual’s breath.

Semiconductor sensors are fairly accurate in the analysis of BAC level if there are no other volatile substances in the bloodstream and breath temperature is constant. So other chemical substances such mouthwash may alter the results of the breathalyzer.

2.4.1.2 Fuel Cell Breathalyzer

Figure 2.9 SafeWay CA20F Professional Fuel Cell Alcohol Breathalyzer

In fuel cell breathalyzers, a permeable acid-electrolyte compound is sandwiched between two platinum electrodes. The platinum oxidizes the alcohol in the air as the suspect's exhaled air travels through one side of the fuel cell, generating acetic acid, electrons, and protons. The generated electrons create an electrical current proportional to the amount of alcohol present, which is then used to determine the blood alcohol concentration (BAC).

2.4.1.3 Infrared (IR) Spectroscopy or Infrared Sensor Model

Figure 2.10 SAF'IR Evolution evidential breathalyzer

The way molecules absorb IR light is used to identify them in this method. First, an infrared beam created by a light travel through a sample chamber before being placed in the center of a revolving filter wheel. Band filters tuned to the wavelengths of ethanol's intramolecular bonds are included in the filter wheel. The light that passes through each filter is then detected by a photocell, which transforms it to an electrical signal.

2.5 GSM Module

A GSM (Global System for Mobile Communications) module is a device used to enable communication between a microcontroller and the GSM network. It is commonly used in various applications such as mobile phones, IoT devices, and embedded systems for wireless communication.

2.5.1 History of GSM Module

The Global System for Mobile Communications (GSM), commonly known as GSM, emerged from a cell-based mobile radio system developed at Bell Laboratories in the early 1970s. The European Conference of Postal and Telecommunications Administrations (CEPT) established the Groupe Special Mobile (GSM) committee in 1983. In 1987, representatives from 13 European countries signed a memorandum of understanding to create a common cellular telephone system across Europe.

In December 1991 Finland implemented the first GSM network. GSM was initially optimized for full-duplex voice telephony over a digital, circuit-switched network. Over time, it expanded to include data communications via General Packet Radio Service (GPRS) and Enhanced Data Rates for GSM Evolution (EDGE). By the mid-2010s, GSM achieved over 90% of its market share globally and operated in more than 193 countries and territories.

GSM served as the foundation for subsequent mobile communication standards like 3G, 4G (LTE Advanced), and 5G. In summary, GSM played a pivotal role in shaping mobile communication standards and remains influential even as newer technologies emerge [17].

GSM modules allow for wireless data sharing as well as networking. These gadgets are tiny, light, and simple to operate, and they consume remarkably little power. They can be utilized for a variety of things, including project tracking, and connecting to remote site monitoring equipment to your LAN. A GSM module, like a cell phone or pager, is a customized device that accepts SIM cards and operates with a mobile operator via subscriptions. Furthermore, because GSM modules utilize existing networks rather than forcing you to modify your infrastructure to include gear that allows direct connections with remote places, they are a cost-effective solution for transmitting and receiving warning signals in most areas of the world.

2.5.2 Types of GSM Module

2.5.2.1 SIM800L

Figure 2.11 SIM800L GSM/GPRS module

The SIM800L GSM/GPRS module, developed by Simcom is a miniature GSM modem that can be used in various IoT projects. This module functions similarly to a normal cell phone, it can perform any tasks that a cell phone can do, such as sending SMS messages, making phone calls, connecting to the Internet via GPRS, and much more. Another advantage is that the board makes use of existing mobile frequencies, which means it can be used anywhere in the world.

2.5.2.2 SIM900A

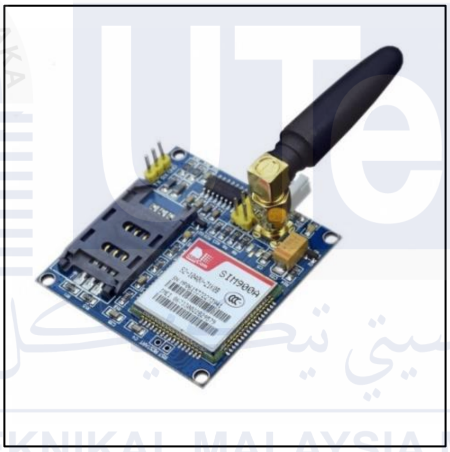

Figure 2.12 SIM900A GSM Module

The SIM900A GSM module is a powerful tool for enabling wireless communication in a wide range of applications. Its support for voice, SMS, and data communication, along with its ease of use through AT commands, makes it an ideal choice for integrating GSM functionality into projects and devices. Whether it is building a remote controlled system, a vehicle tracker, or a home automation setup, the SIM900A provides the necessary connectivity to communicate over the GSM network.

2.6 Microcontroller

A microcontroller is a compact integrated circuit that is designed to govern a specific operation in an embedded system, featuring various hardware components such as built-in memory and peripherals.

2.6.1 History of Microcontroller

In 1971, Intel Corporation developed the world's first microcontroller called the i4004. It was a 4-bit microcontroller initially designed for calculators. The request was originally ordered by a Japanese company called BUSICOM for their calculators but later found success as a general-purpose microcontroller [18].

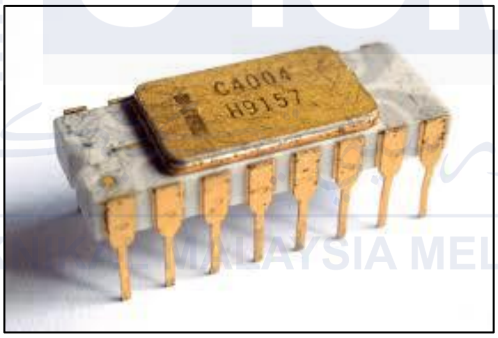

Figure 2.13 i4004 Microcontroller

Around the same time, Gary Boone of Texas Instruments was working on a similar concept. He invented the microcontroller - TMS1802NC2, which was a single integrated circuit chip capable of performing various functions [19].

Since the 1970s, microcontrollers have become ubiquitous in embedded systems. They are compact, self-contained computers on a single chip, controlling everything from washing machines to anti-lock brakes in cars.

2.6.2 Arduino

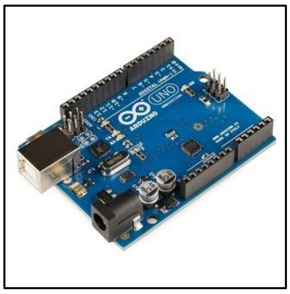

Figure 2.14 Arduino Uno

The Arduino platform is the world's most popular open-source hardware and software platform. With the company's software tools, hardware platforms, and documentation, almost anybody can be technologically creative. Some popular Arduino boards include the Uno, Nano, Mega, and Leonardo. They differ in microcontroller, memory, pins, and features. It's also a popular IoT development platform and one of the most effective for Science, Technology, Engineering and Mathematics (STEM) education platforms. Hundreds of thousands of designers, engineers, students, developers, and inventors use Arduino to produce ideas in entertainment, electronics, toys, smart gadgets, farming, autonomous cars, and other industries all around the world. Additionally, because Arduino boards are open-source hardware, people can tweak and develop variations with a wide range of form factors and functionality. Arduino is made up of a physical programmable circuit board and accompanied with a software, known as an IDE (Integrated Development Environment), that runs on your computer which is used to write and upload computer code to the physical board. With good cause, the Arduino platform has become increasingly popular among beginners in electronics.

2.6.3 NodeMCU Microcontroller

NodeMCU is an open-source IoT platform that uses the Lua scripting language. Compared to Arduino,NodeMCU includes a more powerful processor and a larger memory. Its built-in TCP/IP stack and direct WiFi connectivity capabilities make it ideal for IoT applications. Additionally, NodeMCU is generally cheaper and more compact than Arduino, with low power consumption.

2.6.3.1 ESP8266

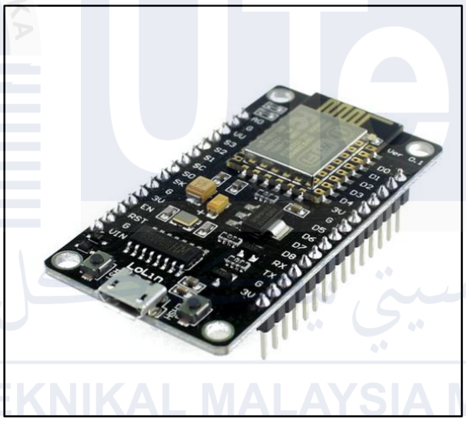

Figure 2.15 ESP8266 Microcontroller

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability developed by Espressif Systems. It was popularized in the maker community in 2014 via the ESP-01 module made by Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections.

The ESP8266 is a versatile and cost-effective Wi-Fi module that integrates a microcontroller, making it ideal for IoT projects and wireless communication applications. With its low power consumption and built-in TCP/IP stack, the ESP8266 can connect to

WiFi networks, host web servers, and interact with other devices over the internet. Its ease of use, extensive community support, and compatibility with popular development platforms like Arduino make it a favorite among hobbyists and professionals who want to incorporate wireless connectivity into their projects.

The ESP8266 can be programmed in the Arduino IDE with the ESP8266 Arduino core. This allows developers to write sketches using familiar Arduino functions and libraries, and run them directly on the ESP8266 without an external microcontroller.

The ESP8266 is a great option for IoT projects due to its affordability, small size, low power usage, and easy integration with different hardware and software components. Its versatility and strong community support make it a popular choice among developers looking to create innovative IoT solutions.

2.6.3.2 ESP32

Figure 2.16 ESP32 Microcontroller

ESP32 is an open-source firmware and development board based on the ESP32 system-on-chip (SoC). It is designed to facilitate the development of Internet of Things (IoT) projects by providing an easy-to-use platform with built-in Wi-Fi and Bluetooth capabilities. The ESP32 chip is a powerful and highly integrated solution that combines a dual-core processor, a large amount of memory, and a wide range of peripherals, making it suitable for a variety of IoT applications. ESP32 inherits the user-friendly features of its predecessor, ESP8266, while offering enhanced performance and expanded functionality. With its comprehensive set of features and compatibility with the Arduino ecosystem, ESP32 is a popular choice among developers for prototyping and building IoT devices.

The ESP32 can be programmed using various development frameworks and platforms, providing developers with a wide range of options to choose from. The official Espressif IoT Development Framework (ESP-IDF) is a popular choice, offering a comprehensive set of tools and libraries for building IoT applications. Alternatively, the ESP32 can be programmed using the Arduino IDE with the ESP32 Arduino core, allowing developers to leverage the familiar Arduino ecosystem and programming language. Other options include MicroPython, Mongoose OS, and Zerynth, each offering its own unique set of features and capabilities.

Applications of the Internet of Things that want less power should use the ESP32. Due to its powerful processor, built-in Wi-Fi, Bluetooth, and Deep Sleep Operating capabilities, as well as its 448 KB of ROM, 520 KB of SRAM, and 4MB of Flash memory, makes it appropriate for the majority of portable IoT devices [20].

