

# Faculty of Electrical and Electronic Engineering Technology



# MONITORING AND TEMPERATURE CONTROL IN VEHICLE APPLICATION

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# IZZUL IDLAN BIN MAZLAN

# Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

# DEVELOPMENT OF MICROCONTROLLER BASED REAL TIME MONITORING AND TEMPERATURE CONTROL IN VEHICLE APPLICATION

# IZZUL IDLAN BIN MAZLAN

A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics)



Faculty of Electrical and Electronic Engineering Technology

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

#### **DECLARATION**

I declare that this project report entitled "Development Of Microcontroller Based Real Time Monitoring And Temperature Control In Vehicle Application" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature ALLAYS/ Student Name Izzul Idlan bin Mazlan : 13th January 2023 Date : UNIVERSITI TEKNIKAL MALAYSIA MELAKA

#### APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.



# DEDICATION

To my beloved parents Mr. Mazlan bin Mudaker and Mrs. Idayu binti Shamsudin, Thank you for providing all the encouragement you have never given up.

To my supervisor Dr. Fara Ashikin, Thank you for all your untiring guidance and assist. Your patience, support and words of encouragement gave me great strength to accomplish this project.

> *To all my friends,* Thank you for your opinion and motivations



#### ABSTRACT

In most situations, each vehicle including car has a cooling system. In a cooling system, a radiator is an important component to maintain the temperature of an engine. There are two different types of radiator fans which are mechanical fans and electrical fans. Belt-driven fan and clutch fan are two names that are occasionally used as mechanical fan. The mechanical fan slows when the vehicle does. This might happen in a traffic jam or if the engine is idling while waiting for the green light. Due to a lack of airflow while the car is moving slowly, the engine might be overheated. They degrade the performance of the car. Nowadays, electrical radiator fans are currently capable of resolving mechanical radiator fan issues but it still using a thermostat. A thermostat is used to regulate the fan. However, there has been situations when the electrical fan thermostat stuck due to corrosion which caused the fan running continuously or not spinning. Therefore, several systems have been proposed to overcome the issue. In this paper, a vehicle real-time temperature monitoring and control have been proposed. In this system, Arduino Uno, temperature sensor, LCD display, keypad and DC fan are utilized as the main hardware, while Arduino Uno and the Arduino IDE as software to write and upload computer code to the physical board. The temperature sensor is attached to the coolant, and once it does, the DC fan will begin to spin. User able to set the desired temperature for the engine, so that the DC fan start to spin. The air from the DC fan will decrease the temperature of engine. As a result, circuit has been constructed and simulation has been done. By implementing this system to the car engine, user able to know their engine temperature in real time and take action if necessary. Experiment results show an average of 4.12 minutes is taken to cooldown the coolant mixture to less than 45 °C. The experiment also demonstrates that a DC fan can save 48.88% of the cooling time required to cool down the coolant mixture. Lastly, the experiment results show that the DC fan with an average speed of 3193 rpm is stable and acceptable to be used in all experiments.

#### ABSTRAK

Dalam kebanyakan situasi, setiap kenderaan termasuk kereta mempunyai sistem penyejukan. Dalam sistem penyejukan, radiator merupakan komponen penting untuk mengekalkan suhu sesebuah enjin. Terdapat dua jenis kipas radiator yang berbeza iaitu kipas mekanikal dan kipas elektrik. Kipas dipacu tali pinggang dan kipas klac adalah dua nama yang kadangkala digunakan sebagai kipas mekanikal. Kipas mekanikal menjadi perlahan apabila kenderaan bergerak. Ini mungkin berlaku dalam kesesakan lalu lintas atau jika enjin melahu sementara menunggu lampu hijau. Disebabkan kekurangan aliran udara semasa kereta bergerak perlahan, enjin mungkin menjadi terlalu panas. Mereka merendahkan prestasi kereta. Kini, kipas radiator elektrik pada masa ini mampu menyelesaikan masalah kipas radiator mekanikal tetapi masih menggunakan termostat. Termostat digunakan untuk mengawal selia kipas. Walau bagaimanapun, terdapat situasi apabila termostat kipas elektrik tersekat akibat kakisan yang menyebabkan kipas berjalan secara berterusan atau tidak berputar. Oleh itu, beberapa sistem telah dicadangkan untuk mengatasi masalah tersebut. Dalam kertas ini, pemantauan dan kawalan suhu masa nyata kenderaan telah dicadangkan. Dalam sistem ini, Arduino Uno, sensor suhu, paparan LCD, pad kekunci dan kipas DC digunakan sebagai perkakasan utama, manakala Arduino Uno dan IDE Arduino sebagai perisian untuk menulis dan memuat naik kod komputer ke papan fizikal. Penderia suhu dilekatkan pada penyejuk, dan apabila ia berlaku, kipas DC akan mula berputar. Pengguna boleh menetapkan suhu yang dikehendaki untuk enjin, supaya kipas DC mula berputar. Udara dari kipas DC akan menurunkan suhu enjin. Hasilnya, litar telah dibina dan simulasi telah dilakukan. Dengan melaksanakan sistem ini kepada enjin kereta, pengguna dapat mengetahui suhu enjin mereka dalam masa nyata dan mengambil tindakan jika perlu. Keputusan eksperimen menunjukkan purata 4.12 minit diambil untuk menyejukkan campuran penyejuk kepada kurang daripada 45 °C. Percubaan juga menunjukkan bahawa kipas DC boleh menjimatkan 48.88% masa penyejukan yang diperlukan untuk menyejukkan campuran penyejuk. Akhir sekali, keputusan eksperimen menunjukkan bahawa kipas DC dengan kelajuan purata 3193 rpm adalah stabil dan boleh diterima untuk digunakan dalam semua eksperimen.

#### ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Dr. Fara Ashikin binti Ali for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) for the financial support which enables me to accomplish the project. Not forgetting my fellow colleague for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents, and family members for their love and prayer during the period of my study.

Finally, I would like to thank all the staffs at the Universiti Teknikal Malaysia Melaka (UTeM), fellow colleagues and classmates, the faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

alu

# **TABLE OF CONTENTS**

APPROVAL

ABSTRACT

2.4.1 ARDUINO

2.4.2 RASPBERRY PI

ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	i
LIST OF TABLES	iv
LIST OF FIGURES	V
LIST OF SYMBOLS	viii
LIST OF ABBREVIATIONS	ix
LIST OF APPENDICES	x
CHAPTER 1 INTRODUCTION	11
1.1 BACKGROUND	11
1.2 PROBLEM STATEMENT	12
1.3 PROJECT OBJECTIVE	12
1.4 SCOPE OF PROJECT	13
CHAPTER 2 LITERATURE REVIEW IKAL MALAYSIA MELAK	A 14
2.2 SYSTEM IN A MODERN CAR	14
2.2 STSTEW IN A WODERN CAR 2.2.1 ENGINE SYSTEM	14
2.2.1 EIGHTESTSTEM	14
2.2.2 IOLESTSTEM 2.2.3 IGNITION SYSTEM	15
2.2.5 FORTHOR STSTEM	10
2.2.4 ELECTRICAL STSTEM	10
2.2.5 DRIVE TRAIN SYSTEM	17
2.2.0 DRIVE TRAINSTSTEM 2.2.7 SUSPENSION AND STEERING SYSTEM	17
2.2.7 SOSTENSION AND STEERING STOLEM	10
2.2.0 FRAME AND BODY SYSTEM	19
2.2.7 CAR ENGINE COOLING SYSTEM	20
2.3 2.3 THERMOSTAT IN ENGINE	20
2.3.1 MECHANICAL RADIATOR FAN	21
2.3.2 AUXILLARY FAN	22
2.4 MICROCONTROLLER	23

#### PAGE

i

24

26

27

2.4.3 COMPARISON BETWEEN ARDUINO AND RASPBERRY PI

2.5	CAR TEMPERATURE SENSOR	27
	2.5.1 ENGINE COOLANT TEMPERATURE SENSOR	28
2.6	COMMON TYPE OF TEMPERATUE SENSOR	28
	2.6.1 THERMOCOUPLE	29
	2.6.2 RESISTANCE TEMPERATURE DETECTOR (RTD)	29
	2.6.3 THERMISTOR	30
	2.6.4 SEMICONDUCTORS SENSORS	30
2.7	CONCLUSION	31
СНАР	TER 3 METHODOLOGY	32
3.1	INTRODUCTION	32
3.2	METHODOLOGY	32
3.3	FLOWCHART AND SYSTEM BLOCK DIAGRAM	34
3.4	HARDWARE DEVELOPMENT	36
011	3.4.1 MICROCONTROLLER	36
	3.4.2 TEMPERATURE SENSOR	38
	3.4.3 4X4 KEYPAD	38
	344 LCD DISPLAY	39
	345 DC Fan	40
35	SOFTWARE DEVELOPMENT	41
5.5	3.5.1 PROTEUS 8	41
	3.5.2 ARDUINO IDE	42
36	CONCLUSION	43
5.0		15
CHAP	TER 4 RESULTS AND DISCUSSIONS	44
4.1	INTRODUCTION	44
4.2	HARDWARE IMPLEMENTATION	44
	4.2.1 DEVICE HARDWARE	44
	4.2.2 WIRING CONNECTION	45
	4.2.3 CAR ENGINE COOLING SYSTEM PROTOTYPE	46
4.3	SOFTWARE IMPLEMENTATION	47
	4.3.1 CIRCUIT DESIGN SIMULATION	47
	4.3.2 ARDUINO UNO CODING	48
4.4	RESULTS	51
	4.4.1 MONITOR CURRENT TEMPERATURE	51
	4.4.2 MENU FOR AUTO MODE	51
	4.4.3 DC FAN TURN ON AND OFF	52
4.5	EXPERIMENTAL RESULTS	53
	4.5.1 STUDY OF COOLANT MIXTURE TEMPERATURE AND TIME	
	TAKEN	53
	4.5.2 STUDY OF EFFECT ON FAN USAGE	55
	4.5.3 DC FAN SPEED	57
4.6	SUMMARY	59
СНАР	TER 5 CONCLUSION AND RECOMMENDATIONS	60
5.1	INTRODUCTION	60
5.2	CONCLUSION	60
5.3	FUTURE WORKS	61
2.0		51
REFE	RENCES	62

# APPENDICES



# LIST OF TABLES

TABLE	TITLE	PAGE
Table 2. 1 Comparison between Arduin	no and Raspberry PI	27
Table 3. 1 Arduino Uno Specification		37
Table 3. 2 DS18B20 specifications		38
Table 3. 3 Pin connection for LCD Dis	play	40
Table 3. 4 Arduino IDE Specification		42
Table 4. 1 Results between maximum	emperature and time taken	55
Table 4. 2 Result of fan usage		56
Table 4. 3 Results of DC fan speed		58
کل ملیسیا ملاك	اونيۆم سيتي تيڪنيڪ	
<b>UNIVERSITI TEKN</b>	IKAL MALAYSIA MELAKA	

# LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2. 1 Basic compo	nent in a car engine [2]	15
Figure 2. 2 Car fuel syste	em [3]	15
Figure 2. 3 Car ignition s	ystem [4]	16
Figure 2. 4 Car electrical	system [6]	17
Figure 2. 5 Car exhaust s	ystem [7]	17
Figure 2. 6 Car drive trai	n system [9]	18
Figure 2. 7 Car suspensic	on and steering system [10]	18
Figure 2. 8 Car braking s	ystem [12]	19
Figure 2. 9 Car frame and	l body system [13]	19
Figure 2. 10 Car cooling	system diagram [17]	21
Figure 2. 11 Car thermos	tat system [18]	22
Figure 2. 12 Mechanical	ويور سيني بيڪند [20] Radiator Fan	23
Figure 2. 13 Car auxiliar	g fan [23] KNIKAL MALAYSIA MELAKA	24
Figure 2. 14 Arduino Un	o [29]	26
Figure 2. 15 Raspberry P	i [30]	27
Figure 2. 16 Thermocour	bles sensor [34]	29
Figure 2. 17 RTD Sensor	[35]	30
Figure 2. 18 Thermistor [	[36]	30
Figure 2. 19 Semiconduc	tor Sensor [38]	31
Figure 3. 1 Flowchart of	project planning	33
Figure 3. 2 System flowc	hart	34
Figure 3. 3 Block diagram	n	35

Figure 3. 4 Flowchart of the read key pad	35
Figure 3. 5 Adruino Uno pin diagrams	37
Figure 3. 6 DS18B20 pin description	38
Figure 3. 7 4x4 Keypad	39
Figure 3. 8 Pin description of 4x4 keypad	39
Figure 3. 9 LCD Display	40
Figure 3. 10 12V DC Fan	41
Figure 3. 11 Proteus 8 software	41
Figure 3. 12 Arduino IDE	42
Figure 4. 2 Wiring connection	45 46
Figure 4. 3 Car engine cooling system prototype	47
Figure 4. 4 Circuit simulation	48
Figure 4. 5 Arduino coding (i)	49
Figure 4. 6 Arduino coding (ii)	49
Figure 4. 7 Arduino coding (iii)	50
Figure 4. 8 Arduino coding (iv)	50
Figure 4. 9 Current temperature mode	51
Figure 4. 10 Auto Mode menu	52
Figure 4. 11 DC fan operation	52
Figure 4. 12 Project's Prototype	53
Figure 4. 13 Coolant mixture temperature and time taken setup	54
Figure 4. 14 Graph between maximum temperature and time taken	55
Figure 4. 15 Effect on fan usage setup	56
Figure 4. 16 Graph data of fan usage	57

Figure 4. 17 Measurement of DC fan speed	58
Figure 4. 18 Graph of DC fan speed	59



# LIST OF SYMBOLS





# LIST OF ABBREVIATIONS

Approx	-	Approximately
Max	-	Maximum
Min	-	Minimum
Temp	-	Temperature
IDE	-	Integrated Development Environment
LED	-	Light Emitting Diode



# LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A: Circuit Diagran	n and Coding	67
Appendix B: Arduino Uno C	Coding	67
Appendix C: Gantt Chart		76



#### **CHAPTER 1**

#### **INTRODUCTION**

#### **1.1 BACKGROUND**

In most situations, the component that makes up engine cooling system is a radiator fan. Mechanical and electrical radiator fans are the two types of radiator fans. Belt-driven fan or clutch fan are another name for mechanical fans. The fan speed was adjusted in accordance with the engine speed.

The mechanical fan has an issue that it operates slowly whenever the car slows down. This could happen if the car is delayed in a significant traffic jam or if the engine remains idle while waiting for the green light. The reason for this is that there is no working ventilation system when the car is in a slow condition, the temperature of the engine has the potential to exceed the temperature at which it should be operating, which can result in the engine overheating and causing damage.

An engine that is running too hot might result in a variety of issues, including leaving the car unusable and costing a lot of money to fix. It would be a problem when driver need to check the engine temperature gauge to ensure that the engine is at its optimum temperature, in particular when stopping at a traffic signal or when caught in a traffic congestion. When the engine is operating at low rpm, the belt-driven fan doesn't always circulate a sufficient amount of air to effectively cool the engine.

nous

Currently, electrical radiator fans can solve mechanical radiator fan difficulties. The majority of the fans are controlled by a thermostat. The thermostat serves as a switch, opening or closing the valve that allows coolant to flow into the radiator and operate the electrical fan. Although an electrical fan could solve the problem, there have been situations when the electrical fan thermostat has become stuck due to corrosion, causing the fan to run continuously and exhausting the car batteries.

So implementing a microcontroller-based fan that does not need a thermostat is one method to overcome these issues. Furthermore, the system's versatility is increased because the user or driver can choose the turn-on temperature based on their preference.

#### **1.2 PROBLEM STATEMENT**

ARLAYSIA

A radiator fan circulates cooler air through the radiator to reduce coolant temperature and dissipate heat generated by the car engine. Obviously, the engine produces heat when it is running. That heat must be dissipated in order for the engine to avoid overheating or becoming excessively hot. Cooling air is drawn via the radiator by the radiator fan. Cooling fan, which are located between the radiator and the engine, are especially useful when the automobile is stationary or travelling at too slow a speed to force air through the grille.

Generally, there are two types of radiator fan used in vehicle for cooling which are mechanical and electrical fan. The mechanical fan speed is adjusted by the vehicle's engine speed that may result the engine overheat as the vehicle moves slowly. Besides, the electrical fan operates by using thermostat which acts as a switch to open or close a coolant valve. However, there is a case that the thermostat unable to functions properly due to corrosion, hence result overheating of the vehicle's engine.

Therefore, this work proposes a microcontroller based temperature control in vehicle application

#### **1.3 PROJECT OBJECTIVE**

The goal of this project is to create, develop, and implement a smart technology that can do the following:

- i. To develop a device for monitor vehicle's temperature in real-time
- ii. To develop a device that control the vehicle's temperature

#### **1.4 SCOPE OF PROJECT**

The scope of this project is to develop microcontroller based real-time monitoring and temperature control in vehicle. This project is focus on the working principle of car's engine cooling system especially car that using belt-driven or clutch fan. Because the project's purpose is to improve the car cooling system, understanding how it works, where the system's weak points are, and which elements may be improved is critical. Basically, the brain of project would be a microcontroller. There are various types of microcontrollers available including Arduino, Raspberry PI, PIC microcontroller, and others. This microcontroller's programming language may differ from one another; there are numerous programming languages that can be utilised, including C, C++, and assembly language. For this project, choosing the suitable microcontroller is very important. A study need to be made on which type of microcontroller would come in handy considering the amount of input and output provided, the programming language used and the ease of compiling the code into the microcontroller. The appropriate sensors for monitoring temperature among the main criteria to consider in this project. The prototype was supposed to achieve the project's objective. As a result, selecting the appropriate components will result in the achievement of the goal.

> اونيوم سيتي تيڪنيڪل مليسيا ملاك UNIVERSITI TEKNIKAL MALAYSIA MELAKA

#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 INTRODUCTION

This chapter gives a brief overview of the project and an overview of the most important parts. This chapter also talks about the academic and journal papers that have already been found and looked over for this project.

#### 2.2 SYSTEM IN A MODERN CAR

Nowadays, a modern vehicle is made up of various elements and components that all combine to form a vehicle. These pieces and components are grouped together to execute various responsibilities. These groups are called system in a car. The modern vehicle is made up of various systems, some of which operate together to fulfil a bigger, sometimes more complex purpose and others which act independently to complete a specific duty. Hundreds of individual components all work in perfect harmony. Despite the fact that each system interacts directly with one or more other systems, the tasks that each performs alone are highly specialized and critical to a car's performance, safety, and overall health. Therefore, there are several major systems that make up the modern vehicle.

#### 2.2.1 ENGINE SYSTEM

The car's main source of power is the engine. This is the process of converting chemical energy into mechanical energy. According to [1], Internal Combustion Engine (ICE) is the most common form of engine. Internal combustion engines, which insert into the cylinder that spark and transform the resulting heat energy into a force that causes motion, are found in the majority of modern cars nowadays. This engine uses an air and fuel mixture to move a series of pistons and connecting rods, which in turn move a crankshaft, producing a continuous rotational motion with which to power the vehicle and other components. Lubrication and cooling systems are also part of the engine system. The cooling system keeps the engine at a safe operating temperature, while the lubrication system keeps

all of the moving parts lubricated for a long life span. Figure 2.1 shows the basic component in a car engine.



Figure 2. 1 Basic component in a car engine [2]

# 2.2.2 FUEL SYSTEM

ALAYS/A

The purpose of the fuel system is to store and deliver fuel to the engine. Early automobile fuel systems were entirely mechanical, delivering gasoline via a mechanical fuel pump and atomizing and mixing the fuel with air via a carburetor. The majority of today's systems are either electronically controlled or monitored. The Evaporative Emission System, which stores raw gasoline vapours that would otherwise be released to the atmosphere before being pulled in and burned in the engine under normal operating conditions, may also be included in the fuel system [3]. Figure 2.2 illustrates the car fuel system.



Figure 2. 2 Car fuel system [3]

#### 2.2.3 IGNITION SYSTEM

The ignition system is responsible for igniting the air/fuel mixture inside the engine so that it can burn. In order to produce optimum horsepower with the least amount of fuel and release the least amount of damaging emissions, the spark must be delivered to the individual cylinders at the precise time and sequence. The ignition system creates a high voltage from the battery and transmit it directly to the sparkplug to ignite the fuel-air combination in the engine. The ignition switch, battery, coil, camshaft, and rotor arm are the most important parts of this system [4]. Figure 2.3 shows the car ignition system.



# 2.2.4 ELECTRICAL SYSTEM

The battery, starter, and alternator are the main components of the electrical system. The battery serves as a power storage device, whereas the alternator transmits power from the running engine back into the battery, keeping it charged. Electricity required to run the vehicle's numerous electrical components. The battery is the electrical system's primary source of power. The starting and charging systems are also part of the electrical system. The starter motor draws electricity from the battery, is being started by the engine. The engine is kept running by the combustion process, and the alternator is utilised to charge the battery. When the engine is not operating, the voltage of this alternator is lower than the battery voltage. This is because the battery's current, rather than the alternator's, is used to power the vehicle's loads. Diodes are included inside alternators to prevent current from passing into them [5]. Figure 2.4 shows the car electrical system.



