DEVELOPMENT OF WATER FLOW MANAGEMENT AND VECTOR CONTROL FOR RAINWATER HARVESTING TANK

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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"DEVELOPMENT OF WATER FLOW MANAGEMENT AND VECTOR CONTROL FOR RAINWATER HARVESTING TANK"

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.

by

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2021

DECLARATION

I hereby, declared this report entitled "Development of Water Flow Management and Vector Control for Rainwater Harvesting Tank" is the results of my own research except as cited in references.

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Date: 14/02/2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

Signature: ……………………………………………………….

Supervisor: TS. FAKHRULLAH BIN IDRIS

ABSTRAK

Krisis air menjadi isu dominan di seluruh dunia. Masalah ini juga berlaku kerana pengedaran air yang buruk, penggunaan yang boros, dan ketiadaan sistem pengurusan air yang mencukupi dan betul. Untuk mengelakkan masalah kekurangan air, sistem penuaian air hujan diperkenalkan oleh kerajaan Malaysia. Tetapi, kawalan vektor yang buruk di tangki penuaian air hujan akan menyebabkan pembiakan vektor yang serius dan akan menyebabkan penyakit vektor seperti denggi, malaria, demam kuning, dan lain-lain. Kes denggi di Malaysia meningkat dari 72 kes untuk 100000 populasi pada tahun 2001 menjadi 361 kes pada 100000 populasi pada tahun 2014. Untuk mengatasi masalah pembiakan vektor ini dan menguruskan kawalan air hujan dengan bijak prototaip untuk pengurusan aliran air dan kawalan vektor untuk tangki penuaian air hujan telah dibina.

ABSTRACT

The water crisis is becoming a dominant issue all over the world. This issue also occurs because of poor water distribution, wasteful use, and absence of sufficient and proper water management system. In order to prevent the water scarcity problem, the rainwater harvesting system (RWHS) is introduced by the Malaysian government. But, poor vector control in the rainwater harvesting tank will cause serious vector reproduction and will lead to vector diseases like dengue, malaria, yellow fever, and others. The dengue cases in Malaysia has risen from 72 cases for 100000 population in 2001 to 361 cases in 100000 population in 2014. In order to overcome this vector reproduction problem and smartly manage the rainwater vector control and water flow management for rainwater harvesting tank prototype had been developed.

DEDICATION

I dedicate this project report to my beloved parents and friends. A special thanks to my mother Mrs. Thanaletchimi a/p Thamotharem and father Mr. Kunalan a/l Rajamani who both always being support my ideas and give encourage to do this project. I also being grateful to thanks my supervisor Ts. Fakhrullah bin Idris who give lot of ideas and share his knowledge on doing report. I will always appreciate the help and knowledge shared especially by Mr Dhevan, Mr Suraien and Mr Loga.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

RWHS	-	Rainwater Harvesting System
LCD	-	Liquid Crystal Display
lcd	-	Liters per Capita
s	-	Distance
v	-	Speed of sound
t	-	Time taken
>	-	More than
<	-	Less than

CHAPTER 1
INTRODUCTION

1.0 Background

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Water is the most significant fluid to sustain life. 70% of the earth is covered with water. Even though the earth has an abundant supply of water the clean water supply is only 3%. Out of this only, 1 % of water can be used because the rest of the water is in the form of ice. The human population has increased 3.1billion over the last decade (Lee *et al.*, 2016). According to (Lee *et al.*, 2016), demand for clean water supply is increasing double fast than the population. According to (Darus, 2009) by 2025, the human population will be facing drastic water shortage. The water crisis is becoming a dominant issue all over the world. This issue also occurs because of poor water distribution, wasteful use, and absence of sufficient and proper water management system. It is more important to reserve water for human daily activities. Rainwater harvesting system introduced by the government to overcome this problem. The government introduced this system because it is the easiest way to store rainwater. The stored water is used for domestic, agricultural, and industrial purposes. The rainwater harvesting method used since ancient times. Till now it is the best way to store water. Plenty of rainwater harvesting systems available in the market since the introduction of the rainwater harvesting system by the government. Nevertheless, a rainwater harvesting tank will make the tank not perfect to store rainwater if it has a poor vector control and water management system.