2.7 GPS Module

A GPS (Global Positioning System) module is a device that receives signals from GPS signals to determine the location of the module on Earth. It is used in various applications such as navigation and tracking.

2.7.1 History of GPS Module

In the early 1970's, the Department of Defense (DoD) in America aimed to establish a robust and reliable satellite navigation system for military use. Referencing previous ideas from Navy scientists, the DoD decided to use satellites to support their proposed navigation system. The DoD launched its first Navigation System with Timing and Ranging (NAVSTAR) satellite in 1978. The 24 satellite system became fully operational in 1993 [21]. On May 1, 2000, President Clinton announced the removal of selective availability (SA) , allowing free civil access to accurate GPS positioning.

GPS module is an electronic device that communicates with GPS satellites to provide geographical location data. GPS modules work based on a system of satellites that orbit the Earth, transmitting precise microwave signals to the module. These modules then receive these signals and use the data collected to calculate the user's exact location through a process called trilateration. Trilateration is a process that involves determining the distances to at least three satellites and, using these measurements, pinpoints the device's exact position on the globe [22].

2.7.2 Characteristics of different types of GPS Module

As to choosing the most suitable GPS Module to use, there are a few categories that need to be looked at. Below are the characteristics of the GPS Modules that need to be considered when choosing the suitable GPS module.

2.7.2.1 Battery Power Consumption

When selecting a GPS module, battery power consumption is a critical factor, especially for portable or battery-operated devices. GPS modules vary in their power usage, with some designed to operate with minimal power usage to extend battery life. Energy-efficient GPS modules can significantly prolong the device's operational time between charges, making them ideal for applications where battery life is a primary concern.

2.7.2.2 Accuracy

Accuracy is another crucial characteristic to evaluate when choosing a GPS module. It determines the precision of the location data provided by the module. High-accuracy modules are essential for applications requiring exact positioning, such as geolocation services, autonomous vehicles, and surveying equipment. Ensuring the GPS module meets the required accuracy specifications for the application is vital for its successful implementation.

2.7.2.3 Scalability

Scalability refers to the GPS module's ability to adapt to varying operational demands and future-proofing your investment. Consider if the GPS module can support additional features or integrations. For instance, some modules can be upgraded with software enhancements or can interface with additional sensors and communication modules. Scalability is particularly important for applications that might evolve over time. A scalable GPS module allows for the integration of more advanced functionalities without the need to completely overhaul the existing hardware setup, thereby saving costs and ensuring long-term viability.

2.7.3 Types of GPS Module

2.7.3.1 NEO-6M

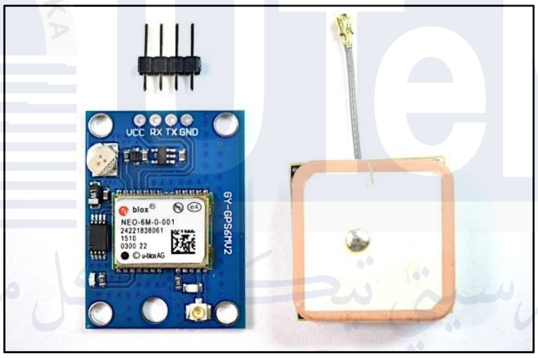

Figure 2.17 NEO-6M GPS Module

The NEO-6M GPS module is a versatile and affordable GPS module that operates on 3-5V with a default baud rate of 9600 bps. It features an external antenna, built-in EEPROM, and communicates via RS232 TTL interface, making it compatible with microcontrollers like Arduino and ESP32. The module uses standard NMEA sentences to output GPS data such as latitude, longitude, time, altitude, and number of visible satellites. The module's accuracy is around 2.5m in ideal conditions, and it can track up to 22 satellites over 50 channels while consuming minimal current. Additionally, the NEO-6M includes a position fix LED indicator and a rechargeable battery for maintaining clock data and position information.

2.7.3.2 L76K GNSS Module

Figure 2.18 L76K GNSS Module

The L76K GNSS Module is a versatile Multi-GNSS receiver supporting GPS, BeiDou, GLONASS, and QZSS systems, offering both combined multi-system and independent single-system positioning capabilities. It supports a wide range of platforms including Raspberry Pi, Arduino, ESP32, and STM32, making it suitable for various applications such as GPS navigation, tracking, smart city solutions, and logistics management. With a compact form factor, low power consumption, and compatibility with the Seeed Studio XIAO series, the L76K GNSS Module is ideal for asset tracking and robotics, ensuring reliable signal reception and precise positioning accuracy.

2.8 Gas Sensor

Several gas sensors have been created so far. Electrochemical sensors based on electrolyte solutions have long been designed for professional usage. With the development of semiconductor combustible gas sensors, solid electrolyte oxygen sensors, and humidity sensors in the 1970s, an accurate sensor era dawned. Significant efforts have been made over the last two decades to upgrade these sensors and produce a variety of new gas sensors, which have been in high demand for a range of reasons, including protection, health, amenity, environmental preservation, and energy savings. Based on the project that is being researched, we will focus on alcohol detection and have found that the MQ3 is the most suitable component to use for this project.

2.8.1 MQ3 Alcohol Sensor

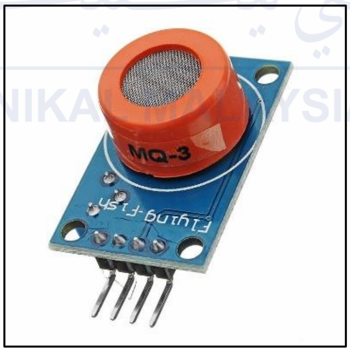

Figure 2.19 MQ3 Alcohol Sensor

The Grove - Gas Sensor (MQ3) module can detect gas leaks. It is capable of detecting alcohol, benzene, CH4, hexane, LPG, and carbon monoxide. Measurements can be carried out as fast as possible because of its high sensitivity and rapid reaction time. The sensor's sensitivity may be adjusted using the potentiometer. The MQ3 Alcohol Gas Sensor was used to create this module. It is a low-cost semiconductor sensor that can detect alcohol gas concentrations as low as 0.05 mg/L up to as high as 10 mg/L. SnO2 is the sensitive material in this sensor. In pure air, their conductivity is lower. As the concentration of alcohol gases rises, the conductivity also increases in proportion. As a result, it has a high sensitivity to alcohol and a high tolerance for smoke, vapor, and gasoline-related disturbances. Both digital and analogue outputs are available on this module. Microcontrollers, Arduino boards, Raspberry Pi, and other devices may interact readily with the MQ3 alcohol sensor module.

When the surface of a SnO2 semiconductor sheet is heated to a high temperature, oxygen is absorbed, according to a Last-Minute Engineering article [23]. Electrons from tin dioxide's conduction band are pulled to oxygen molecules in clean air. By forming an electron depletion layer just below the top of SnO2 particles, this creates a potential barrier. As a result, the SnO2 layer becomes extremely resistant, preventing electric current from flowing.

The surface density of absorbed oxygen drops in the presence of alcohol when it reacts with the alcohols, lowering the potential barrier. The tin dioxide is subsequently bombarded with electrons, allowing current to freely flow through the sensor.

2.8.2 Adafruit MiCS5524 CO, Alcohol and VOC Gas Sensor Breakout

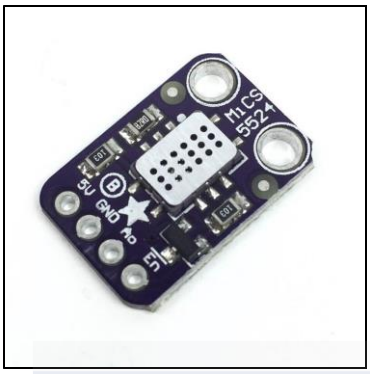

Figure 2.20 Adafruit MiCS5524

The MiCS-5524 is a robust MEMS sensor for carbon monoxide and natural gas leakage detection in indoors. It is also suitable for indoor air quality monitoring, breath checking, and early fire detection. The sensor is sensitive to multiple types of gas, including CO, ammonia, ethanol, H2, methane, propane, and isobutane.

The MiCS-5524 comes in a module form for easy use, with an operating voltage of 5VDC and low current draw for the heater. It provides an analog voltage output that increases proportionally with the detected gas concentration. However, the sensor cannot indicate the specific type of gas detected.

The MiCS-5524 is not recommended for safety, medical, or finished product usage, but rather for hobby, education, and experimentation purposes. All gas sensors require calibration for precise output. To use the sensor, you power it with 5VDC, read the analog voltage on the output pin, and the voltage will increase when gases are detected.

2.9 Key Switch

Figure 2.21 SRL5MD2 Key Switch

Key switches are electromechanical switches that require a specific key to oeprate, which can be turned to different positions to break or complete the circuit. The different positions align with different states of the switch, such as 'ON' state or 'OFF' state, providing a clear indicator of the current state of the circuit. Key switches are commonly used for operations and processes that require a higher level of safety or security clearance as they cannot be accidentally activated or deactivated without using the appropriate key.

2.10 I2C LCD

Figure 2.22 I2C LCD

The I2C LCD (Inter-Integrated Circuit Liquid Crystal Display) is a user-friendly display module that utilizes the I2C communication protocol for easy connection to microcontrollers like ESP8266. With high resolution (128x64 pixels) and adjustable backlight, it simplifies displaying text, graphics, and sensor data. By requiring only two pins for connection and supporting multiple fonts and cursor functions, the I2C LCD is versatile for various projects. Its ability to display pictures and operate in parallel with multiple screens makes it ideal for creating interactive displays, showcasing sensor data, and building complex visual interfaces with ease and efficiency.

2.11 IoT Software Platforms

IoT (Internet of Things) software platforms are frameworks that provide the necessary tools and services to develop, manage, and operate IoT systems. These platforms help manage the connection and data exchange between IoT devices and other systems, enabling the creation of comprehensive IoT solutions.

2.11.1 Blynk

Figure 2.23 Blynk

Blynk is an IoT platform that offers a drag-and-drop app builder for connected products and IoT projects. It caters to developers and businesses, allowing them to prototype, deploy, and manage connected electronic devices easily. Blynk supports various hardware like ESP32, Arduino, Raspberry Pi, and more, enabling users to visualize sensor data, control electronics, and create user interfaces efficiently. The platform provides features such as device activation, management, real-time data visualization, alerts, notifications, and over-the-air firmware updates. Blynk's user-friendly approach includes a no-code application builder, making it accessible for a wide range of users, from hobbyists to large enterprises. Additionally, Blynk offers a low-code IoT software platform, a mobile app builder, and supports over 400 hardware models, making it a versatile and comprehensive solution for IoT development.