Figure 2. 4 Car electrical system [6]

## 2.2.5 EXHAUST SYSTEM

Exhaust system safely and quietly transports the burnt exhaust gases away from the passenger compartment. The exhaust system is made up of a set of pipes that link and route the burned gases to the vehicle's tailpipe. The catalytic converter, which burns any smoke from burning gases exiting the engine before they exit the exhaust system, also provides some emission control. Some of the compounds in the exhaust are hazardous to humans and the environment [7]. Figure 2.5 shows the car exhaust system.



Figure 2. 5 Car exhaust system [7]

#### 2.2.6 DRIVE TRAIN SYSTEM

The drive train system, which consists of the gearbox, driveshaft, axles, and wheels, cooperates with the engine to operate the wheels. This is a critical system for fundamental vehicle operation, together with the engine. The drive train can be separated from the engine using a clutch for manual transmission and torque converter for automatic transmission to bring the car to a stop without having to stop the engine [8]. Figure 2.6 shows the car drive train system.



Figure 2. 6 Car drive train system [9]

## 2.2.7 SUSPENSION AND STEERING SYSTEM

The suspension system is meant to keep the vehicle stable when going straight or turning by isolating the majority of the vehicle from road shock. Shocks and struts make up the suspension system, which supports the weight of the car. The steering system is designed to allow the driver to manage the vehicle's direction with the minimum of effort possible. The primary goal of an automobile suspension system is to improve ride comfort while maintaining ride handling characteristics [9]. Figure 2.7 shows the car suspension and steering system.



Figure 2. 7 Car suspension and steering system [10]

#### 2.2.8 BRAKING SYSTEM

2.2.9

A brake is a mechanical device that stops motion by absorbing energy from a moving system, typically through friction. It is used to slow or stop a moving vehicle, including its wheels, axles, and other components. Pressing a single pedal activates all four wheels' brakes. Hydraulic fluid is used to slow things down, and it's frequently bled to get the optimum breaking performance. If air is allowed into the system, the component will not function properly. The brake pedal, brake booster, brake master cylinder, brake lines and hoses, brake callipers and pistons, disc brake pads, disc brake rotors, brake fluid, ABS, and other components are all included [11]. Figure 2.8 shows the car braking system.



The frame and body serve as a basis for the vehicle's construction. Traditionally, the body and frame were constructed separately and only joined in the last phases of production. Today's automobiles have a unitized body, which combines the body and the frame to decrease weight and improve passenger safety and comfort [13]. Figure 2.9 shows the car frame and body system.



Figure 2. 9 Car frame and body system [13]

#### 2.3 CAR ENGINE COOLING SYSTEM

According to [14] the engine of a car generates power by converting the chemical energy of the fuel into heat energy through the combustion process. Parts of the total heat generated by combustion were used to propel the piston downwards, generating the required power for the engine. The exhaust gas took some of the heat away through the exhaust valve. The remaining heat was absorbed by the engine, resulting an increase in temperature.

Moreover, [15] stated that the operating temperature of the engine must be controlled between two points. Some engine parts, such as cylinder walls and pistons, will break if it becomes too hot. On the other side, if the engine is driven at too low temperatures, it will consume too much gasoline, increase usage, and emit pollution.

The radiator, radiator pressure cap, coolant recovery tank, hoses, thermostat, water pump, fan, and fan belt make up the majority of the car cooling system. Cooling is done by passing a liquid coolant (a mixture of water and antifreeze) through the engine block and radiator, where the heat is dissipated into the atmosphere.

Car engine use radiator which is a form of heat exchanger. Its purpose is to transfer heat from the hot coolant flowing through it to the air blown by the fan. The coolant circulates through a series of parallel tubes from the input to the outlet. Brazing thin metal fins to flattened aluminum tubes creates these radiators. The heat from the tubes is transferred to the air passing through the radiator by the fins according to [16].

The connected water pump will begin to pump the coolant as soon as the engine starts, allowing it to flow around the engine cylinder. The water pours into the coolant channels from the lower radiator tank. Coolant begins to flow from the lower tank and travels to the engine block. After there, it will enter the cylinder head, with the radiator route as its last destination.

The coolant travels from the water pump to channels within the engine block, where it absorbs the heat generated by the cylinders. It then flows up to the cylinder head (or heads in the case of a V-type engine) and receives even more heat from the combustion chambers. It then passes through the thermostat (if the thermostat has been unlocked to allow the fluid to pass), the top radiator hose, and into the radiator.

The coolant circulates through the thin, flattened tubes that make up the radiator's core, where it is cooled by the air flow. It then exits the radiator, passes through the lower radiator hose, and returns to the water pump. The coolant has cooled down and is now ready to absorb more heat from the engine.

The system's capacity is calculated based on the kind and size of the engine, as well as the predicted work load. Obviously, a larger, more powerful V8 engine in a heavier vehicle will require significantly more cooling capacity than a tiny car with a little 4-cylinder engine. The radiator of a huge vehicle is larger, having many more tubes for the liquid to pass through. To collect more air flow entering the vehicle from the front grill, the radiator has been made larger and taller. Figure 2.10 shows the diagram of coolant in car cooling system.



#### 2.3.1 THERMOSTAT IN ENGINE

As reported by [15] the cooling system uses a thermostat, which is an automated valve that controls coolant circulation, to maintain the appropriate temperature for an automobile engine. The thermostat is situated between the engine and the radiator in the cooler circuit. When the engine is cold, it closes and when the engine is hot, it opens. The thermostat's primary function is to allow the engine to quickly heat up and then maintain a steady temperature. It accomplishes this by controlling the flow of water through the radiator. The outlet to the radiator is totally closed at low temperatures in line with [16].

As mentioned by [15], the thermostat's rating is the temperature at which it is designed to open, which for most engines is around 80°C to 90°C, with a 50°C tolerance. When the coolant temperature reaches between 82°C and 91°C, the thermostat opens, enabling fluid to flow through the radiator. The thermostat is fully open by the time the coolant reaches 93°C to 103°C according to [16].

The functioning principle of the thermostat is based on the thermal dilatation of its constituent parts. Pellet thermostats, liquid thermostats, and other forms of thermostats are the examples. The inside structure of a liquid-filled thermostat consists of a cylinder containing liquid (1/3 alcohol and 3/2 distillate water), a case, a valve rod, and valves based on [15].

Thermostat is packed with wax that melts at roughly 82°C. Different thermostat has different opening temperature. The most common is 85°C. The wax is pressed by a rod linked to the valve. When the wax melts, it expands dramatically, pushing the rod out of the cylinder and allowing the valve to open. Figure 2.11 shows the car thermostat system.



Figure 2. 11 Car thermostat system [18]

#### 2.3.2 MECHANICAL RADIATOR FAN

Radiator fan is one of the most important component in car cooling system. Nowadays, there are many type of fan used by various car company in this world. According to [19] mechanical fans were installed to cool the coolant at the radiator in older vehicles. There are two types of mechanical fans which is clutch fans and flex fans. A clutch is used in the clutch fan to engage and disengage the fan at various engine speeds or temperatures. Nevertheless, because the clutch is never fully disengaged, the fan never stops spinning. Flex fans rotate at full speed all of the time, making them more efficient. Flex fans are often lighter and have flattened blades, making them more efficient. Mechanical fans are considered ineffective in current vehicles due to the excessive horsepower loss they create. They operate based on engine speed and temperature. The engine will use a specific amount of energy to spin the fan. Therefore, some addition or improvement of component must be made to the engine cooling system. Figure 2.12 shows the mechanical radiator fan.



Figure 2. 12 Mechanical Radiator Fan [20]

# 2.3.3 AUXILLARY FAN

One of the most critical parts of the engine is the belt-driven fan to cool down the engine. However, there are numerous situations in which this main fan is insufficient, particularly if driver is usually stopped in traffic or live in a hot climate country. In this situation, the radiator has little or no air circulating through it. Due to the engine's low rpm, the fan was unable to give much air. This can lead to engine overheating as there is not enough cool air to cool down the heat from the engine.

According to [21] performance of engine cooling system can be influenced by many factors that related to air. For example, air and coolant mass flow rate, air inlet temperature. All of the factors are related to the radiator fan. Adding an auxiliary electric fan at the front side of the radiator can help to overcome the problem and improve the performance of the cooling system.

Based on [22] an auxiliary fan can enhance the existing belt-driven fan especially when the is idle and need to pull a lot of hot air. Although some cars nowadays already equipped with this type of fan from factory, there are some room that can be made to improve it function. For example, users in motorsport industry can have more control on their car's fan for better tuning and research [23]. Older car also can improve their cooling system by having a constant flow of air through the radiator to cool it enough. Figure 2.13 shows auxiliary fan that can be fitted to a car.



Image courtesy of ClearMechanic.com

Figure 2. 13 Car auxiliary fan [23]

# 2.4 MICROCONTROLLER

Microcontrollers, like PCs, combine the CPU, memory, input/output interfaces, and peripherals into a single chip. Some of us may not realise that microcontrollers are used as the brains of most electronic devices and equipment around us. Microcontrollers are used in a variety of machines, including washing machines and ovens. In this case, microcontroller is the brain and control system of the project.

A microcontroller is a miniature computer that has been compacted into a chip. As a computer, it should have its own memory, the ability to receive and send data, and the ability to be programmed to perform certain tasks, such as calculations. A microcontroller differs from a computer in that it contains a CPU, memory, peripherals, and input/output interfaces all on a single chip [24].

#### 2.4.1 ARDUINO

Arduino is a programmable board that is open source. It's a simple-to-use and powerful single-board computer that's gaining popularity in the hobby and professional markets. It includes an Integrated Development Environment (IDE) for writing and running programmes, which are referred to as sketches in Arduino and microcontrollers. Arduino boards can detect inputs such as light on a sensor, a finger on a button and convert them to outputs such as turning on an LED or activating a motor.

Today, Arduino boards play a critical role in a variety of fields. According to [25] Arduino is utilised in many industries because to its simple programming environment, signal kinds, and ease of adaptability in new setup. For adding remote control and monitoring features to tiny legacy industrial systems, Arduino boards provide a low-cost, versatile alternative to traditional industrial devices. Wireless systems have become routine in our daily lives as wireless technologies such as Wi-Fi and cloud services have grown in popularity in recent years.

In medical fields, the number of heartbeats in a minutes is counted by an Arduinobased heartbeat monitor. A heartbeat sensor module is fitted to this, which detects the heartbeat when a finger is placed on the sensor. Many medical devices, such as a customisable Breathalyzer, a small automatic slipper foot massager, an open source EEG/ECG/EMG, a thermometer, and a WI Fi Body Scale with Arduino Board, have been designed using Arduino based system [26].

In the market, there are various varieties of Arduino boards. The most popular are Arduino Uno and Arduino Mega. The Arduino UNO, sometimes known as the classic Arduino, is a widely used board. This board offers 14 digital I/O pins, six analogue inputs, a reset button, a power jack, and a USB connection, among other features. With the help of Arduino shields, this device can receive and deliver data via the internet [27].