In order to overcome this issue, a water management and vector control for rainwater harvesting tanks had developed. This system consists of raspberry pi, ultrasonic sensor, water pump, and LCD. Raspberry pi acts as a microcontroller. The amount of water left in the tank will be measured by the ultrasonic sensor. Water flow is managed precisely by pumping water from the sump tank to the header tank using a water pump. Meshing is applied to the inlet and overflow of the tank to avoid vector reproduction.

1.1 Problem Statement

In Malaysia, the supply of water for everyday consumption originates from treated water. Being a developed country, Malaysia still cannot escape from water shortage because of the increase in population and development of industries and agriculture. The issues emerge when the water isn't adequate to fulfill the need or being contaminated (Ayob and Rahmat, 2017). Besides, environmental change is one of the reasons for the water shortage. It changes the accessibility, amount, and quality of the water supply (Ayob and Rahmat, 2017). El Nino is the main natural phenomenon that affects the supply of water in Malaysia (Che-Ani *et al.*, 2009). This phenomenon will occur in the Pacific Ocean, which will cause an impact on the climate like the surrounding temperature will be increased and the amount of rainfall will be reduced (Ayob and Rahmat, 2017).

In order to get better of the water scarcity problem, the rainwater harvesting system (RWHS) is introduced by the Malaysian government (Che-Ani *et al.*, 2009). RWHS is known as storage and collection of rainwater by avoiding wastage from flowing into drains. But, poor vector control in the rainwater harvesting tank will cause serious vector reproduction and will lead to vector diseases like dengue, malaria, yellow fever, and others. The dengue cases in Malaysia has risen from 72 cases for 100000 population in 2001 to 361 cases in 100000 population in 2014 (Mudin, 2015). In order to overcome this vector reproduction problem and smartly manage the rainwater, vector control and water flow management for rainwater harvesting tank prototype had been developed.

1.2 Objective

Objectives that need to achieve in this project:

- To design and develop a water flow management and vector control system for rainwater harvesting tank.
- To study the possibility of vector infestation in rainwater tank.
- To analyse the performance of the developed prototype in terms of water inflow and vector infestation.

1.3 Scope

For experimentation purposes, the design of experiment method will be used in small residential testing. Only one prototype will be developed and one type of water tank tested. The project focuses on using raspberry pi to communicate with the ultrasonic sensor, linear solenoid actuator, and water pump. This prototype can be attached to any rainwater tank to smartly manage water and control vector reproduction. Besides, this project focuses to study the effectiveness of the prototype and the possibility of vector infestation in the rainwater harvesting tank. This prototype will be tested in a housing area. The effectiveness of the water pump to pump water and resistance of the vector control against vector reproduction will be analysed for a time period of 14 days.

1.4 Thesis Organisation

Chapter 1 provides the background of water management and vector control. The problem statement is stated and objectives are listed to set as a benchmark to be achieved to solve the problems. Lastly, this chapter covers the scope of research.

Chapter 2 discusses the previous research on water issues in Malaysia, rainwater harvesting tank, vector-borne disease in water tank, and vector control in water tank. Comparison between the projects is done to identify the main idea, theory, and provide a wider view on the type of implementation which will be suitable for this project. Chapter 3 gives an overview of the methodology done to complete this project. The methodology is done by taking specific steps to develop the project while obeying the objectives stated. A flow chart will be designed to show the procedures taken.

Details of results are provided in Chapter 4. The data or output of the project will be analysed and discussed in detail. Figures of output will be attached. Chapter 5 concludes and summarises the main ideas and states whether the project output has achieved the objectives.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter is all about previous research on water issues in Malaysia, rainwater harvesting tank, vector-borne disease in water tank, and vector control in water tank. This chapter emphasize mostly on the history, facts, previous research, and difference between technique used by the researcher. The source for the research and fact-finding is taken from article, journal, manuscript, books, and internet. At the end of this chapter, the research that had done can be used to improve the project and making it different from other projects. Therefore, this chapter is the most important part in improving the project.