2.11.2 myDevices Cayenne

Figure 2.24 myDevicesCayenne

myDevices Cayenne is an IoT project builder that simplifies the development of Internet of Things products by offering a drag-and-drop interface for creating connected devices and prototypes. Cayenne supports various hardware platforms like Raspberry Pi, Arduino, and ESP32, allowing users to visualize real-time and historical data, manage IoT projects through a mobile app and online dashboard, and create customized digital dashboards with widgets for controlling devices remotely [24]. The platform has been recognized for its ease of use, with features like GPIO control, scheduling, trigger actions, and instant remote access, making it popular among developers, makers, and IoT enthusiasts. Additionally, Cayenne has received positive feedback from its community users for its versatility and user-friendly interface, enabling quick and easy development of IoT projects.

2.11.3 Arduino IoT Cloud

Figure 2.25 Arduino IoT Cloud

The Arduino IoT Cloud is a comprehensive platform that simplifies IoT project development by offering an integrated development environment (IDE) for programming Arduino boards, cloud backend services for data synchronization, and a graphical dashboard for monitoring and controlling devices remotely. Users can easily create properties for controlling devices, upload sketches, and visualize sensor data through widgets on customizable dashboards. With support for various Arduino and ESP-based boards, over-the-air (OTA) updates, and a user-friendly interface, the Arduino IoT Cloud caters to a wide range of users, from beginners to professionals, providing a seamless IoT solution for creating, managing, and sharing projects efficiently.

2.11.4 Android Studio

Figure 2.26 Android Studio

Android Studio is the official IDE for Android app development, providing a powerful set of tools to build high-quality applications. Its advanced code editor, built on IntelliJ IDEA, offers code completion, debugging, and refactoring capabilities.

The emulator allows developers to test on virtual devices, and live editing enables updates in emulators and physical devices. Code templates and GitHub integration streamline development, while extensive testing tools and frameworks catch performance and compatibility issues.

Android Studio supports C++ and NDK development, and includes built-in support for Google Cloud Platform. Projects are structured with modules for Android app, library, and Google App Engine development.

Setting up Android Studio involves downloading and installing the IDE, along with required components like the Android SDK and emulator. Once installed, developers can configure the IDE to suit their preferences.

Using Android Studio, developers can create new projects, design user interfaces, write code, test and debug, and deploy to the Google Play Store. Android Studio is a comprehensive and powerful tool for Android app development, empowering developers to create innovative applications.

2.11.5 Firebase Realtime Database

Figure 2.27 Firebase

Firebase is a Google-backed platforms which provides Platform-as-a-Service. It allows developers to build and run mobile or web apps by providing tools and services that simplify app development. Firebase provides services which include features such as Realtime Database, Cloud Firestore, Fire Cloud Messaging, hosting and many more.

The Firebase Realtime Database is a cloud-hosted database which synchronizes with every connected client in real-time. Firebase Realtime Database can be accessed directly from the user's mobile devices or web application without accessing the application server, this architecture reduces latency and increases the update speed of the data. This makes Firebase Realtime Database faster compared to traditional databases that rely on HTTP requests, allowing instant synchronization among all connected devices. This allows the users to obtain data in real-time.

Besides that, Firebase is directly integrated into Android Studio, allowing developers to add backend services to the Android applications such as authentication and real-time databases that enhances the functionality of the application and improve the user experience.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, the project flow will be examined in detail. This chapter will explain how the "development of an IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller" will be carried out. This chapter consists of all the project implementation and development to realize this project.

3.2 Flowchart

A project flowchart is a visual representation of the sequence of steps and decisions needed to perform a project. Project flowcharts are essential tools in project management as they simplify complex processes, aid in understanding project structures, and help in visualizing how different project components interact and lead to successful project outcomes. Project flowcharts are essential for simplifying processes, improving communication, documenting workflows, and planning projects effectively.

3.2.1 Project Implementation Flowchart

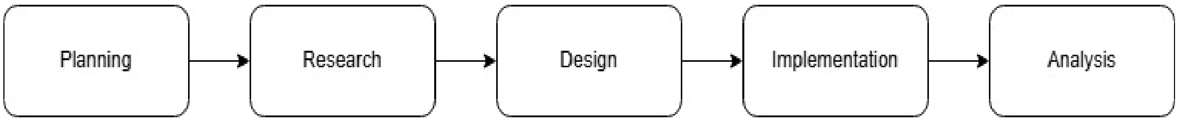

Figure 3.1 Project Workflow

Based on Figure 3.1, the planning phase involves defining the objectives, goals, scope and resources for the project. This phase involves identifying the task to be completed and setting up the overall project plan. In the research phase, it involves gathering information and data necessary to understand the problems and objectives that this project is trying to address to. Research includes market analysis, literature review and other methods of data collection to inform the project’s direction. The design phase is about creating detailed plans, prototypes of the project. This can include architectural designs, system designs, wireframes and other necessary blueprints. In the implementation phase, the designs and plans are translated into real, function products. This phase involves coding, building, manufacturing and executing the plans developed in the design phase. Finally, in the analysis phase, the outcomes of the project are reviewed and evaluated. Feedback is collected to adjust or improve the project if necessary.

3.2.2 Project Flowchart

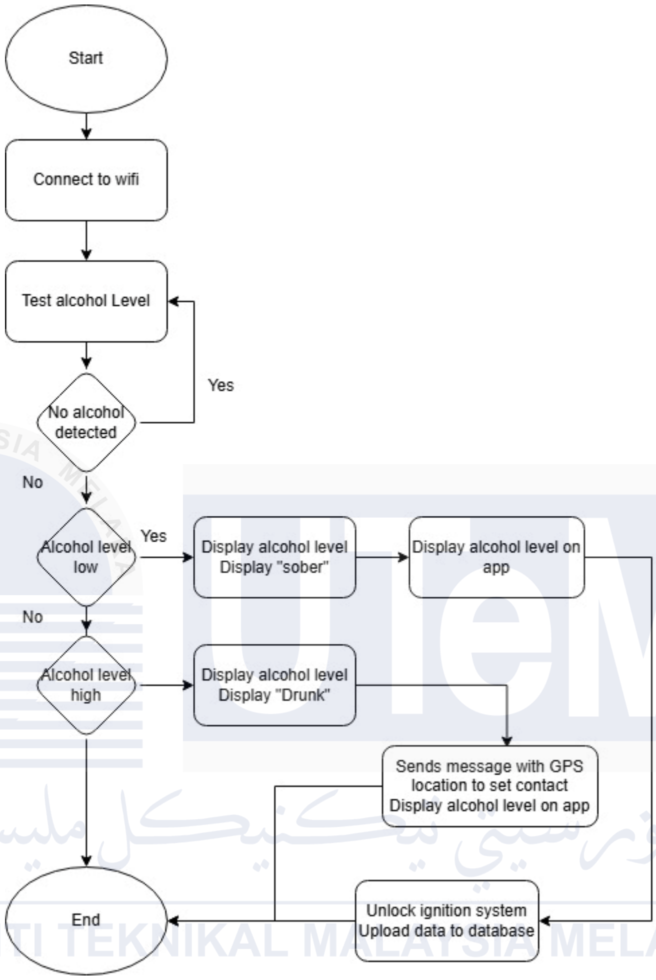

Figure 3.2 Project Flowchart

The flowchart above explains how the system will work. The value of the alcohol level will be displayed on the LCD. The ignition system will not work if the driver does not do the alcohol test of the system. When the driver uses the device, the device will display the test results, if the alcohol level is below the level of "driving under influence" stated by the law, then the LCD will inform the driver that he is sober by displaying the word "sober" and unlocking the ignition system, meanwhile the results of the test will displayed on the app. If the system detects an abnormal high level of alcohol that is unfit for driving, the LCD will display "drunk" and the ignition system will not be unlocked, at the same time, a message will be sent to the user's preferred emergency contact, which will inform the receiver the location of the car.

3.2.3 Project Block Diagram

A block diagram is a simplified representation of a project's concept, similar to a flowchart but presents it in a simpler manner. It typically illustrates the input, process, and output of a project, simplifying the components and materials used in the design. The purpose of a block diagram is to aid in understanding the project's overall structure and to identify potential issues early in the design process. By breaking down the project into its basic components, a block diagram can provide a clear visual representation of the project's flow and help ensure its successful completion. In Figure 3.3, it depicts the MQ3 Alcohol Sensor as the input of the system, the ESP8266 processes the information while the GSM Module, GPS Module, I2C LCD and Blynk Apps acts as the output.

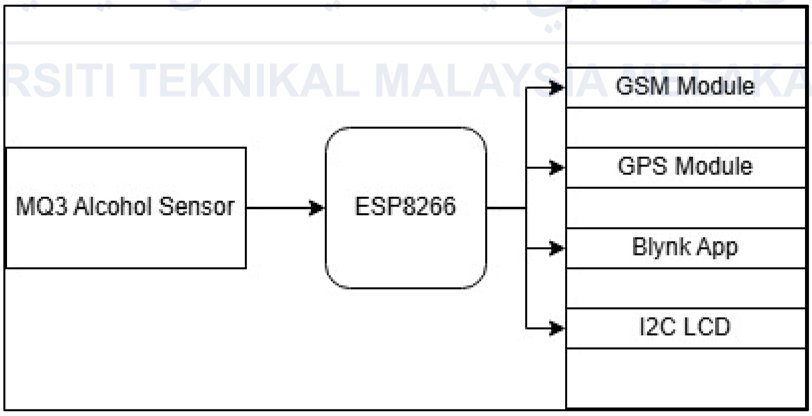

Figure 3.3 Block Diagram

3.3 Project Implementation and Development

Based on the prior research and studies done, the components that are used for this project is the ESP8266 as the microcontroller, the alcohol sensor is the MQ3 alcohol sensor.

The SIM900A will be chosen for the GSM module and the NEO-6M GPS module will be used for the GPS module. I2C LCD will be used for display and LEDs as indicator for the engine. The key switch is used to simulate the turning on the car.

3.3.1 ESP8266

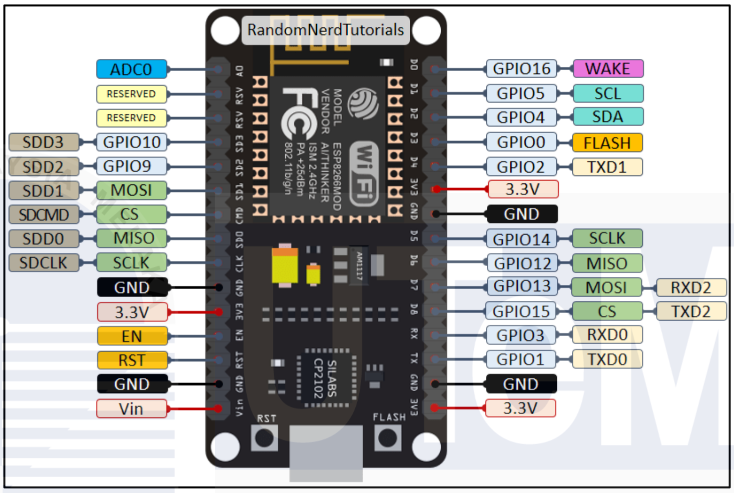

Figure 3.4 Pin Layout of ESP8266

The ESP8266 is chosen as the main component of the project. It is a low-cost WiFi microchip with full TCP/IP stack and microcontroller capability developed by Espressif Systems. It is widely chosen for the development of Internet of Things (IoT) embedded applications due to its cost-effectiveness and versatility. The module's small form factor facilitates integration into compact devices, enabling the development of stylish and lightweight IoT and embedded system solutions. The ESP8266 consumes a small amount of energy, making it suitable for battery-powered applications and extending the lifespan of devices.