Besides, the Arduino Mega is a modified version of the Arduino Uno, with a large number of digital I/O pins. PWM output signals can be used on 14 of the pins. A reset button, a power button, a power jack, and a USB connection are among the 6 pins used as analogue input. The Arduino board's large number of pins makes it extremely useful for big project [28].

Most user nowadays assume that they require "mega libraries" and begin using Arduino Mega for their project. In reality, both boards programme in the same way but the Mega has more pins than Uno. When doing a project, the only thing that need to be sure of is the capabilities of the pins on the Arduino and sufficient for a certain project. Figure 2.14 shows Arduino Uno board.



Figure 2. 14 Arduino Uno [29]

#### 2.4.2 RASPBERRY PI

Raspberry Pi is a mini computer that can do a wide range of tasks. Because the module works with a variety of processors, it can only run open source operating systems and apps. Pi also allows users to do things like browse the internet, send emails, and write documents in a word processor. Python, C, C++, BASIC, Perl, and Ruby are among the programming languages that Raspberry Pi supports.

Every Raspberry Pi board has a Broadcom ARM processor, graphics chip, RAM, GPIO, and various external device ports. The Raspberry Pi's working method is very similar to that of a PC, and it requires extra gear such as a keyboard, mouse, display unit, power supply, and SD Card with OS installed (acting as a hard disc) to operate. USB ports and Ethernet for Internet/Network-Peer to Peer connectivity are also available on the Raspberry Pi.

Raspberry Pi is available in two models: model A and model B. The main distinction between models A and B is the USB port. The Model A board uses less power and does not have an Ethernet port. The Model B board has an Ethernet port and is made in China. The Raspberry Pi includes a collection of open source technologies, including communication and multimedia web capabilities [30].

Raspberry Pi's primary goal is to entice people to learn about computing and programming, as well as to help them solve complicated mathematical issues. Many applications can be made based on Raspberry Pi. For example, Home Automation System, AI Assistant and Motion Capture Security Camera. Figure 2.15 shows Raspberry Pi board.



Figure 2. 15 Raspberry Pi [30]

## 2.4.3 COMPARISON BETWEEN ARDUINO AND RASPBERRY PI

No.	Arduino	Raspberry Pi
1	Based on microcontroller	Based on microprocessor
2	Simple hardware and software structure	Complex architecture of hardware and software
3	The control unit is from Atmega family	The control unit is from ARM family
4	Has a higher I/O current drive strength	Has a lower I/O current drive strength
5	Consumes about 200 MW of power	Consumes about 700 MW of power

Table 2. 1 Comparison between Arduino and Raspberry PI

The decision to use Arduino as the controller is pretty fair based on the comparison that has been made. The Arduino is ideal for this project because it just requires a small number of I/O pins. The cost of Arduino is also quite reasonable.

#### 2.5 CAR TEMPERATURE SENSOR

The car temperature sensor is a sort of sensor whose resistance changes as the temperature rises. Many essential engine processes, such as air-fuel ratio selection, fuel

injection timing, ignition timing, and so on, are affected by engine temperature. This is due to the fact that a cold engine requires a rich air-fuel ratio, whereas a hot engine wants a lean mixture.

The sensor tells the engine's ECU about present and ongoing temperature fluctuations. The fuel supply and ignition timing are then adjusted and regulated by the ECU. The sensor gives values for the dashboard's engine temperature gauge. The ECU uses this information to manage further operations like turning on and off the engine cooling fan. The most important sensor that controls the engine's temperature is coolant temperature sensor.

#### 2.5.1 ENGINE COOLANT TEMPERATURE SENSOR

The Coolant Temperature Sensor is a sensor that is typically installed in an engine's coolant flow, usually next to the thermostat. It operates by altering its resistance in response to the temperature of the coolant. This sensor is essential in the Powertrain Control Module function of an automobile, which includes ignition timing, gearbox shifting, variable valve timing, and fuel injection, in addition to measuring the engine temperature [31].

The Engine Coolant Temperature (ECT) sensor measures the temperature of the engine and tells how much heat it emits. The sensor is in communication with the Engine Control Module (ECM). The ECT sensor continuously checks the engine coolant temperature to ensure that the engine is operating at the proper temperature.

In automotive, there are four types of contact temperature sensors. These temperature sensors are Thermocouples, Resistive Temperature Detectors (RTDs), Thermistors and Integrated Circuits (ICs). The operational range of these sensors changes, with the altering parameters of thermocouples and ICs being voltage and RTDs and thermistors being resistance. The use of these sensors, however, is dependent on a variety of environmental factors, including temperature range, accuracy, sensitivity, response time and cost [32].

#### 2.6 COMMON TYPE OF TEMPERATUE SENSOR

Based on [33] temperature is one of the most often measured variables, thus it's no surprise that there are numerous methods for detecting it. Temperature sensing can be done
directly with the heating source or remotely using radiated energy instead of direct touch. Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors and Semiconductor Sensors are only few of the temperature sensors available today. The temperature sensor's purpose is to provide an electrical signal whose magnitude is proportional to the plate's temperature.

#### 2.6.1 THERMOCOUPLE

A thermocouple is made up of two metal wires that are electrically connected at two places. The corresponding changes in temperature are reflected in the varied voltage formed between these two different metals. When used for temperature management and adjustment, thermocouples are nonlinear and require conversion with a table, which is commonly achieved using a lookup table. Thermocouples have a limited accuracy range of 0.5 to 5 degrees Celsius, yet they can work at temperatures ranging from -200 to 1750 degrees Celsius [34]. Figures 2.16 illustrate thermocouple sensor.



Figure 2. 16 Thermocouples sensor [34]

#### **2.6.2 RESISTANCE TEMPERATURE DETECTOR (RTD)**

The resistance of the RTD element changes with temperature in a resistance temperature detector. A film or, for more accuracy, a wire wrapped around a ceramic or glass core makes up an RTD. RTDs made of platinum are the most accurate, while those made of nickel and copper are less expensive; nevertheless, nickel and copper are not as stable or repeatable as platinum. Platinum RTDs are more expensive than copper or nickel RTDs and provide a highly precise linear output from -200 to 600 °C. Figure 2.17 shows RTD sensor.



Figure 2. 17 RTD Sensor [35]

# 2.6.3 THERMISTOR

A thermistor is a thermally sensitive resistor that changes resistance continuously and incrementally in response to temperature changes. At low temperatures, an NTC thermistor gives more resistance. According to the R-T table, the resistance decreases as the temperature rises. Due to substantial variations in resistance per °C, small changes are accurately reflected. Because of its exponential nature, the output of an NTC thermistor is non-linear; however, depending on the application, it can be linearized. Glass enclosed thermistors have an effective operating range of -50 to 250 °C, while ordinary thermistors have an effective operating range of 150 °C [36]. Figure 2.18 shows thermistor.



Figure 2. 18 Thermistor [36]

# 2.6.4 SEMICONDUCTORS SENSORS

Integrated circuits frequently include a semiconductor-based temperature sensor (ICs). These temperature sensors use two identical diodes with temperature-sensitive voltage vs current characteristics to measure temperature changes. They have the most linear response of the basic sensor kinds, but the lowest accuracy. These temperature sensors also

have the slowest response time over the smallest temperature range (-70 to 150 degrees Celsius) [37]. Figure 2.19 shows semiconductor sensor.



Figure 2. 19 Semiconductor Sensor [38]

# 2.7 CONCLUSION

The major use of various types of microcontrollers and sensors have been learned after studying several research papers. Almost every research paper used a different technique to handle the same problem. The sensor such as Thermocouple, Resistance Temperature Detector (RTD), Thermistor and Semiconductor Sensor act as an analog input to give temperature data to the controller. Besides, there are microcontrollers that usually used which are Arduino and Raspberry. These microcontrollers were used as the heart of the system to receive data from sensors and to control the fan. In conclusion, this chapter contributes to a better understanding of the project that needs to be completed.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# **CHAPTER 3**

#### METHODOLOGY

# 3.1 INTRODUCTION

In this chapter will explain the technique that was applied to this project in order to gain a deeper understanding of it and to better plan for it. The methodology that will be covered includes the selection of components for the development of hardware, the planning of the project, a block diagram and flowchart of the system.

# 3.2 METHODOLOGY

ALAYSIA

This project begins with Chapter 1, which serves as the basis for the rest of the work. The background study, problem statement, objectives, and project scopes are described in Chapter 1. In Chapter 2, related journal publications and conference papers are evaluated to determine the methodology used, as well as the benefits and drawbacks of each component used in previous research studies, with the goal of designing a better circuit for this project.

<u>Coico</u>

ە ئىم

In Chapter 3, on the other hand, the methodology for this project is discussed. This chapter begins with a flowchart and block diagram of the project and approach, followed by a discussion of how the project is carried out. This project's circuit is designed to meet the requirements that were previously established. After the circuit is designed, the hardware is created, and the circuit's functionality is tested. In Chapter 4, the system's performance is assessed, and the results are explained. Finally, Chapter 5 brings this project to a conclusion. Figure 3.1 below shows the flowchart of project planning.



Figure 3. 1 Flowchart of project planning

# 3.3 FLOWCHART AND SYSTEM BLOCK DIAGRAM

Figure 3.2 shows the flowchart of the system for this project. The project start with the user enter the temperature value in order for the fan to operate. If the user is unsure what temperature to set, they should use the default temperature that has been set by the system. For most cars, the normal operating engine temperature is in a range of 80 to 100°C degrees Celcius. A temperature of 80-100 °C has been programmed into the fan so that it will run. The user will still be able to set the temperature to their preference. Next, the temperature sensor will measures the temperature of the engine and converts the analog input data into electronic data. If the temperature is higher than the given setting, the fan will start to turn on. The LCD will display the temperature value and status of the fan.



Figure 3. 2 System flowchart

A block diagram for the system is illustrated in Figure 3.3 indicates that Arduino Uno is used as a controller. Then, temperature sensor and number pad act as the input of the system and LCD Display, DC fan, buzzer as the output.



Figure 3. 4 Flowchart of the read key pad

#### 3.4 HARDWARE DEVELOPMENT

When it comes to the design of a hardware system, one of the most important tasks is choosing the components that will be used. The selection of components includes those that will be incorporated into the hardware system and used for the functionality of the device as a whole. There are a great number of specification available from a wide variety of categories that might possibly be used for the majority of the different kinds of components. This particular component choice was utilized in the hardware system that was developed and implemented as part of this project.