2.1 Water Issues in Malaysia

Malaysia even though being a developed country it still faces water crisis. Malaysia is generally wealthy in water sources having around 2400 mm yearly rainfall, (Che-Ain et al.,2009). Malaysia is among the Indian Ocean and the Pacific Ocean. Southwest monsoon and northeast monsoon mostly affect Malaysia's climate (Lee *et al.*, 2016). Southwest monsoon is often called as the dry season it usually occurs from May till August while northeast monsoon is often called as wet season and it usually occurs from November till February.

Malaysia has experienced a lot of development since its independence in 1957. Due to this rapid development, it put a higher demand for water resources (Rahman *et al.*, 2013). Other than rapid development, the number of populations also drastically increased. According to (Lani, Yusop and Syafiuddin, 2018) cities like Malacca, Penang, and Johor Bahru has high number of population and these cities needed a greater amount of water supply compare to other cities (Lani, Yusop and Syafiuddin, 2018). The future rainfall in Malaysia is anticipated to decrease this will cause water supply shortage in highly populated cities (Mohammed, Megat Mohd. Noor and Ghazali, 2003). Figure 2.1 shows the yearly precipitation map in Malaysia. Table 2.1 shows the mean annual rainfall in Malaysia. Also, figure 2.2 shows annual non-revenue water in Malaysia (Lani, Yusop and Syafiuddin, 2018).

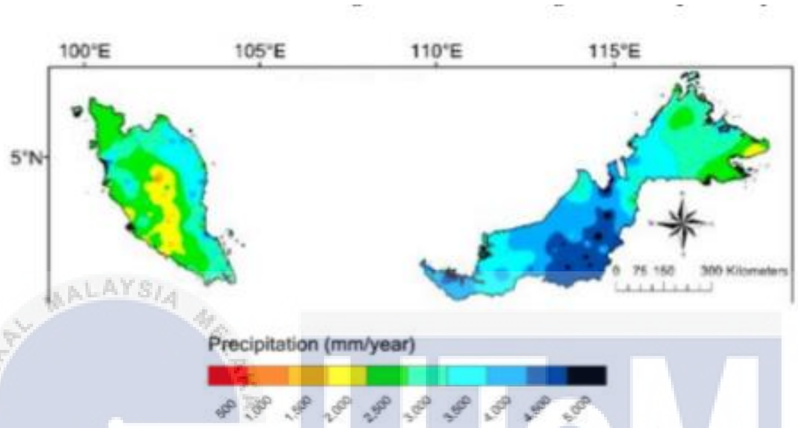


Figure 2.1: Annual rainfall in Malaysia (Lani, Yusop and Syafiuddin, 2018)

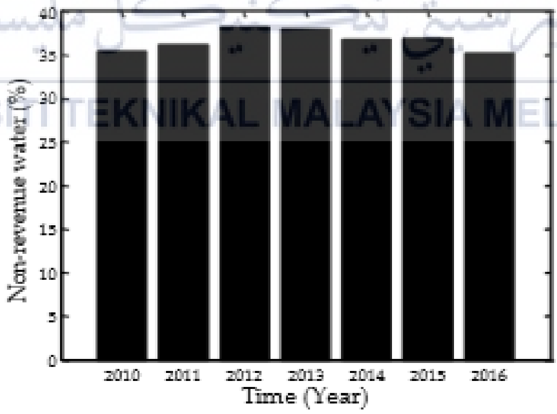


Figure 2.2: Non-revenue water in Malaysia (Lani, Yusop and Syafiuddin, 2018)

Table 2.1: Mean annual rainfall (Lani, Yusop and Syafiuddin, 2018)