The ESP8266 supports various types of communication, which makes it easier to adapt to different project requirements. Its versatility allows it to be used in a wide range of applications, from simple home automation projects to complex IoT systems. The ESP8266's compatibility with common development boards, sensors, and libraries enhances the overall user experience and streamlines the development process. Its affordable price makes it accessible to both hobbyists and professionals, fostering innovation across diverse projects and applications.

The ESP8266 has a strong and active community that provides support, resources, and libraries to assist developers in creating innovative projects. The open-source design of the ESP8266 promotes collaboration and community-based development, allowing users to customize the module to meet their specific requirements. The simple setup and programming environment of the ESP8266 lowers the barrier to entry for beginners, enabling them to learn about and experiment with IoT and embedded systems.

Overall, the ESP8266 is an excellent choice for IoT projects due to its cost-effectiveness, compact size, low power consumption, and ease of integration with various hardware and software components. Its versatility and robust community support make it a popular choice among developers looking to create innovative IoT solutions.

Wi-Fi Parameters	Frequency Range	2.4G-2.5G (2400M-2483.5M)
	Wi-Fi Protocols	802.11 b/g/n
	Types of Antenna	PCB Trace, External, IPEX Connector, Ceramic Chip
Hardware Parameters	Peripheral Bus	UART/SDIO/SPI/I2C/I2S/IR Remote Control
		GPIO/PWM
	Operating Voltage	3.0~3.6V
	Operating Current	Average value: 80mA
	Operating Temperature Range	-40°~125°
	Ambient Temperature Range	Normal temperature
Software Parameters	Package Size	5x5mm
	Wi-Fi mode	station/softAP/SoftAP+station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network)
	Software Development	Supports Cloud Server Development / SDK for custom firmware development
	Network Protocols	IPv4, TCP/UDP/HTTP/FTP

Figure 3.5 ESP8266 Specification

3.3.2 MQ3 Alcohol Sensor

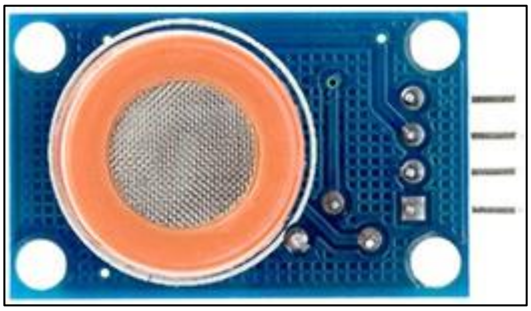

Figure 3.6 MQ3 Alcohol Sensor

The MQ3 alcohol sensor is chosen for this project due to its high sensitivity to alcohol and low sensitivity to gases such as carbon dioxide and benzene, which could otherwise affect the results. This sensor is based on metal-oxide-semiconductor (MOS) and is used for alcohol sensing. The sensitivity can be varied with the use of tin dioxide which is suitable to sense the alcohol. When the alcohol concentration is high the resistivity of the sensor will change, hence affecting the output voltage. The alcohol sensor can be used to detect the presence of alcohol within 2-meter range. The advantages of the MQ3 alcohol sensor are its has high sensitivity and good selectivity to ethanol vapor, fast recovery time and long lifespan, so user won't always have to change the component. In the element, two of which are 4 terminals of which 2 of them are the source terminal and ground terminal, while two others are terminal AOUT for analog output and DOUT for digital output.

Operating voltage	5V
Load resistance	200 KΩ
Heater resistance	33Ω ± 5%
Heating consumption	<800mw
Sensing Resistance	1 MΩ – 8 MΩ
Concentration Range	25 – 500 ppm
Preheat Time	Over 24 hour

Figure 3.7 MQ3 Alcohol Sensor Specifications

3.3.3 GPS Module NEO-6M

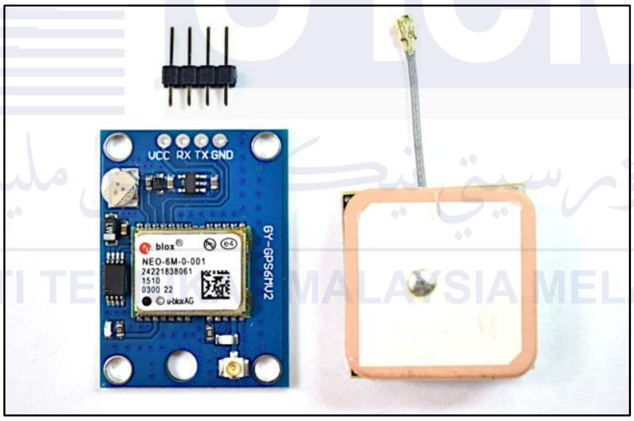

Figure 3.8 NEO-6M GPS Module

This GPS module is a global navigation satellite system that uses the medium Earth Orbit Constellation between 24 and 32 to transmit precise microwave signals that allow GPS receivers to work out someone's location, speed, direction, and time. Compared to other GPS modules, it can perform up to 5 location updates in a second with 2.5m horizontal position accuracy. The U-blox 6 positioning engine also has a Time-To-First-Fix (TTFF) of less than 1 second. Using the GPS Module, the driver's location can be pinpointed when the message by the system is sent to the emergency contact, and this will make it easier for the contact to locate where the driver is. Same as the MQ3 alcohol sensor, GPS Module also has 4 terminals which two of them are ground and source, and there is pin TX as the transmitter and pin RX as the receiver.

Receiver Type	50 channels, GPS L1(1575.42Mhz)
Horizontal Position Accuracy	2.5m
Navigation Update Rate	1HZ (5Hz maximum)
Capture Time	Cool start: 27sHot start: 1s
Navigation Sensitivity	-161dBm
Communication Protocol	NMEA, UBX Binary, RTCM
Serial Baud Rate	4800-230400 (default 9600)
Operating Temperature	-40°C ~ 85°C
Operating Voltage	2.7V ~ 3.6V
Operating Current	45mA
TXD/RXD Impedance	510Ω

Figure 3.9 NEO-6M GPS Module Specifications

3.3.4 SIM900A GSM Module

Figure 3.10 SIM900A GSM Module

The GSM Module is a hardware device that uses the GSM of mobile telephone technology to provide a data link to a remote network. It has the same concept as a mobile telephone as it also needs a SIM to identify itself to the network. However, it is a wireless modem, so the difference between the GSM Module and a regular mobile telephone is that it sends and receives data through radio waves. The reason that this component been choosen as one of the main components is to allow the message to be sent to the emergency contact if the driver's alcohol level is above the limit to notify them that the driver is drunk and cannot drive. It is also easy to use the component because it only needs to insert a SIM cardinto the GSM Module, and with some programming, it will work well with the system. This component only has 3 terminals: one for the ground, the TX pin of the module will be connected to the RX pin in the microcontroller, and the RX pin of the module will be connected to the TX pin in the microcontroller. This component also needs an external power supply to turn it on.

Modes	Frequency	Current Consumption
Power down		60 uA
Sleep mode		1 mA
Stand by		18 mA
Call	GSM850	199 mA
	EGSM900	216 mA
	DCS1800	146 mA
	PCS1900	131 mA
GPRS		453 mA
Transmission burst		2 A

Figure 3.11 SIM900A GSM Module Specifications

3.3.5 I2C LCD

Figure 3.12 I2C LCD

The I2D LCD display is chosen for this project. The main advantage of using an I2C LCD is the simplified wiring required compared to a standard LCD. An I2C LCD only needs four connections: two for power and two for data (SDA and SCL). This contrasts with a standard LCD which can require over ten connections, which can be problematic if the microcontroller has limited GPIO pins available.

3.3.6 Arduino IDE Program

The software that will be used in this project is Arduino IDE. From this software, programs that had been made and transferred to the hardware components via microcontroller which ESP8266 as the bridge to transfer the data and to make the hardware components execute the work. It contains the text for writing codes, programs, a toolbar with buttons for standard functions and a couple of menus. Arduino IDE will be combined with the hardware to communicate with them. When the ESP8266 is connected by USB, the program will get transferred to the hardware.