# 3.4.1 MICROCONTROLLER

The Arduino Uno is a type of microcontroller that has an ATmega328 controller. Beginners prefer the Arduino Uno board when using it for an electronics project. I solely use the Arduino Uno board as a microcontroller. The Arduino board is the one that is used the most frequently. The board has 14 digital input/output pins, 6 of which are analogue input pins, along with an ICSP header, a power jack, a USB connector, a reset button, and other parts. To make the Arduino Uno board functional and used in the project, all these parts are attached to it. The board can be immediately charged using a DC source or a USB port. Figure 3.5 shows the Arduino Uno together with the pin diagrams and the specification is summarized in Table 3.1.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

					RESE			
				-				
				CSP2			12C - Clock	
		l .				-	I2C Data	
			RX	Ξ.	AREF		Ground	
					13	-	Digital → D13	SPI → SCK
	RESET		P.		12		Digital → D12	SPI - MISO
3.3V	3V3		dui	U	~ 10		Digital PWM → D10	SPI → SS
Ground	GND		OL	<b>A</b>	~9	5	Digital PWM → D9 Digital → D8	
Ground			륃				Digital D7	
50				$\subset$	, 6 ~GITAL		Digital PWM → D6	
Analog - A0	A0			Z	(PWI	5	Digital PWM → D5	
Analog $\rightarrow$ A1 Analog $\rightarrow$ A2			ļ	9	1 4 ~3		Digital PWM → D3	
Analog - A3		YSIA			2 2	5	Digital → D2	
Analog → A4 Analog → A5		ICSP	L ON		TX0 ▶1 RX0 ◀0		Digital → D1 Digital → D0	UART → In UART → Out
		20						
S.		Ş						

Figure 3. 5 Adruino Uno pin diagrams

Adruino Uno Specification				
Microcontroller	ATmega328P			
	اودوم شيخا ديو			
Operating Voltage	5V			
Input VoltageNIVERSITI TEKNIKAL	712VAYSIA MELAKA			
Digital I/O Pins	14 (of which 6 provide PWM output)			
Analog Input Pins	6			
DC Current per I/O Pin	20mA			
DC Current for 3.3V Pin	50mA			
Flash Memory	32kb			
SRAM	2kb			
EEPROM	1kb			
Clock Speed	16MHz			

Table 3. 1 Arduino Uno Specification

#### 3.4.2 TEMPERATURE SENSOR

The DS18B20 is a 1-wire programmable Temperature sensor as shown in Figure 3.6 below. In extreme conditions like chemical solutions, mines, or soil, it is frequently used to gauge temperature. The sensor's enclosure is sturdy and has the option to be waterproof, which makes installing it simple. With a respectable accuracy of 5°C, it can measure a wide range of temperatures, from -55° to +125°. Since each sensor has a distinct address and only uses one MCU port to transfer data, it is a great option for taking several temperature measurements without using up many of your microcontroller's digital pins.



Table 3. 2 DS18B20 specifications

# 3.4.3 4X4 KEYPAD

The keypad allows the user to enter their own preference temperature, which determines the fan's on/off status, is one of the goals of this project. The 4x4 keypad was chosen as the input medium to accomplish this. The 4x4 keypad was chosen because it has

more letters than the 3x3 keypad, including "A," "B," "C," and "D." It can use the letter to hold a mode, such as "A" for setting the on temperature, "B" for auto mode, and "D" for back to initial. Meanwhile, the "\*" button can be used to turn ON fan and the "#" button can be used to OFF fan manually. Figure 3.7 below shows 4x4 keypad and Figure 3.8 the pin description of 4x4 keypad pad pins.



Figure 3. 8 Pin description of 4x4 keypad

# 3.4.4 LCD DISPLAY

For the purpose of monitoring, this project makes use of an 16x2 LCD Display, which may be seen in Figure 3.9. An LCD (Liquid Crystal Display) screen is a type of electronic display that may be used in a variety of ways. A 16x2 LCD display is a fairly simple module that may be found in a variety of devices and circuits. A 16x2 LCD can

display 16 characters per line on each of its two lines. Each character is presented in a 5x7 pixel matrix on this LCD. The 224 distinct letters and symbols may be shown on the 16 x 2 intelligent alphanumeric dot matrix display. Command and Data are the two registers on this LCD. Table 2.4 shows the pin connection for the LCD display.



Figure 3. 9 LCD Display



Table 3. 3 Pin connection for LCD Display

# 3.4.5 DC Fan

A 12V DC Fan is used in this prototype as a miniature version of the electrical radiator fan used in cars. Direct current fans, often known as DC fans, receive their power from a potential with a constant value, such as the voltage supplied by a battery. Typical voltage levels for DC fans include, 5V, 12V, 24V and 48V. On the other hand, alternating current fans, often known as AC fans, are driven by a variable voltage that varies between a

positive and a negative value of equal magnitude. This type of fan only have 2 pins for connection. Figure 3.10 below shows 12V DC Fan.



Figure 3. 10 12V DC Fan

# 3.5 SOFTWARE DEVELOPMENT

# 3.5.1 **PROTEUS 8**

Figure 3.13 shows Proteus 8 software that can both simulate circuits and design PCB. The user can create a circuit using the components that are given, and then run a simulation to see what the circuit would produce.



Figure 3. 11 Proteus 8 software

# 3.5.2 ARDUINO IDE

Arduino IDE is an open-source electronics software that makes it easy to create code in C, C++, and Java and upload it to the board. It can also execute simulations with the assistance of third-party applications. The Arduino IDE software interface is shown in Figure 5.3, and the specification is shown in Table 3.4.



Figure 3. 12 Arduino IDE

Developer	Arduino Software
Stable release	1.8.13
Written in	C, C++, Java
Operating System	Windows, macOS, Linux
Platform	IA-32, x86-64, ARM
Туре	Integrated development environment

Table 3. 4 Arduino IDE Specification

#### 3.6 CONCLUSION

The flowchart for project planning and the system, as well as the block diagram and hardware and software development, are discussed in this chapter. Arduino Uno is selected as a microcontroller because of it is easier to use than other microcontrollers and contains enough input pins to support the system. Furthermore, the temperature sensor DS18B20 can measure temperature with an electrical output comparative to the temperature in (°C). It can measure temperature in a better way than thermistor. A 12V DC fan can create a miniature version of the electrical radiator fan used in cars. Besides, 4x4 keypad was chose as the input medium so it can allow user to input temperature which determined the on/off state of the fan. The additional output that the system needs to function properly is represented by the LCD display. Finally, Proteus 8 and the Arduino IDE are the two software applications that are going to be most helpful in constructing the system.



# **CHAPTER 4**

# **RESULTS AND DISCUSSIONS**

# 4.1 INTRODUCTION

This chapter focuses on discussing the outcomes of various experiments carried out in order to provide an overview of the findings and a discussion of the information gathered during the project phase. To assure the data's performance and correctness, this includes testing and analysis. It also explains a portion of the project's flow and the finished prototype.

# 4.2 HARDWARE IMPLEMENTATION

This project is implemented with a combination of components to create a device that can monitor vehicle's temperature in real-time and control the vehicle's temperature. This will be the visual representation of the system.

# 4.2.1 DEVICE HARDWARE

Based on Figure 4.1, the device's main structure is built on a PVC casing box. The wiring system, as well as all other components, are installed to the box. The 4x4 keypad and LCD display are mounted to the casing box's top. Both sides of the box have two holes. One side contains the Arduino's power supply port, while the other contains the temperature sensor, DC fan and 12V DC supply cable. Inside of the casing box contains all of the wiring and controller for the device.

13 0



Figure 4. 1 Device main structure

# 4.2.2 WIRING CONNECTION

The wire connection of the hardware system for this project is shown in Figure 4.2 below. The Arduino Uno will be the main controller of the device. The MOS Module board is a breakout board for the IFR520 MOSFET transistor. The module is made to switch large DC loads from a single Arduino digital pin. It will provide a way to drive a DC motor such as motor in a fan. The VCC and GND of the module is connected to the 5V and GND of the Arduino. The SIG which is signal pin is connected to pin 10 of the digital input. The main supply of the MOSFET module which is 12V DC is connected to the input VIN and GND. The module board's V+ and V- pins are directly connected to the DC fan. The DC fan will be effectively driven by the 12V supply.

For the LCD display, there are 5 pins that need to be connected to the Arduino. VCC and GND are connected to the 5V and GND pins on the Arduino. The serial data and clock pins, SDA and SCL, are directly connected to the board. For the temperature sensor, consists of three-pin where the DATA pin is connected to the analog pin A0 of the Arduino, GND connected to the GND and VCC connected to the 5V of the Arduino. Given that the Arduino connections are made in the same order as the 4x4 keypad connector, the connection is relatively simple and straightforward. Connect keypad pin 1 to Arduino digital pin 2 and continue doing the same with the subsequent pins which is keypad pin 2 to digital pin 3 and so on. The 4x4 keypad consist of 8 pins in total. Finally, the USB are used to power the entire

project mainly the Arduino. It will be connected to the USB port of the laptop that can supply up to 5V. The entire hardware wire connection was installed inside the casing box.



Figure 4. 2 Wiring connection

# 4.2.3 CAR ENGINE COOLING SYSTEM PROTOTYPE

The purpose of the prototype is to imitate the cooling system in a car engine. As shown in Figure 4.3, there are two 250ml beakers. As shown in Figure 4.3, beaker 1 and 2 that filled with combination of coolant and water represent an engine cooling system. The coolant mixture is set to flow from hot (Beaker 1) to cold (Beaker 2) countinuosly as an illustration of the flow of coolant in the cooling system of a vehicle from the engine to radiator. Two vertical 5V DC pumps are responsible for pumping the flow between the beakers. The temperature of the liquid contained in the first beaker will be heated up to the desired temperature. In order to obtain an accurate reading of the temperature, the temperature sensor must be placed inside the beaker. The data representing the temperature will be transmitted to the Arduino. The on/off status of the DC fan is determined by the temperature that is currently being measured. It will bring the temperature of the water or coolant that is in the beaker down.



Figure 4. 3 Car engine cooling system prototype

# 4.3 SOFTWARE IMPLEMENTATION

Software implementation refers to the process of integrating and embedding a software application into project systems and procedures. The Arduino software implements software by producing code in hardware and uploading it to the Arduino Uno board.

# 4.3.1 CIRCUIT DESIGN SIMULATION

Figure 4.4 below shows the circuit design of the project. Proteus 8 software is used to design and simulate the circuit. The Arduino Uno serves as a microcontroller in this circuit design project, determining the coding for each component. Because there is no specific component in the Proteus library, the temperature sensor DS18B20 is replaced with terminal VCC, GND, and SIGNAL. The temperature sensor will play a significant role as the device's primary input. The temperature of the coolant or water will be measured by the sensor, and the results will be transmitted to the Arduino. The second input is a 4x4 keypad where the user can enter the desired temperature to switch on or off the DC fan. The DC fan can also be manually or automatically activated and deactivated through the use of the keypad. The DC fan is connected through IRF520 MOSFET using 12V supply. The LCD display which is connected directly to the Arduino will display the current and input temperature.