Name of Town	Period of Record	Number of Rain-Day/Year
Alor Star	1948–2007	147
Ipoh	1972–2008	181
Klang	1953–2008	132
Kuala Lumpur	1953–2008	177
Seremban	1959–2008	141
Melaka	1954–1998	179
Kluang	1948–2006	163
Johor Bahru	1948–2007	158
Kota Bharu	1981–2008	138
Kuala Terengganu	1954–2008	161
Kuantan	1948–2008	136
Kota Kinabalu	1985–2009	177

Figure below shows water consumption in Malaysia, from the figure it can be stated that water utilization in Malaysia ranges from 210 to 230 liters per capita per day (lcd). The amount of water consumed is still over the limit allowed by the World Health Organization (WHO). Penang is the state which consume highest amount of water while Sabah is the least (Lani, Yusop and Syafiuddin, 2018). When compare Malaysia water consumption with Singapore nation, Singapore consume only less amount of water where 143 liters per capita per day (lcd) in 2017 (Lani, Yusop and Syafiuddin, 2018). Therefore, Malaysia will experience water scarcity within a reasonable time-frame if water utilization isn't improved.

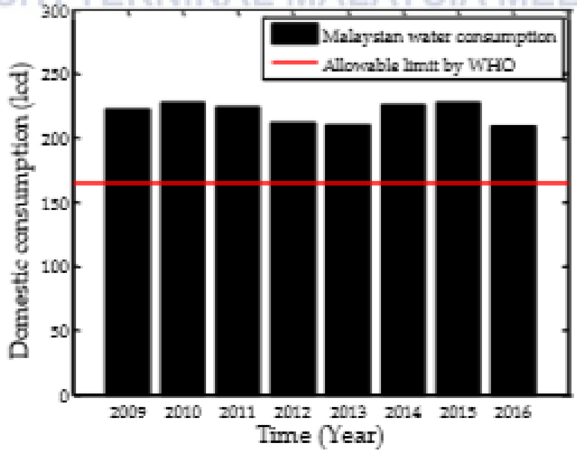


Figure 2.3 : Water consumption in Malaysia (Lani, Yusop and Syafiuddin, 2018).

Besides, water tariff in Malaysia is lower than other nations (refer table 2.2) (Lani, Yusop and Syafiuddin, 2018), but the tariff shows an increasing trend. For example, in Johor state the water tariff had increased from RM0.36/m^3 in 1964 to RM3.0 m^3 in 2020 (Lani, Yusop and Syafiuddin, 2018). This is a serious situation, for countries like Malaysia because the poor had to allocate a lot of money to get water supply.

Table 2.2: Water tariff in Malaysia for 2019 (Lani, Yusop and Syafiuddin, 2018)

State	Domestic	Non-Domestic
Johor	3.00	3.30
Kedah	1.30	1.80
Kelantan	1.42	1.80
Labuan	2.00	2.28
Melaka	1.45	2.05
N. Sembilan	1.40	2.70
P. Pinang	1.30	1.45
Pahang	0.99	0.99
Perak	1.03	1.40
Perlis	1.10	1.30
Selangor	2.00	2.28
Terengganu	1.00	1.15

The above water tariff is presented in RM/m^3.

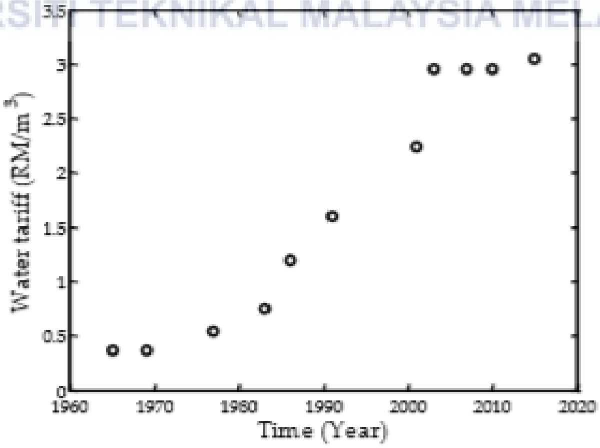


Figure 2.4: Water tariff in Johor (Lani, Yusop and Syafiuddin, 2018)