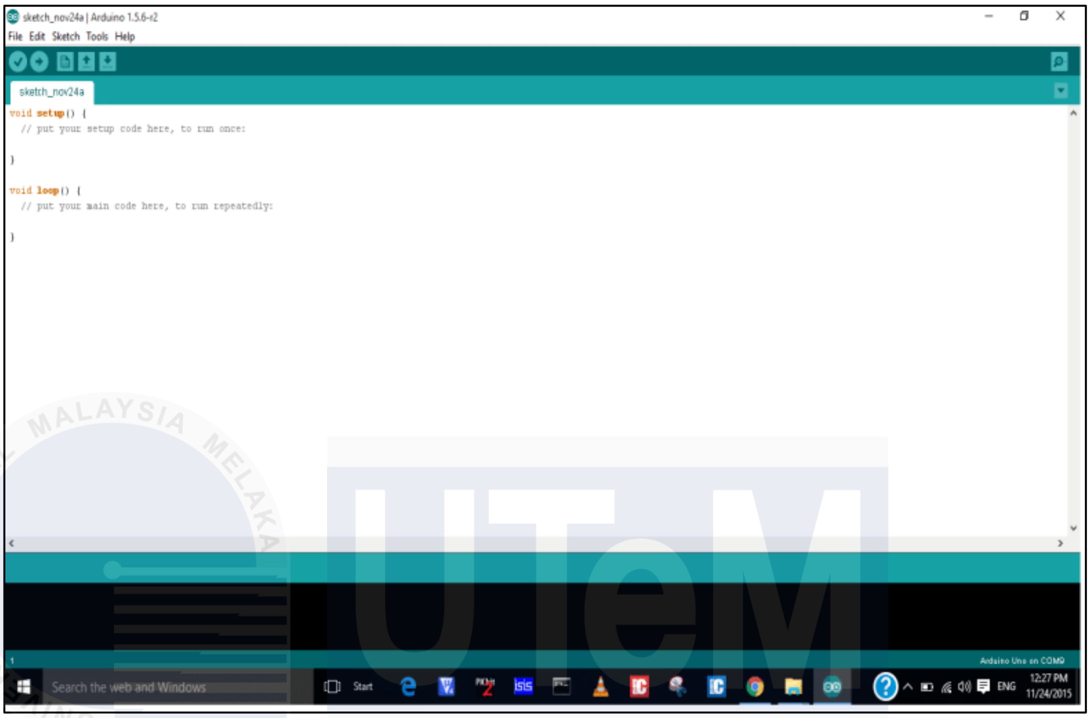

Figure 3.13 Arduino IDE

3.3.7 Android Studio

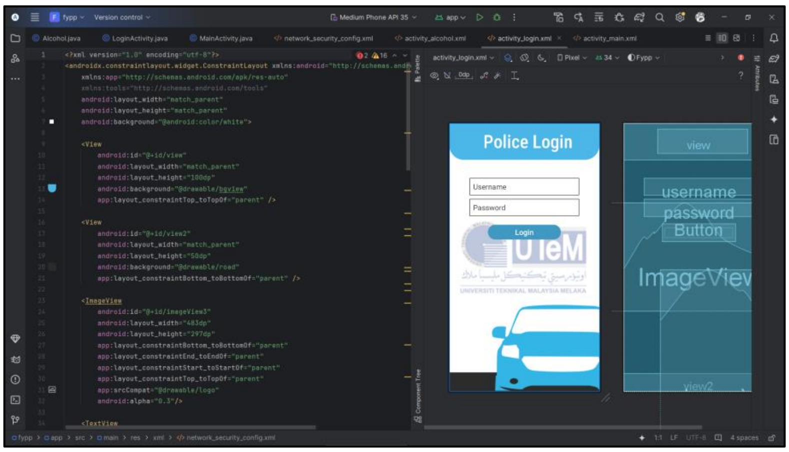

Figure 3.14 Android Studio Layout

Android Studio will be used in the project to develop the application that assist law enforcemenet officers such as policemen to quickly access the alcohol test results of the drivers. The application will be developed in Android Studio by designing the user interface and implementing the necessary class activities. The Firebase Realtime Database which is in built inside Android Studio can be instantly integrated into the application. Finally the application is tested and run on an Android device which is linked to Android Studio to ensure its functionality and reliability.

3.4 Sustainable Development

Figure 3.15 Sustainable Development Goals

Integrating IoT-based Car Ignition Interlock System with Alcohol Detector aligns with several United Nations Sustainable Development Goals (SDGs). The primary impact of alcohol detectors is on Good Health and Well-being. These devices can significantly reduce the incidents of drunk driving, a major cause of road traffic accidents. By preventing impaired individuals from operating vehicles, alcohol detectors directly contribute to lowering the number of road traffic injuries and deaths.

The project also impacts on Industry, Innovation, and Infrastructure is also advanced through the development and integration of alcohol detectors. These devices represent a significant technological innovation, encouraging advancements in the automotive and safety industries. This hastens the development of smarter and safer transportation solutions. Supporting the widespread adoption of these technologies also improves in infrastructure, such as updating vehicle safety standards and regulatory frameworks, thereby contributing to creating a safer transport systems.

Finally, the project impacts on Sustainable Cities and Communities, alcohol detectors enhance the safety of urban transportation networks by ensuring that only sober individuals operate vehicles. This leads to safer roads and communities, promoting the goal of making cities inclusive, safe, resilient, and sustainable. Safe and reliable transportation is a cornerstone of sustainable cities, and by reducing drunk driving incidents, alcohol detectors significantly contribute to this objective.

3.5 Hardware Connections

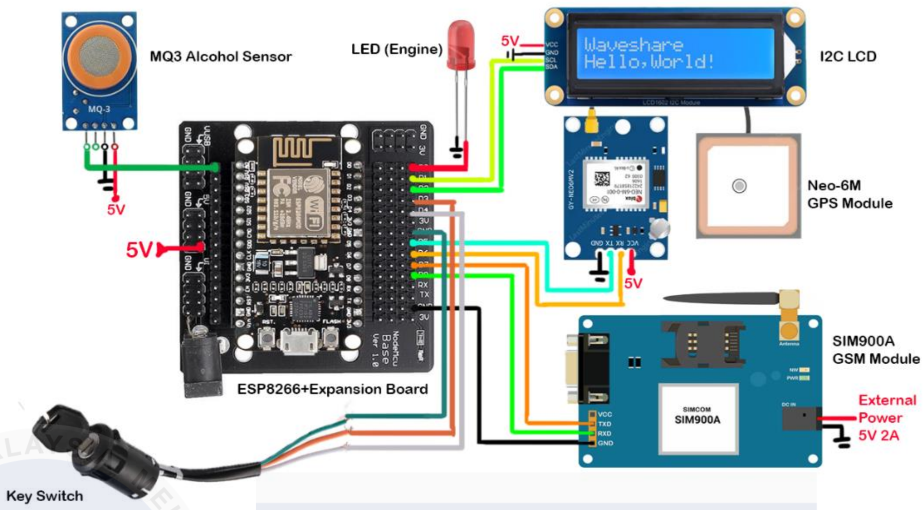

Figure 3.16 Circuit Connection of the Prototype

The hardware connection used in the IoT-based Car Ignition Interlock System. The MQ3 alcohol sensor, GPS module, GSM module and I2C LCD are powered by the 5V pins on the expansion board. The MQ3 alcohol sensor's analog pin is connected to A0, or the analog input of the ESP8266. The SCL and SDA pin of the I2C LCD is connected to D1 and D2 respectively. The Tx and Rx pin of the Neo-6M GPS module is connected to the D5 and D6 of the ESP8266. For the SIM900A GSM Module, it has the same pins as the GPS module, which is the Tx and Rx pin, these pins are connected to D7 and D8 of the ESP8266. Meanwhile, the LED which represents the engine is connected to D0, while the key switch input wires are connected to D3 and D4. Finally, all the component's ground pins are assigned to the GND port of the microcontroller.

3.6 Software Implementation

This part is focused on building the programs used for the IoT-based Car Ignition Interlock System. Since ESP8266 is used as the microcontroller, Arduino IDE is used to program the ESP8266. In Arduino IDE, necessary libraries, such as TinyGPS++, are downloaded in order to use the components. The overall system design and program logic are then created and implemented through this software.

Meanwhile, Android Studio is used to design and develop the mobile application. In Android Studio, the user interface for each page or in each screen is designed using XML code, while the functionality of the app's interface can be implemented inside the class methods.

3.6.1 Arduino IDE Program

Figure 3.17 Partial Coding of the System

After settling the hardware connections, the program is required to be uploaded into the ESP8266 to run the system. In the figure above, a partial program of the project can be seen, showing that Arduino IDE is needed to upload the program into the ESP8266 to run the system. If the system gives any unwanted results, adjustments are to be made through this program.

3.6.2 Android Studio Program

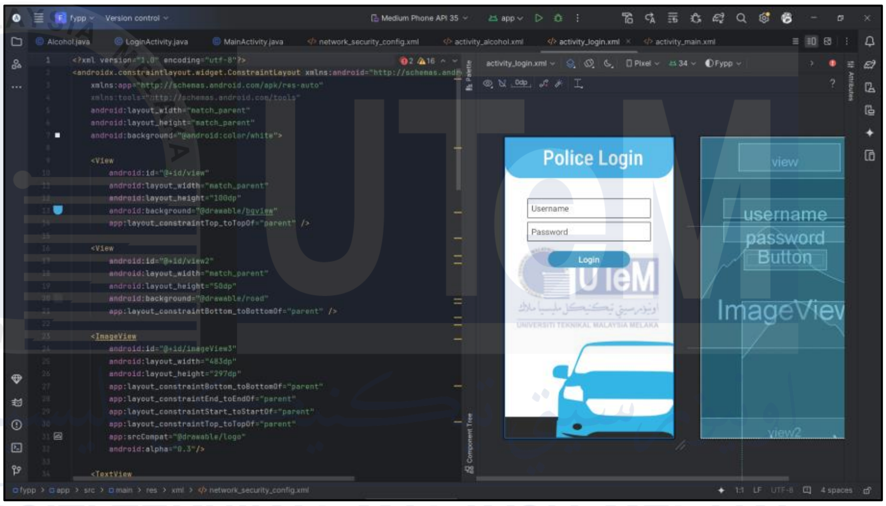

Figure 3.18 Application Preview

The figure above shows the development of the mobile application that can access the test results of drivers. The application is tested using Android Studio's tools such as the emulator and Logcat to resolve any errors or performance issues. Once finalized, it can be installed on smartphones to be used by law enforcement officers. Future updates and improvements can also be managed through Android Studio.

3.7 Summary

The methodology defines the method we used to reach our objectives. From this chapter, a lot of components specification have already been elaborated to know how each component works in this project. With detailed research and revision, the component was chosen carefully and can be developed to make sure the system works at its best. By listing the hardware connection and software implementation, the project is designed successfully and tested properly with the data collected for analysis.

CHAPTER 4

PRELIMINARY RESULTS

4.1 Introduction

This chapter discusses the results and analysis of the project through extensive experimentation and testing. Besides that, the prototye of the project was built with all the planned components such as ESP8266, Neo-6M GPS Module, SIM900A GSM Module and I2C LCD.

4.2 Flow of the project

To show the validity of the system, various testing and experiments were conducted. The data collected below is acquired to find out the accuracy and analyze the efficiency of the project. The data collected will also be used as references to help me troubleshoot the system if there is something wrong with the components.