# 4.3.2 ARDUINO UNO CODING

In order to write code, compile and upload to an Arduino Uno board, the project relied entirely on Arduino IDE as its primary software platform. With the help of the programme, the Arduino can control whether or not the DC fan is running and display the current temperature on the LCD display. Figure 4.5 shows the program code for this project using Arduino IDE software. Firstly, all the libraries that are going to be used are added and also declare the port as well as defined the variables that are going to be used at the initial of the program. The Arduino programme is consisted of several essential parts, the first of which is void setup to display information on an LCD display. The lcd set and print the desired information needed.

ودية

```
#include <Keypad.h>
#include <OneWire.h>
//#include <LiquidCrystal.h>
#include <Wire.h> // Comes with Arduino IDE
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x3F, 16, 2);
//LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);
//LiquidCrystal_I2C lcd(0x3F, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);
#define Buzz 13
#define FAN 10
#define SW 12
```

Figure 4. 5 Arduino coding (i)

Figure 4.6 shows the second part is to take the measured temperature and to determine its equivalent in degrees Celsius by converting it from Fahrenheit. The int convert the data to actual temperature because the result is a 16-bit signed integer, it should be stored to an "int16\_t" type, which is always 16 bits even when compiled on a 32-bit processor. The unit of temperature is converted using Celsius = (float)raw / 16.0; Fahrenheit = Celsius \* 1.8 + 32.0 and the ActTemp will be Celsius.



Figure 4. 6 Arduino coding (ii)

The third part of the programme is to control the DC fan. In the situation that ActTemp is greater than TSet, the fan will be set to HIGH. In the event that ActTemp is

lower than TSet, the fan speed will be set to LOW. The speed of the fan is set using SPEED=(100-((TSet/ActTemp) \*100)) as show in Figure 4.7 below.



Programming the 4x4 keypad that serves as the input medium for the device is the

task of the fourth part of the programme code as shown in Figure 4.8.

ستر تحكيحك مليسيا ملاك	lever u
.* 15 (mode≠=0) { .* .* .*	0
<pre>if (key != NO_KEY &amp;&amp; key =='*') {</pre>	
UNIVERSITI, PEKNIKAL MALAYSIA	MELAKA
<pre>if (key != NO_KEY &amp;&amp; key =='#') {     OP=0;</pre>	
<pre>} if (key != NO_KEY &amp;&amp; key =='A') {     OP=0; mode=1;</pre>	
<pre>} if (key != NO_KEY &amp;&amp; key =='B') {     OP=0; mode=2;</pre>	
<pre>} if (key != NO_KEY &amp;&amp; key =='D') {     OP=0; mode=0; FANSTATE=0;     dictably is (FAN_TOP); }</pre>	
} }	
if (mode==1) {	
<pre>lcd.clear();</pre>	
<pre>lcd.setCursor(0, 0);</pre>	
<pre>lcd.print("Set Temperature");</pre>	
<pre>lcd.setCursor(0, 1);</pre>	
<pre>lcd.print(PwordIn);</pre>	

Figure 4. 8 Arduino coding (iv)

#### 4.4 RESULTS

## 4.4.1 MONITOR CURRENT TEMPERATURE

The mode that can be used to display the current temperature can be accessed once the device has been turned on, as shown in the Figure 4.9 below. The temperature sensor will take readings from the area immediately surrounding the metal probe. The measurement of the data will be done in real time.



# 4.4.2 MENU FOR AUTO MODE

Based on Figure 4.10 below, the LCD display shows the menu for AUTO mode. Simply pressing the B button on the keypad will allow to enter this mode. This mode means that the DC fan will turn on automatically based on the temperature set by the user. The data remain unchanged until another temperature value is inputted into the system. Users can press the A button located on the keypad in order to change the temperature reading or set a new one. The message "Set Temperature" will show up, indicating that the system is prepared for a new temperature value to be entered as shown in Figure 4.10 below. After entering the desired temperature, proceed to the next step by pressing the # button to enter and store the value. Then, press the B button to return to the AUTO mode menu. Now the system is ready to run based on the value entered.



Figure 4. 10 Auto Mode menu

# 4.4.3 DC FAN TURN ON AND OFF

Figure 4.11 below shows the DC Fan is turned ON based on the set temperature. In this case, the set temperature value is 25°C and the current temperature measured by the temperature sensor is 28.31 °C. When the temperature reaches or exceeds 25°C, the DC fan will start spinning. This will happen automatically. When the temperature drops below 25°C the fan will automatically turn off as shown in Figure 4.11 below.



Figure 4. 11 DC fan operation

#### 4.5 EXPERIMENTAL RESULTS

Figure 1 shows the completed hardware and software that has been assembled and its functionality has been checked.



4.5.1 STUDY OF COOLANT MIXTURE TEMPERATURE AND TIME TAKEN

Figure 4.12 below shows the setup used for the study. The objective of this study is to measure the maximum temperature of the coolant mixture and time take for the coolant to reach its desired temperature. The desired temperature is the temperature at which the user wants the DC fan to start spinning. If they are unsure, the optimum car temperature of 80-90 °C will be preset. For the study, a beaker filled with mixture of coolant and boiling water is used. The proportion of water to coolant is 1:1 that replicates the real usage in a car. Depending on the model, a car will typically require 3-5 litres of coolant. In this study, 100ml of boiling water and 100ml of coolant is mixed together. The boiling water is to imitate the hot coolant in a car. The average temperature of the boiling water from a specific water heater is 66.87°C and pure coolant is 29.5°C. Temperature for the mixture is measured accordingly.

Next is to measure the time taken for the coolant mixture to reach its optimum temperature. The optimum temperature in this study is 45°C. The reason that particular temperature was selected was so that it would imitate the real optimal temperature for a car,

which is between 80°C and 100°C. In this study, the real car and prototype optimum temperatures have a 2:1 ratio.

The DC fan will run until the temperature reaches 45°C or lower. To provide maximum cooling area, the fan is placed quite close to the beaker. The time taken are measured using stopwatch.



Figure 4. 13 Coolant mixture temperature and time taken setup

Table 4.1 shows the results between maximum temperature and time taken. The data is taken from 10 trials of experiment. On the other hand, a combo graph was plotted based on the data in Table 4.1 with all of the trials in one graph to highlight the difference and consistency of the maximum temperature of the coolant and time take for the coolant to reach its optimum temperature which is 45°C for this case. From Figure 4.13 below, the line graph demonstrates that the maximum temperature is fairly constant for every trials. The bar graph also demonstrates that the time taken for the coolant to reach its desired temperature is stable for every trials. The average value for maximum temperature is 54.92°C and time taken is 4.13 minutes.

Trial	Maximum Temperature	Time Taken to $\leq 45^{\circ}$ C	
Inal	(°C)	(min)	
1st	57.63	4.52	
2nd	53.13	3.75	
3rd	54.69	4	
4th	53.15	3.88	
5th	56.19	4.42	
6th	56.14	4.37	
7th	55.19	4.07	
8th	55.25	4.22	
9th	53.19	3.96	
10th	54.67	4.13	
Average	54.92	4.13	

Table 4. 1 Results between maximum temperature and time taken



Figure 4. 14 Graph between maximum temperature and time taken

# 4.5.2 STUDY OF EFFECT ON FAN USAGE

The second experiment is to study the effect of fan usage. Figure 4.14 shows the set up for the experiment. Two beakers with the same amount of coolant mixture and maximum temperature are used. The room temperature during the experiment is about 27°C and the average coolant mixture temperature is 55.63°C. The optimum temperature is set at 45°C. The fan for the first beaker will run until the temperature reaches 45°C or lower. The second beaker will naturally cool down by itself. Both beaker time taken are measured using stopwatch.



Figure 4. 15 Effect on fan usage setup

Table 4.2 shows the data analysis for time difference between using a fan and not using a fan to reach a desired temperature. The data is drawn from ten experimental trials. A bar graph was created using the data from the table. Figure 4.15 shows that there is significant difference in time taken to reach 45°C or lower between both methods. The average time taken by using fan is 4.78 minutes while without using fan is 9.78 minutes. Based on the result, the difference between the time taken is about 48.88%. It shows how effectively a fan can be used to bring the temperature down.

Trial	Max Temp	Time Taken to ≤ 45°C (min)			
Indi	(°C)	With fan	W/o fan		
1st	53.14	4.08	8.98		
2nd	57.25	5.33	10.83		
3rd	55.03	4.5	9.42		
4th	54.46	4.37	9.35		
5th	57.1	5.18	10.38		
6th	56.24	5.08	9.82		
7th	55.15	4.58	9.54		
8th	55.37	4.72	9.57		
9th	56.83	5.11	10.13		
10th	55.76	4.87	9.73		
Average	55.63	4.78	9.78		

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Table 4. 2 Result of fan usage



Figure 4. 16 Graph data of fan usage

# 4.5.3 DC FAN SPEED

A DC fan is the primary component used to control the temperature in this project. For the purpose of this study to determine the consistency of the DC fan speed since the fan only provides on and off . From Figure 4.16, the speed of the fan is measured using a digital tachometer. The fan's fin is mounted with a thin reflective tape that the tachometer's laser can detect. The laser is pointed about 15cm directly to the tape. Table 4.16 displays the table with the results of 10 different measurements. The average value of the fan speed 3193 rpm. A standard real car radiator fan has an average maximum speed of around 3500 rpm. When compared to an actual fan, the 12V DC fan runs at a similar speed. The graph seen to be relatively linear as shown in Figure 4.16. The result shows that fan is speed is stable and valid to be used in every experiment.



Figure 4. 17 Measurement of DC fan speed

	Trial	Fan speed in 3s (rpm)	
	1st	3205	
	2nd	3204	
MALAY	314 3rd	3201	
(F)	4th	3189	
S.	5th	3190	
E .	6th 🎽	3187	
	7th	3184	
Ser.	8th	3195	
SAIND.	9th	3183	
2.1.1	10th	3192	
سا ملاك	Average		اودية م
44	. 0		0
	Table /	3 Results of DC fan sneed	

UNIVERSITI TEKNIKAL MALAYSIA MELAKA



Figure 4. 18 Graph of DC fan speed

# 4.6 SUMMARY

Figure 4.18 shows the finalised hardware and software system in the prototype model proposed for the Bachelor Degree Project. The goal of this project is to construct the project based on the objective and title provided. This chapter has gone over the entire project's progression, including implementation and data analysis. Each component's functionality was individually tested during the initial system testing to make sure they worked as intended. The components were verified to be in good functioning order after being tested. The components were then assembled and tested together with the software. The system is capable of monitoring and controlling the temperature of the coolant mixture as intended. The DC fan could be turned on and off according to the temperature set by user. The coolant can be brought down to the required temperature using the DC fan's cooling ability. Finally, the real-time temperature value will be displayed on the LCD panel.

# **CHAPTER 5**

#### CONCLUSION AND RECOMMENDATIONS

# 5.1 INTRODUCTION

This section will cover the conclusion and suggestions for further research. The section will come to a close with a summary of all the project's findings and recommendations for further work that should be done on related topics in the future.