Apart from that, in 1998, Malaysia faces some serious water shortage due to natural phenomena called El Nino which cause serious drought. El Nino happens when the colder supplement rich water being replaced by the warm water of the western coast of South America (Rahman *et al.*, 2014). This phenomenon causes impacts on the climate examples such as increment in temperature and lessen the amount of rainfall. Figure 2.5 shows the effect of El Nino in Malaysia. Due to this phenomenon from June to August the nation experienced dry and warm conditions which had caused serious water shortage in certain regions.

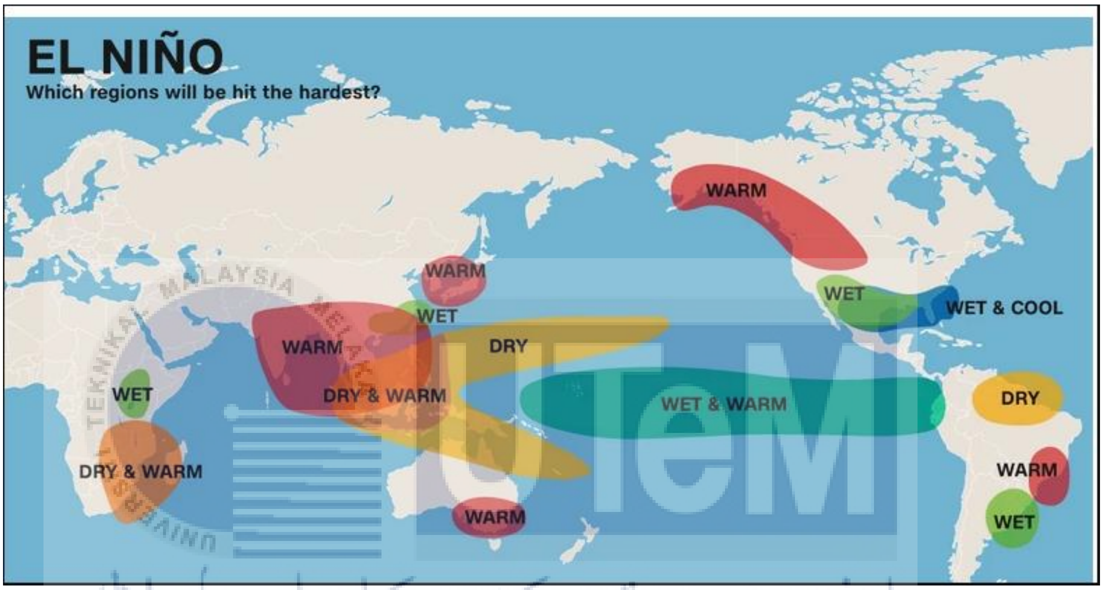
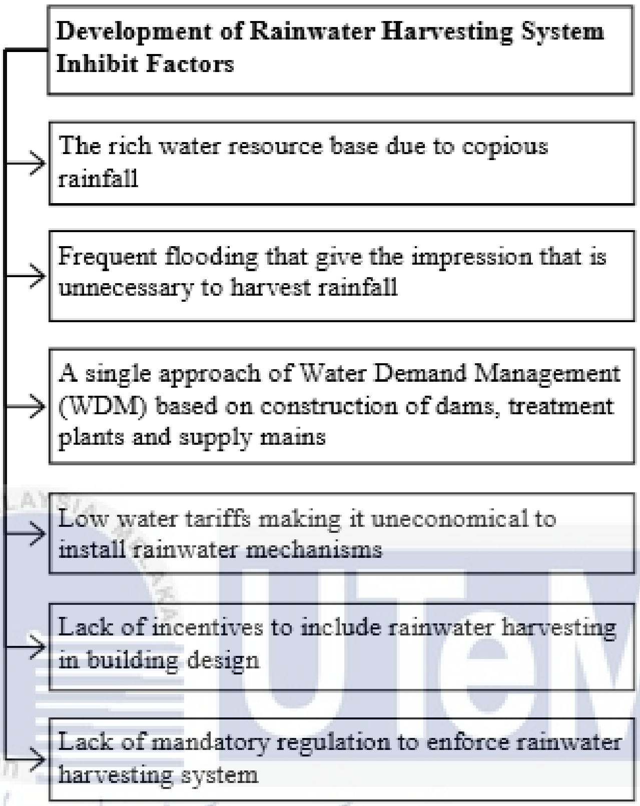