4.3 MQ3 Alcohol Sensor

One of the primary objectives of this project is to analyze the accuracy and efficiency of the MQ3 Alcohol Sensor in detecting alcohol levels like a breathalyzer. Special attention is given to the sensor's readings to validate its reliability. The MQ3 sensor has been tested using various products with different alcohol concentrations. These readings are analyzed and calibrated to align with the legal alcohol limits defined by Malaysian law. Below are the substances that are used to run the test on the MQ3 Alcohol Sensor:

Figure 4.1 Hand Sanitizing Spray

Figure 4.2 Alcohol Wipes

Figure 4.3 Disinfectant Spray

Table 4.1 Alcohol Reading Collection

Item	Alcohol Percentage	Test 1	Test 2	Test 3	Test 4	Test 5	Average
Idle	0%	201	210	202	204	199	203.2
Blowing air (3s)	0%	138	135	139	132	135	135.8
Disinfectant Spray	60%	810	820	812	814	808	812.8
Alcohol Wipes	70%	900	897	903	897	890	897.4
Hand Sanitizing Spray	75%	960	958	967	950	963	959.6

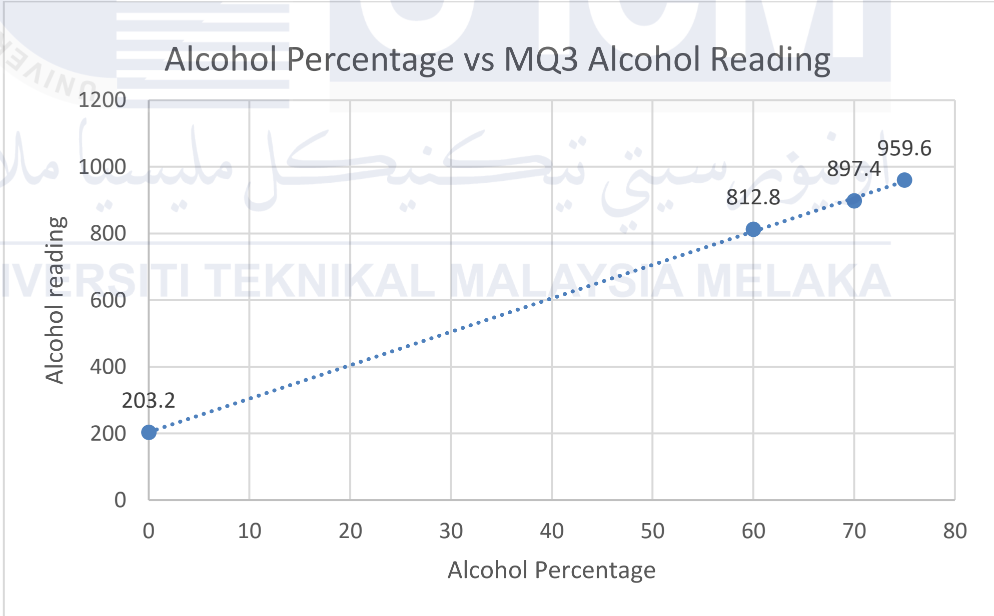

Figure 4.4 MQ3 Alcohol Reading vs Alcohol Percentage

The experiment was held 5 times, each separated by an interval of 10 minutes. The idle reading acts as the control variable, while the blowing air simulates the reading when a sober person performs the tests. The substances used to test the MQ3 Alcohol Sensor has various alcohol percentages. The items were tested one by one and the readings obtained are recorded in the table and a graph plotted which shows MQ3 Alcohol Readings against Alcohol Percentage.

Based on the readings and the graph, it is safe to assume that the MQ3 alcohol can measure alcohol with reasonable accuracy. The MQ3 sensor's reading align with the actual alcohol percentages of the items. However, there are some shortcomings with the MQ3 alcohol sensor, it takes some time to return to the idle value and the value drifts due to external interference such as temperature and humidity. Despite these shortcomings, the MQ3 Alcohol Sensor demonstrates potential for detecting alcohol levels effectively.

4.4 Neo-6M GPS Module

The next data collection is the Neo-6M GPS Module. The location recorded by the GPS module is in latitude and longitude format. The location obtained will be used to detect the location of the drunk driver and vehicle. This will enable predetermined family members or emergency contacts to find the driver's whereabouts.

For testing purposes, the GPS module is brought to various places in Ayer Keroh region to collect the readings of the location. The latitude and longitude coordinates displayed by the GPS module on the serial monitor is recorded. These coordinates were then compared with the actual locations of the device on the map to evaluate the module's performance and reliability.

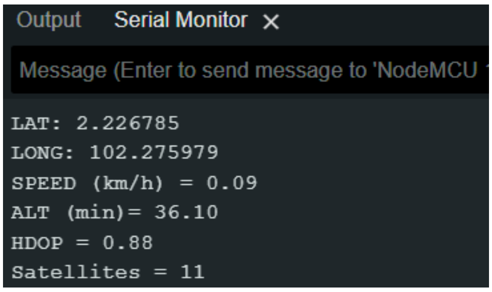

Figure 4.5 GPS module reading on Taman Delima Raya

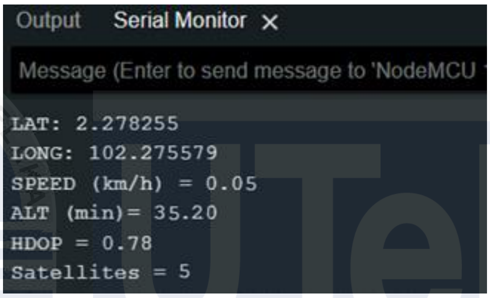

Figure 4.6 GPS module reading on Kampus Teknologi UteM

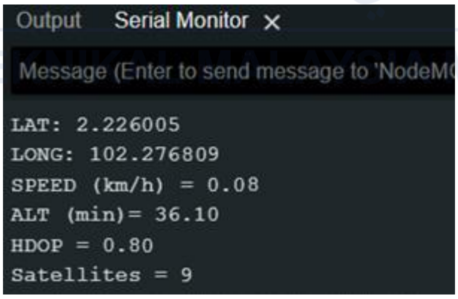

Figure 4.7 GPS module reading on Jiki Food Court

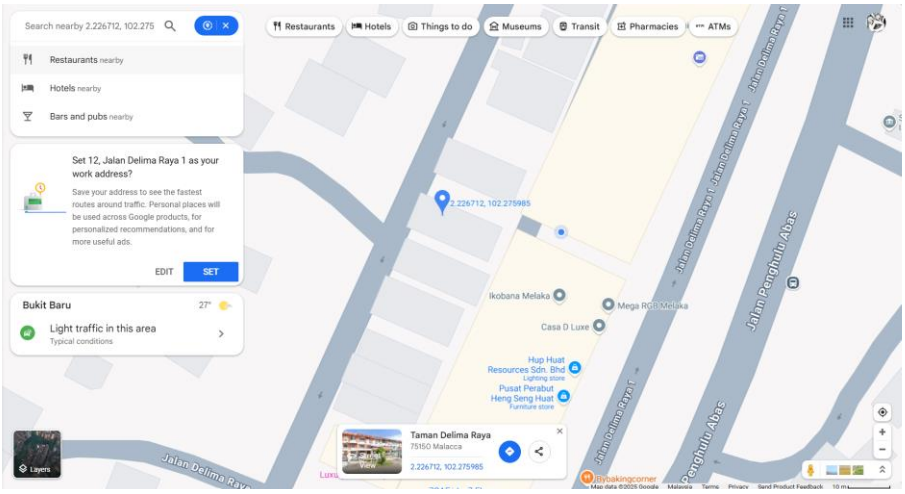

Figure 4.8 Google Maps reading on Taman Delima Raya

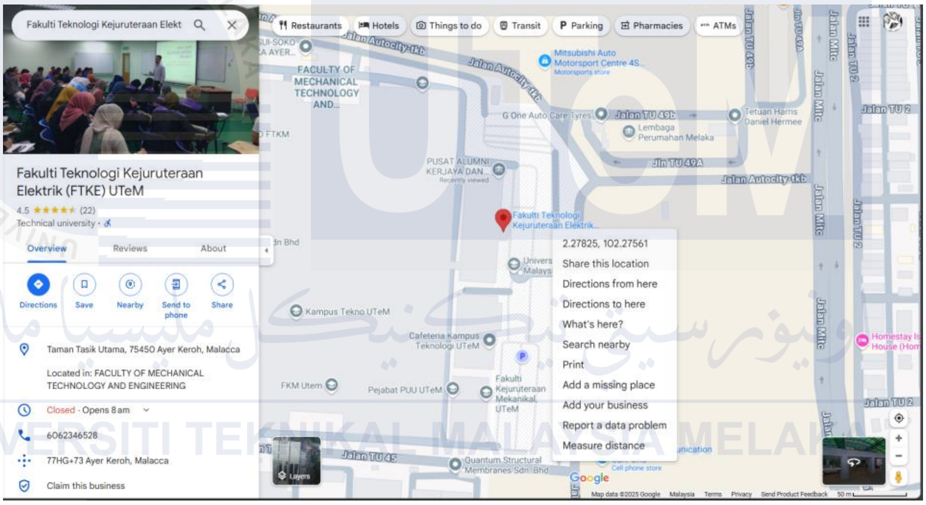

Figure 4.9 Google Maps reading on Kampus Teknologi UteM

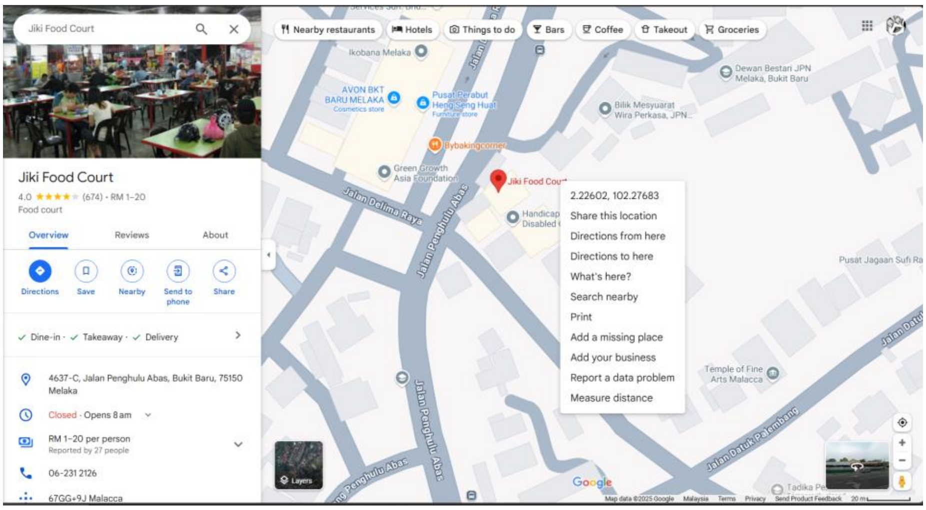

Figure 4.10 Google Maps reading on Jiki Food Court

Table 4.2 Comparison between GPS module and Google Maps

Location	GPS Module Coordinates	Google Map Coordinates
Taman Delima Raya (House)	Lat:2.2268 Long:102.2760	Lat:2.2267 Long:102.276
Kampus Teknologi UTeM	Lat:2.2783 Long:102.2756	Lat:2.2783 Long:102.2756
Jiki Food Court	Lat:2.2260 Long:102.2768	Lat:2.2260 Long:102.2768

Based on the tests above, it is observed that the location recorded by the GPS module is accurate when compared to the locations recorded on Google Maps. It is also observed that the GPS module will take a long time to obtain the signal when the module is operated indoors or under cloudy conditions. However, the Neo-6M GPS module has sufficient accuracy to effectively record the location of the vehicle.

4.5 Product Prototype

In order to run the system properly, a prototype needs to be designed and built. For the prototype, after assigning the pins and coding that is used to execute the prototype, the prototype is developed with the functions intended.

Figure 4.11 Prototype of the project

The figure above is the prototype of the IoT-based Car Ignition Interlock System using micrcontroller. The I2C LCD, LED and key switch are displayed outside the container. While the other components are stored inside the container. While the application is downloaded into the user's phone.

4.5.1 Hardware Demonstration

Figure 4.12 System in LOCK state

When the system is powered on, the LCD will not display anything, this is to simulate the car environment, where the car is completely turned off, or in the LOCK state.