#### 5.2 CONCLUSION

The purpose of the project is to develop microcontroller based real-time monitoring and temperature control in vehicle especially for car. The Arduino Uno was used as the microcontroller. Temperature sensor, LCD display, 4x4 keypad, and 12V DC fan are used as the hardware in this system. Arduino IDE is used to write and compile the Arduino coding into the physical board. The DC fan begins to turn on and off based on the temperature set by the user. From the testing, the LCD displayed the real time temperature and the DC fan workes as the temperature of the coolant mixture exceed the desired temperature. This result shows that the first objective of the project is achieved.

Besides, the feasibility of the prototype also has been investigated. Based on the experiment, results show that the DC fan able to cool down the coolant mixture within a time period which resulted the achievement of second objective. This research project also served as a good beginning point for the creation of a low-cost, simple, and effective engine cooling system for a certain vehicle. It strengthens the study's thesis that, as technologies progress, it is critical to build systems at a low cost that are versatile and require only a moderate level of maintenance. The testing of the prototype demonstrated that the system is simple to use and that any new device that are dependable, adaptable for development, and very low in cost when compared to current market products may be placed on it. The system of software and hardware testing was used to validate the specifications for a system with its specific demands on a whole, integrated system. As a result, all procedures worked properly. Finally,

this work provides important new insight and knowledge that can be used to stimulate future research.

# 5.3 FUTURE WORKS

The system's prototype is intended to be simple, low-cost, efficient, and dependable. However, the prototype requires further development and improvement in terms of system functionality. The concept simulation prototype that is on a smaller scale can be turned into the actual product and can be implemented in a real vehicle. For suggestion, replace the small DC fan with a genuine radiator fan, the DS18B20 temperature sensor with a proper car temperature coolant sensor and make minor adjustments to the output signal to suit the input for any component of the prototype. It is suggested that a wireless keypad be used for user input since this may help save space, or in other words, reduce the size of the prototype that can be mounted to the car especially on the dashboard for easier monitoring. Lastly, utilizing a printed circuit board rather than an Arduino Uno board is another way to cut costs and simplify the process during the construction of the prototype.



#### REFERENCES

- V. K. Sundar Rao, S. Kurbet, and V. V Kuppast, "A Review on Performance of the IC Engine Using Alternative Fuels 

  ." [Online]. Available: www.sciencedirect.comwww.materialstoday.com/proceedingsPMME2016
- [2] I. Johnson, "Know the Basics of the Car Engine Parts," *newnorth1.blogspot.com*,
   2011. http://newnorth1.blogspot.com/2011/08/know-basics-of-car-engine-parts.html
   (accessed Jun. 07, 2022).
- [3] I. Y. M. AUTOMOTRIZ, "FUEL SYSTEM: COMPONENTS, WORKING PRINCIPLES, SYMPTOMS AND EMISSION CONTROLS - INGENIERÍA Y MECÁNICA AUTOMOTRIZ," *ingenieriaymecanicaautomotriz.com*, 2019. https://www.ingenieriaymecanicaautomotriz.com/fuel-system-components-workingprinciples-symptoms-and-emission-controls/ (accessed Jun. 07, 2022).
- [4] S. Bansal, Y. Vashiath, and U. Batra, "Issn-3855-0154 journal of mechanical and civil engineering," vol. 2, no. 5, pp. 59–62, 2015.
- [5] K. Peters, "Design options for automotive batteries in advanced car electrical systems," *J. Power Sources*, vol. 88, no. 1, pp. 83–91, 2000, doi: 10.1016/S0378-7753(99)00514-5.
- [6] D. A. S. Inc., "Electrical System | Dutch's Auto Service Inc.," *dutchauto.wordpress.com.* https://dutchauto.wordpress.com/147-2/ (accessed Jun. 07, 2022).
- [7] J. Wall, Dynamics Study of an Automobile Exhaust System. 2003.
- [8] P. Bingham, S. Theodossiades, T. Saunders, E. Grant, and R. Daubney, "A study on automotive drivetrain transient response to 'clutch abuse' events," *Proc. Inst. Mech. Eng. Part D J. Automob. Eng.*, vol. 230, no. 10, pp. 1403–1416, 2016, doi:

10.1177/0954407015611293.

- [9] DriveSmartWarranty.com, "Drivetrain | What is a Drivetrain | How Car Drivetrain Works," *drivesmartwarranty.com*, 2019. https://drivesmartwarranty.com/car-center/resources/extended-warranty/drivetrain (accessed Jun. 07, 2022).
- [10] M. Tips, "Suspension System MechanicsTips," *mechanicstips.blogspot.com*, 2015. https://mechanicstips.blogspot.com/2015/07/suspension-system.html (accessed Jun. 07, 2022).
- [11] Z. Xu, "Talking about the Automobile Braking System," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 274, no. 1, 2017, doi: 10.1088/1757-899X/274/1/012141.
- [12] T. Techs, "What you need to know about your Automotive Brake System -TOYTECHS – Automotive Repair & Service," *toytechs.com*, 2019. https://toytechs.com/what-you-need-to-know-about-your-automotive-brake-system/ (accessed Jun. 07, 2022).
- [13] P. Mishra, "Types of Chassis and Different Types of Cars According to Body Style -Mechanical Booster," *mechanicalbooster.com*, 2014. https://www.mechanicalbooster.com/2014/02/what-is-chassis-in-automobile-howmany-types-of-car-according-to-the-body-style.html (accessed Jun. 07, 2022).
- [14] M. B. & K. Hall-Geisler, "How Car Engines Work | HowStuffWorks," auto.howstuffworks.com, 2021. https://auto.howstuffworks.com/engine.htm (accessed Jun. 07, 2022).
- [15] I. Lita, I. O. N. B. Cioc, M. Teodorescu, and D. A. Vlsan, "Of The Thermostat From Automobile," no. 1.
- [16] K. Nice, "Radiator How Car Cooling Systems Work | HowStuffWorks," auto.howstuffworks.com, 2021. https://auto.howstuffworks.com/coolingsystem6.htm (accessed Jun. 07, 2022).

- [17] Pinterest, "(47) Pinterest," *pinterest.com*.https://www.pinterest.com/blvdradiator/radiators/ (accessed Jun. 07, 2022).
- [18] S. T.-P. I. Co.Ltd, "Automotive Thermostat," *.tu-poly.com*. http://www.tu-poly.com/solutions/thermostat (accessed Jun. 07, 2022).
- [19] D. Fuller, "Mechanical vs. Electric Fans: Which is Best for Your Vehicle? -OnAllCylinders," *onallcylinders.com*, 2012. https://www.onallcylinders.com/2012/07/24/mechanical-vs-electric-fans-whichbest-your-vehicle/ (accessed Jun. 07, 2022).
- [20] N. Reddi, "RADIATOR FAN And WATER PUMP C Chamber," *cchamber.com*,
   2017. http://www.cchamber.com/understanding-cars/radiator-fan-and-water-pump/
   (accessed Jun. 07, 2022).
- [21] P. S. Amrutkar and S. R. Patil, "Automotive Radiator Performance Review," no.
  3, pp. 563–565, 2013.
- [22] D. LIFE, "How and When to Use an Auxiliary Electric Fan: Know the Answer in this Post," *drivinglife.net*, 2021. https://drivinglife.net/how-and-when-to-use-anauxiliary-electric-fan/ (accessed Jun. 07, 2022).
- [23] M. Motorsport, "Quick, easy fit Cooling Products for Race cars," *merlinmotorsport.co.uk*, 2019. https://www.merlinmotorsport.co.uk/knowledge\_base\_articles/view/top-quick-fixcooling-products-for-your-racing-car-316 (accessed Jun. 07, 2022).
- [24] C. Stanford, "Microcontroller Architechture," *ccrma.stanford.edu*, 2016. https://ccrma.stanford.edu/workshops/2006/PID/lectures/ucontrollers.html (accessed Jun. 07, 2022).
- [25] Y. Sabri, A. Siham, and A. Maizate, "Internet of Things (IoT) based Smart Vehicle Security and Safety System," Int. J. Adv. Comput. Sci. Appl., vol. 12, no. 4, pp. 708–
714, 2021, doi: 10.14569/IJACSA.2021.0120487.

- [26] R. Rákay, M. Višňovský, A. Galajdová, and D. Šimšík, "Testing Properties of E-health System Based on Arduino," *J. Autom. Control. Vol. 3, 2015, Pages 122-126*, vol. 3, no. 3, pp. 122–126, 2015, doi: 10.12691/AUTOMATION-3-3-17.
- [27] K. S. Kaswan, S. P. Singh, and S. Sagar, "Role of Arduino in real world applications," *Int. J. Sci. Technol. Res.*, vol. 9, no. 1, pp. 1113–1116, 2020.
- [28] M. Verma, "Working, Operation and Types of Arduino Microcontroller," © Int. J. Eng. Sci. Res. Technol., vol. 6, no. 6, pp. 155–158, 2017, doi: 10.5281/zenodo.805403.
- [29] A. CC, "Arduino Mega 2560 Rev3 Arduino Online Shop," store-usa.arduino.cc. https://store-usa.arduino.cc/products/arduino-mega-2560-rev3?selectedStore=us (accessed Jun. 07, 2022).
- [30] H. Ghael, H. Dipak Ghael, L. Solanki, G. Sahu, and A. Professor, "A Review Paper on Raspberry Pi and its Applications," *Int. J. Adv. Eng. Manag. (IJAEM*, vol. 2, no. February, p. 225, 2008, doi: 10.35629/5252-0212225227.
- [31] Prestone, "What is a Coolant Temperature Sensor? | Prestone," *holtsauto.com*, 2017. https://www.holtsauto.com/prestone/news/coolant-temperature-sensor/ (accessed Jun. 07, 2022).
- [32] T. Sugiarto, D. S. Putra, and W. Purwanto, "Analysis on the Role of Engine Coolant Temperature Sensor in Gasoline Engine," *VANOS J. Mech. Eng. Educ.*, vol. 2, no. 2, 2017, doi: 10.30870/vanos.v2i2.2927.
- [33] G. C. M. Meijer, G. Wang, and A. Heidary, "Smart temperature sensors and temperature sensor systems," *Smart Sensors MEMS Intell. Sens. Devices Microsystems Ind. Appl. Second Ed.*, no. February, pp. 57–85, 2018, doi: 10.1016/B978-0-08-102055-5.00003-6.