Figure 4.13 System in ACCESSORY state and the reading is invalid

When the key switch is turned into the first position, which is the ACCESSORY state, the LCD will light up, immediately reading the alcohol level using the MQ3 alcohol sensor and displaying the real time readings on the I2C lCD.

When the user does not perform the test or does not blow air towards the alcohol sensor long or hard enough, the LCD will display "Invalid" along with the real time readings of the alcohol sensor. If the user attempts to turn the key to the ON state to turn on the engine, the LED which represents the engine will not turn on.

Figure 4.14 LCD when the reading indicates sober

Figure 4.15 LCD and LED when the engine successfully turns on

When the sober user performs the alcohol test by blowing air towards directly towards the MQ3 alcohol sensor, the LCD will display "sober" along with the real time readings. If the user turns the key to turn on the engine this time, the LED will turn on, signalling that the engine has been turn on. The LCD will display “Engine On Drive Safely” and turns off after 5 seconds.

Figure 4.16 LCD when the reading indicates drunk

If by any chance the driver was intoxicated by alcohol and performs the test, the LCD will display “Drunk” along with the high alcohol reading from the MQ3 alcohol sensor. The LED which represents the engine will not turn on despite the user turning the key to the ON state. Meanwhile, an SMS and an email, provided that internet connection is available, will be sent to the driver’s emergency contact to inform them about the driver’s status and whereabouts. In the figure, a threshold of 700 analog value is set for demonstration.

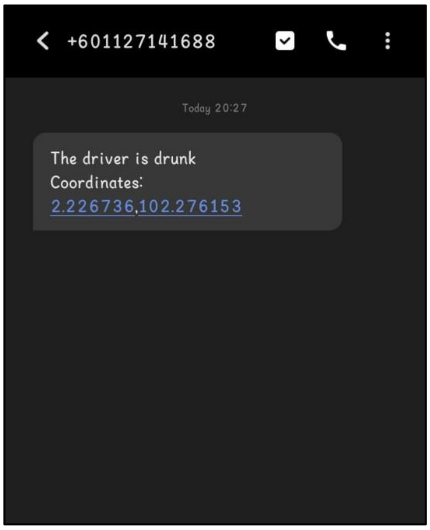

Figure 4.17 SMS with coordinates received from the system

From the figure shown, the SMS sent by the SIM900A can send the message successfully with a delay of 3 to 5 seconds. The message sent can notify the receiver about the driver's condition. Moreover, the coordinates provided in the message shows the recipient the location of the driver. Unfortunately, due to the law enacted by the MCMC, URLs are unable to be sent via SMS after September 1 2024 [25], thus the user needs to manually type the coordinates given in the message.

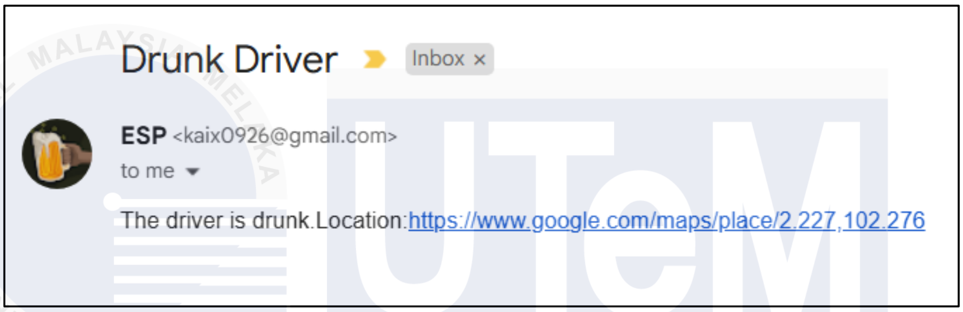

Figure 4.18 Email with Google Maps link received from the system

As shown in the figure, if there is an internet connection, the ESP8266 will send an email to the predesignated email address to inform the recipient that the driver is drunk. The email also includes a Google Maps link which indicates the location of the drunk driver and vehicle.

4.5.2 Software Demonstration

A supporting software is developed to compliment the product prototype. The software mainly functions to help the law enforcement to increase the efficiency of the road blocks.

Figure 4.19 Main page

The screenshot above shows the main page of the alcohol testing application. On the page displays the car number plate, a login button a live reading of the MQ3 sensor, which can be used to view the current alcohol level in the surrounding air or the drivers BAC when performing the test.

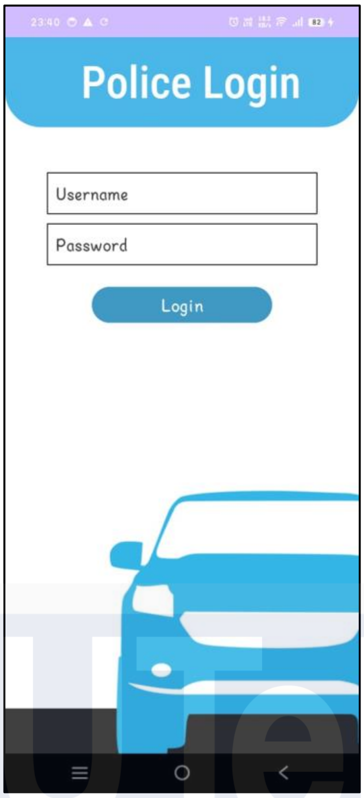

Figure 4.20 Login page

If the user is a law enforcer such as a traffic police, they can use this application to access the alcohol reading history based on the vehicle's number plate. The user can access this function after logging into their account created by the law enforcement force. Since the data accessed is considered private, an account is required to access the alcohol checker page, this account is created and given to law enforcers to access the page.

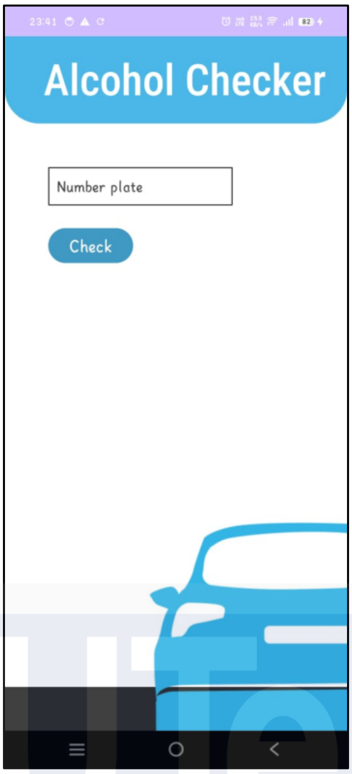

Figure 4.21 Alcohol Checker page

After entering the page, the user can access a vehicles alcohol reading history by entering the vehicles number plate and pressing “check”.

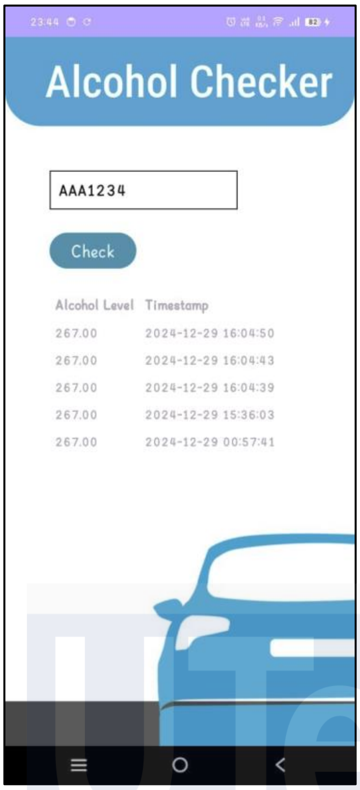

Figure 4.22 Alcohol Checker page with results

After pressing the button, the 5 most recent readings recorded in the vehicle will be displayed in descending order, the results will show the alcohol level and timestamp where the reading is uploaded to the database.

By using this function, law enforcers can easily check the alcohol readings of the driver, choosing to flag down vehicles with suspicious or incorrect readings. This not only help saves the time and energy of the law enforcers, but also helps increase the efficiency of roadblocks as the law enforcers do not have to flag down every vehicle to perform alcohol tests.

4.6 Summary

By studying the data collection, it can be concluded that the system can work properly with some minor issues or conditions. Although no major issues will occur if there is no internet, the system still requires internet connection to perform some of its actions. The MQ3 sensor needs to warm up first before the testing can be done, the sensor also needs to have proper voltage (5V) in order to have the maximum accuracy. For the Neo-6M GPS module, there is around a 50–100 meter difference to the actual location, the GPS module may also perform poorly indoors or during bad weather as it will have poor reception. Next, the SIM900A GSM Module, there may be bad reception due to the telco company having poor signal in the area, making it hard to send messages in certain areas.

Overall, the prototype can work properly in most scenarios. However, the overall system can still be improved in the future.

CHAPTER 5

CONCLUSION

5.1 Conclusion

In conclusion, the prototype of my project can function properly and can perform as per the requirements stated in the objectives. This project has been developed as a precautionary measure for alcoholics who drive while they are still drunk, risking their lives and others on the road. The system was built with components which can detect the alcohol level of a person (MQ3 Alcohol Sensor), determine the person's or vehicle's whereabouts (Neo-6M GPS module), alert the drunk's person of choice using SMS and email, and also an application that can view readings of not drunk drivers that can increases the efficiency of law enforcers during roadblocks.

At the end of the project, the prototype of an IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller has been successfully designed and implemented. In addition, the system prevents the driver from igniting the engine should the driver be drunk. This helps reduce the chance of someone causing fatalities on the road due to driving under the influence of alcohol. This prototype is not perfect and many improvements can be made to make this project to perform its best and add more useful functions.

Finally, the objectives of the project has been achieved. An IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller has been successfully designed and developed by using various components such as alcohol sensors, GPS modules and GSM modules. The efficiency of an IoT-based Car Ignition Interlock System with Alcohol Detector using Microcontroller is also analyzed through various tests. By implementing this project into the community, accidents caused by driving under the influence of alcohol can be reduced and prevented, people will have less to worry on the road and less innocent bystanders may be injured or killed.Future Improvements and Modifications

In the future, the project is expected to be improved further to avoid any bugs and improve accuracy. More effort will be made to fine-tune the accuracy of the alcohol detection mechanism through meticulous sensor calibration procedures, ensuring that sensor readings remain precise and dependable. Any loopholes or workarounds will be identified and fixed to safeguard against unauthorized access and cyber threats. Enhancements to the user interface and experience are also considered, with an emphasis on crafting a more intuitive and user-friendly interface that facilitates seamless interaction Through these concerted efforts, the project endeavors to deliver a robust, reliable, and user-friendly IoT-based Car Ignition Interlock System with an Alcohol Detector that meets exacting standards of performance and safety.

5.2 Future Works

For future works, I will add more functions to the application that can further improve the system, such as live location tracking and user registration, as well as other detection or tests so that this product is not limited to alcohol only. Next, I will make this product more power efficient and robust to support various types of vehicles. Lastly, I will try to implement this project on my own car to see its potential functionality and hope to implement this on another car as well.