- [34] H. Lundström and M. Mattsson, "Modified thermocouple sensor and external reference junction enhance accuracy in indoor air temperature measurements," *Sensors*, vol. 21, no. 19, 2021, doi: 10.3390/s21196577.
- [35] L. Facility, "RTD Temperature Sensor & Integral Transmitter," *labfacility.com*. https://www.labfacility.com/rtd-temperature-sensor-integral-transmitter.html (accessed Jun. 07, 2022).
- [36] D. Tutunea, G. Gherghina, I. Dumitru, and A. Dima, "Evaluation of Thermistors Used for Temperature Measurement in Automotive Industry," *Appl. Mech. Mater.*, vol. 880, no. August, pp. 157–162, 2018, doi: 10.4028/www.scientific.net/amm.880.157.

ARLAYSIA

- [37] B. C. Yadav, R. Srivastava, S. Singh, A. Kumar, and A. K. Yadav, "Temperature Sensors based on Semiconducting Oxides: An Overview," pp. 1–22, 2012, [Online]. Available: http://arxiv.org/abs/1205.2712
- [38] B. T. Services, "Working Principle of Temperature Sensor and Its Application Blaze Probes," *blazeprobes.com.* https://www.blazeprobes.com/working-principletemperature-sensor-application/ (accessed Jun. 07, 2022).

## APPENDICES

## Appendix A: Circuit Diagram



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## **Appendix B: Arduino Coding**

```
KeyPadLockTemp
#include <Keypad.h>
```

#include <OneWire.h>
//#include <LiquidCrystal.h>
#include <Wire.h> // Comes with Arduino IDE
#include <LiquidCrystal\_I2C.h>

LiquidCrystal\_I2C lcd(0x3F, 16, 2); //LiquidCrystal\_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Set the LCD I2C address //LiquidCrystal\_I2C lcd(0x3F, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); //some address is different

#define Buzz 13
#define FAN 10
#define SW 12

OneWire ds(A0); // on pin 10 (a 4.7K resistor is necessary)



```
int countOK;
int countKEY;
int commaPosition;
int index = 0;
int Pfull;
double PwordInx;
char check;
int LOCK=0;
String PwordIn;
double NowPword:
int mode=0;
int SMSX=0;
int StatusHIGHL;
float SetTemp=45;
float ActTemp=0;
String MESSAGE1="
                   WELCOME";
String MESSAGE2=" ";
int TSet=45;
int count;
int OP=0;
int FANSTATE=0; MALAYSIA
const byte ROWS = 4;
const byte COLS = 4;
char keys[ROWS][COLS] = {
  {'D', '#', '0', '*'},
  {'C','9','8', '7'},
{'B','6','5', '4'},
  {'A','3','2',
                .'1'}
};
                 4
byte rowPins[ROWS] = {
  6,7,8,9}; //connect to row pinouts
byte colPins(COLSERSITI TEKNIKAL MALAYSIA MELAKA
  2,3,4,5}; //connect to column pinouts
```

Keypad keypad = Keypad( makeKeymap(keys), rowPins, colPins, ROWS, COLS );

```
void setup() {
    PwordIn = "";
    countKEY = 0;
    pinMode(Buzz,OUTPUT);
    pinMode(FAN,OUTPUT);
    pinMode(SW,INPUT);
    digitalWrite(SW,HIGH);
    digitalWrite(FAN,LOW);
    Serial.begin(9600);
```

```
lcd.backlight(); // finish with backlight on
 lcd.begin();
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("Initializing..");
 lcd.setCursor(0, 1);
 lcd.print("pls wait");
 delay(2500);
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print(MESSAGE1);
 lcd.setCursor(0, 1);
 lcd.print(MESSAGE2);
}
void loop(){
//-----
 byte i;
 byte present = 0;
 byte type_s;
 byte addr[8];
 float celsius, fahrenheit, celsius1, fahrenheit1;
 //------
                          ----
 if ( !ds.search(addr)) {
 // Serial.println("No more addresses."); L MALAYSIA MELAKA
 // Serial.println();
   ds.reset_search();
   delay(250);
   return;
 }
// Serial.print("ROM =");
 for( i = 0; i < 8; i++) {
 // Serial.write(' ');
 // Serial.print(addr[i], HEX);
 }
 if (OneWire::crc8(addr, 7) != addr[7]) {
  // Serial.println("CRC is not valid!");
     return;
 1
// Serial.println();
 // the first ROM byte indicates which chip
 switch (addr[0]) {
   case 0x10:
```

```
// Serial.println(" Chip = DS18S20"); // or old DS1820
     type s = 1;
     break:
   case 0x28:
  // Serial.println(" Chip = DS18B20");
     type s = 0;
     break:
   case 0x22:
    // Serial.println(" Chip = DS1822");
     type s = 0;
     break:
   default:
   // Serial.println("Device is not a DS18x20 family device.");
     return;
 ł
 ds.reset():
 ds.select(addr);
 ds.write(0x44, 1);
                         // start conversion, with parasite power on at the end
                 // maybe 750ms is enough, maybe not
 delay(1000);
 // we might do a ds.depower() here, but the reset will take care of it.
 present = ds.reset();
 ds.select(addr);
 ds.write(0xBE);
                         // Read Scratchpad
// Serial.print(" Data = ");
// Serial.print(present, HEX);
// Serial.print(" ");
  for ( i = 0; i < 9; i++) {
                                      // we need 9 bytes
   data[i] = ds.read();
                                      14
    Serial.print(data[i], HEX);
11
    Serial RAWERSITI TEKNIKAL MALAYSIA MELAKA
11
 1
// Serial.print(" CRC=");
// Serial.print(OneWire::crc8(data, 8), HEX);
// Serial.println();
 // Convert the data to actual temperature
 // because the result is a 16 bit signed integer, it should
 // be stored to an "intl6 t" type, which is always 16 bits
 // even when compiled on a 32 bit processor.
 intl6 t raw = (data[1] << 8) | data[0];</pre>
 if (type_s) {
   raw = raw << 3; // 9 bit resolution default</pre>
   if (data[7] == 0x10) {
     // "count remain" gives full 12 bit resolution
     raw = (raw \& 0xFFF0) + 12 - data[6];
   }
  } else {
   byte cfg = (data[4] \& 0x60);
   // at lower res, the low bits are undefined, so let's zero them
   if (cfg == 0x00) raw = raw & ~7; // 9 bit resolution, 93.75 ms
```

```
else if (cfg == 0x20) raw = raw & ~3; // 10 bit res, 187.5 ms
   else if (cfg == 0x40) raw = raw & ~1; // 11 bit res, 375 ms
  //// default is 12 bit resolution, 750 ms conversion time
 1
 celsius = (float)raw / 16.0;
 fahrenheit = celsius * 1.8 + 32.0;
 //Serial.print(" Temperature = ");
 if (celsius>0) {
  ActTemp=celsius;
 1
 11.
// Serial.print(" Celsius, ");
 //Serial.print(fahrenheit);
// Serial.println(" Fahrenheit");
if (mode==0) {
 lcd.clear();
  lcd.setCursor(0, 0);
 lcd.print("Temp(c):");
 lcd.print(ActTemp, 2);
if (OP==1) {
  digitalWrite(FAN, HIGH);
   lcd.setCursor(0, 1);
  lcd.print("FAN ON");
}
if (OP==0) {
  digitalWrite(FAN,LOW);
}
}
            *******
//********
                                 *******
                       ***
                           老大生
if (mode==2) {
                                         14
                                                   10
  lcd.clear();
  1cd. setCurson (ERSITI TEKNIKAL MALAYSIA MELAKA
  lcd.print("T(c):");
  lcd.print(ActTemp, 2);
  lcd.print(" AUTO");
   lcd.setCursor(0, 1);
  lcd.print("Set T(c):");
  lcd.print(TSet);
if (ActTemp>TSet) {
  if (FANSTATE==0) {
     digitalWrite(FAN, HIGH);
     delay(2000);
     FANSTATE=1;
```

```
}
 SPEED=(100-((TSet/ActTemp)*100));
 if (SPEED>255) {
  SPEED=255;
 }
}
if (ActTemp<TSet) {
 SPEED=0;
 FANSTATE=0;
  digitalWrite(FAN,LOW);
}
if (ActTemp>TSet) {
 // analogWrite(FAN, SPEED);
 digitalWrite(FAN, HIGH);
  if (SPEED>=255) {
   digitalWrite(FAN, HIGH);
  }
}
Serial.print (SPEED); AYS/A
 Serial.print("\t");
Serial.print (celsius);
 Serial.print("\t");
  Serial.println(TSet);
}
//*********
                        *****
                   KEYPAD
  11
            $
      char key = keypad.getKey();
      if (modell2) FRSITI TEKNIKAL MALAYSIA MELAKA
         if (key != NO KEY && key == 'D') {
          OP=0; mode=0; FANSTATE=0;
          digitalWrite(FAN,LOW);
        }
      }
      if (mode==0) {
        if (key != NO KEY && key == '*') {
          OP=1;
        }
         if (key != NO KEY && key == '#') {
          OP=0;
        }
        if (key != NO_KEY && key == 'A') {
          OP=0; mode=1;
        }
         if (key != NO KEY && key == 'B') {
         OP=0; mode=2;
        }
        if (key != NO_KEY && key == 'D') {
```

```
OP=0; mode=0; FANSTATE=0;
    digitalWrite(FAN,LOW);
   }
}
if (mode==1) {
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("Set Temperature");
lcd.setCursor(0, 1);
lcd.print(PwordIn);
//lcd.print(dummy);
}
if (key != NO_KEY && key == "*") {
}
while (mode==1) {
        char key = keypad.getKey();
if (mode==1) {
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("Set Temperature
                            ");
lcd.setCursor(0, 1);
lcd.print(PwordIn);
//lcd.print(dummy);
}
if (key != NO_KEY) {
     UNIVERSITI TEKNIKAL MALAYSIA MELAKA
```

I

```
mode=1;
  PwordIn += key;
  dummy +="*";
  lcd.setCursor(0, 1);
  lcd.print(PwordIn);
  countKEY = countKEY + 1;
11
  Serial.println(countKEY);
// Serial.println(PwordIn);
// Serial.println(PASSWORD.toInt());
  delay(500);
}
if (key == '*') {
  PwordIn = ""; PwordInx = 0;
    dummy="";
    countKEY = 0;
    SMSX=0; mode=0;
}
 if (key == '#') {
  TSet=PwordIn.toInt();
   lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("Temp Set...");
 lcd.setCursor(0, 1);
 lcd.print(TSet);
 lcd.print("C");
 delay(2000);
 PwordIn = ""; PwordInx = 0;
   dummy="";
   countKEY = 0;
   SMSX=0; mode=0;
}
 if (countKEY > 5) [
 //NowPword = PASSWORD.toInt();
 // PwordInx = PwordIn.toInt();
 int Check=1;
if (Check==1) {
}
}
}
```

```
delay(100);
}
void Clear() {
    WRONGCOUNT=0;
    PwordIn = ""; PwordInx = 0;
    dummy="";
    countKEY = 0; mode=0;
    digitalWrite(Buzz,LOW);
    delay(1000);
}
void DoorOpen() {
```

}











PSM 2