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APPENDICES

Appendix A PSM 1 Gantt Chart

No.	Task/Activity	Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Briefing	/													
2	Submission of Proejct Title	/													
3	Hardware and Sensor Finalization		/	/	/										
4	Literature Review					/	/	/	/	/	/				
5	Components Ordering						/	/	/	/					
6	Experimental Setup								/	/	/	/			
7	Report Writing		/	/	/	/	/	/	/	/	/	/	/	/	
8	Submission of the Final Report													/	
9	Preparation and Presentation													/	/

	Plan
/	Actual

Appendix B PSM 2 Gantt Chart

Task/Activity	Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Detailed calculation and Theory Concept	/	/												
Project Design Finalization	/	/												
Hardware and Software Finalization	/	/	/	/	/	/								
Assemble Hardware Part					/	/	/							
Collecting the Data							/	/	/					
Final Documentation and Report Writing								/	/	/	/			
PSM 2 Draft Submission											/			
Preparation and Presentation												/		/
Submission of the Final Report														/

Appendix C Arduino Code

```
#if defined(ESP32)
#include <WiFi.h>
#elif defined(ESP8266)
#include <ESP8266WiFi.h>
#endif
#include <Firebase_ESP_Client.h>
#include <ESP_Mail_Client.h>
#include "addons/TokenHelper.h"
#include "addons/RTDBHelper.h"
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
#include <TinyGPS++.h>
#include <ESP8266HTTPClient.h>
#include <ezButton.h>

#define WIFI_SSID "Tan"
#define WIFI_PASSWORD "kaisxuan"
#define API_KEY "AIzaSyAQTy7LH5wqHDP9RD4OyrBMegAkrtP0WdY"
#define DATABASE_URL "https://fypp-82943-default-rtdb.asia-
southeast1.firebasedatabase.app/"
#define MQ3_SENSOR_PIN A0
#define AlcoholReadInterval 1000
#define FirebaseUpdateInterval 1000
#define RX 14
#define TX 12
#define numberplate "ABC1235"

//email components
#define SMTP_HOST "smtp.gmail.com"
#define SMTP_PORT 465
#define AUTHOR_EMAIL "kaix0926@gmail.com"
#define AUTHOR_PASSWORD "qglu mctu hoia cgde"
#define RECIPIENT_EMAIL "tankaisxuan2@gmail.com"
SMTPSession smtp;
void smtpCallback(SMTP_Status status);

ezButton switch1(D3);
ezButton switch2(D4);
TinyGPSPlus gps;
LiquidCrystal_I2C lcd(0x27,16,2);
SoftwareSerial mySerial(13, 15);
SoftwareSerial gpsSerial(RX, TX);

const char* serverUrl = "http://192.168.112.224/fypp/submit_check.php";
float sensorValue;
char msg;
int control = 0;
```

```
int alcoholLevel = 0;
int data = 0;
bool key = false;
bool engineOn = false;
bool notificationSent = false;
bool offlineMode = false;
FirebaseData fbdo;
FirebaseAuth auth;
FirebaseConfig config;

unsigned long sendDataPrevMillis = 0;
unsigned long lastAlcoholReadTime = 0;
unsigned long lastControlUpdateTime = 0;
const unsigned long controlUpdateInterval = 120000;
bool signupOK = false;

void setup() {
  Serial.begin(9600);
  switch1.setDebounceTime(100);
  switch2.setDebounceTime(100);
  pinMode(D0, OUTPUT);
  lcd.init();
  lcd.clear();
  lcd.noDisplay();
  gpsSerial.begin(9600);
  mySerial.begin(9600);

  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  int retryCount = 0;
  while (WiFi.status() != WL_CONNECTED && retryCount < 10) {
    delay(1000);
    retryCount++;
  }

  if (WiFi.status() == WL_CONNECTED) {
    config.api_key = API_KEY;
    config.database_url = DATABASE_URL;

    if (Firebase.signUp(&config, &auth, "", "")) {
      signupOK = true;
    }

    config.token_status_callback = tokenStatusCallback;
    Firebase.begin(&config, &auth);
    Firebase.reconnectWiFi(true);
  } else {
    offlineMode = true;
  }
    Firebase.RTDB.setString(&fbdo, "/Car", numberplate);
    control = analogRead(MQ3_SENSOR_PIN);
```

```
}

void loop() {
  switch1.loop();
  switch2.loop();
  updateControlValue();

  if (millis() - lastAlcoholReadTime >= AlcoholReadInterval) {
    lastAlcoholReadTime = millis();
    alcoholLevel = analogRead(MQ3_SENSOR_PIN);
  }

  if (!offlineMode && Firebase.ready() && signupOK && (millis() -
sendDataPrevMillis > FirebaseUpdateInterval || sendDataPrevMillis == 0)) {
    sendDataPrevMillis = millis();
    Firebase.RTDB.setInt(&fbdo, "/Alcohol", alcoholLevel);
  }

  if (switch1.getState() == HIGH) {
    engineOn = false;
    digitalWrite(D0, LOW);
    lcd.clear();
    lcd.noDisplay();
    lcd.noBacklight();
    notificationSent = false;
    key = false;
  }
  else if (engineOn == true) {
    return;
  }
  else if (switch1.getState() == LOW && switch2.getState() == HIGH && key == false)
{
      lcd.display();
      lcd.backlight();
      lcd.setCursor(2, 0);
      lcd.print(alcoholLevel);
      updateLCD(alcoholLevel);
  }

  while (gpsSerial.available() > 0) {
    gps.encode(gpsSerial.read());
  }

  if (switch2.getState() == LOW && key == true) {
      EngineOn();
      key = false;
      lcd.noDisplay();
      lcd.noBacklight();
      bool success = sendDataToServer(numberplate, alcoholLevel);
      engineOn = true;
```

```
  }
}

void updateLCD(int alcoholLevel) {
  if (alcoholLevel > 950) {
    lcd.setCursor(2, 1);
    lcd.print("Drunk  ");
    if (!notificationSent) {
      SendMessage();
      SendEmail();
      notificationSent = true;
    }
  }
  else if (alcoholLevel < control - 20)
  {
    lcd.setCursor(2, 1);
    lcd.print("Sober  ");
    data = alcoholLevel;
    key = true;
  }
  else{
    lcd.setCursor(2, 1);
    lcd.print("Invalid");
  }
}

void SendMessage()
{
  mySerial.println("AT+CMGF=1");
  delay(1000);
  mySerial.println("AT+CMGS=\"+60169225136\"");
  delay(1000);

  if (gps.location.isValid())
  {
    mySerial.println("The driver is drunk");
    mySerial.print("Coordinates: ");
    mySerial.print(gps.location.lat(), 6);
    mySerial.print(",");
    mySerial.print(gps.location.lng(), 6);
  } else {
    mySerial.println("GPS data not valid");
  }
  mySerial.println((char)26);
  delay(3000);
}

void EngineOn()
{
  digitalWrite(D0, HIGH);
```

```
  lcd.clear();
  lcd.setCursor(2,0);
  lcd.print("Engine On");
  lcd.setCursor(2,1);
  lcd.print("Drive Safely");
  delay(5000);
}

void SendEmail(){
  MailClient.networkReconnect(true);

  smtp.debug(1);

  smtp.callback(smtpCallback);

  Session_Config config;

  config.server.host_name = SMTP_HOST;
  config.server.port = SMTP_PORT;
  config.login.email = AUTHOR_EMAIL;
  config.login.password = AUTHOR_PASSWORD;
  config.login.user_domain = "";

  config.time.ntp_server = F("pool.ntp.org,time.nist.gov");
  config.time.gmt_offset = 3;
  config.time.day_light_offset = 0;

  SMTP_Message message;

  message.sender.name = F("ESP");
  message.sender.email = AUTHOR_EMAIL;
  message.subject = F("Drunk Driver");
  message.addRecipient(F("KaiX"), RECIPIENT_EMAIL);

  String textMsg = "The driver is drunk.Location:";
  textMsg += "https://www.google.com/maps/place/";
  textMsg += String(gps.location.lat(), 3) + "," + String(gps.location.lng(), 3);
  message.text.content = textMsg.c_str();
  message.text.charSet = "us-ascii";
  message.text.transfer_encoding = Content_Transfer_Encoding::enc_7bit;

  message.priority = esp_mail_smtp_priority::esp_mail_smtp_priority_low;
  message.response.notify = esp_mail_smtp_notify_success |
esp_mail_smtp_notify_failure | esp_mail_smtp_notify_delay;

  if (!smtp.connect(&config)){
    ESP_MAIL_PRINTF("Connection error, Status Code: %d, Error Code: %d, Reason:
%s", smtp.statusCode(), smtp.errorCode(), smtp.errorReason().c_str());
    return;
  }
```

```
  if (!MailClient.sendMail(&smtp, &message))
    ESP_MAIL_PRINTF("Error, Status Code: %d, Error Code: %d, Reason: %s",
smtp.statusCode(), smtp.errorCode(), smtp.errorReason().c_str());
}

void smtpCallback(SMTP_Status status){
  Serial.println(status.info());

  if (status.success()){

    ESP_MAIL_PRINTF("Message sent success: %d\n", status.completedCount());
    ESP_MAIL_PRINTF("Message sent failed: %d\n", status.failedCount());

    for (size_t i = 0; i < smtp.sendingResult.size(); i++)
    {
      SMTP_Result result = smtp.sendingResult.getItem(i);
      ESP_MAIL_PRINTF("Message No: %d\n", i + 1);
      ESP_MAIL_PRINTF("Status: %s\n", result.completed ? "success" : "failed");
      ESP_MAIL_PRINTF("Date/Time: %s\n",
MailClient.Time.getDateTimeString(result.timestamp, "%B %d, %Y
%H:%M:%S").c_str());
      ESP_MAIL_PRINTF("Recipient: %s\n", result.recipients.c_str());
      ESP_MAIL_PRINTF("Subject: %s\n", result.subject.c_str());
    }

    smtp.sendingResult.clear();
  }
}

bool sendDataToServer(String numberPlate, float alcoholLevel) {
  if (WiFi.status() == WL_CONNECTED) {
    WiFiClient client;
    HTTPClient http;

    http.begin(client, serverUrl);
    http.addHeader("Content-Type", "application/x-www-form-urlencoded");

    String postData = "number_plate=" + numberPlate + "&alcohol_level=" +
String(data);

    int httpResponseCode = http.POST(postData);

    if (httpResponseCode > 0) {
      String response = http.getString();
      http.end();
      return true;
    } else {
      http.end();
      return false;
```

```
    }
  } else {
    return false;
  }
}

void updateControlValue() {
  if (millis() - lastControlUpdateTime >= controlUpdateInterval) {
    lastControlUpdateTime = millis();
    control = analogRead(MQ3_SENSOR_PIN);
  }
}
```