Figure 2.5: Impact of El Nino (Ayob and Rahmat, 2017)

Because of this, Malacca is one of the top cities for having water shortage frequently. To overcome this problem government has introduced rainwater harvesting system (Darus, 2009). Due to lack of awareness among user the execution of this framework isn't moving further (Che-Ani *et al.*, 2009). Because there is more than 95 percent coverage of piped water for rural areas the development of RWHS has stopped (Che-Ani *et al.*, 2009). In any case, it isn't the primary factor that makes this issue occurred. Table 2.3 shows the factors that cause failure for rainwater harvesting system implementation (Che-Ani *et al.*, 2009).

Table 2.3: Factors that cause RWHS to be not successfully developed (Che-Ani *et al.*, 2009)



2.2 Vector-Borne Disease in Rainwater Harvesting Tank

Vector-borne disease are spread by insects. The insects go about as a fundamental stage in the transmission of the contamination starting with one individual then onto the next or from creature hosts to people. There are countless dangerous, illnesses that are transmitted by vector (Kumarasamy, 2006). A table regarding the vector and vector disease is shown in table 2.4. Vector-borne disease caused a portion of deaths every year for example malaria disease causes around 1 million death every year (Hunter, 2003).

The objective of this part is to deal with vector-borne disease in the rainwater harvesting tank. This is in acknowledgment that urban areas can build the danger of vector-borne disease when implementing rainwater harvesting system without proper vector control. Most of the vector-borne disease caused by mosquito. Eggs, larvae, pupae, and adult are the four phases experienced by mosquitoes throughout its life cycle (Samat and Percy, 2012). Mosquitoes normally reproduce on water surfaces or wet vegetation which are stagnant (Mohd-Zaki *et al.*, 2014). Consequently, water tanks present a suitable environment for mosquitoes to reproduce. Health officials from South East Queensland stated that when the presence of mosquito is over 1% in rainwater harvesting tank the system is intolerable (Moglia, Gan and Delbridge, 2016). Besides, (Moglia, Gan and Delbridge, 2016) stated that the usage of rainwater harvesting tank during dry spell resulted in dengue epidemic.

The highest number of vector-borne disease that face by Malaysia is dengue. Dengue epidemic started to occur in Malaysia at 1962 with 40 cases and 5 deaths were recorded (Mudin, 2015). Then in 1973 1,487 cases were recorded with 54 deaths (Mudin, 2015). The cases of dengue in Malaysia kept increasing till in 2014 the highest cases of dengue recorded where 108,698 cases were reported (Mudin, 2015). Figures 2.6 and 2.7 shows the dengue case fatality, incidence rate, number of dengue cases, and deaths in Malaysia.

Table 2.4: Type of vector diseases and clinical effects (World Health Organization).

Vector		Disease caused	Type of pathogen
Mosquito	*Aedes*	Chikungunya	Virus
		Dengue	Virus
		Lymphatic filariasis	Parasite
		Rift Valley fever	Virus
		Yellow Fever	Virus
		Zika	Virus
	Anopheles	Lymphatic filariasis	Parasite
		Malaria	Parasite
	Culex	Japanese encephalitis	Virus
		Lymphatic filariasis	Parasite
		West Nile fever	Virus
Aquatic snails		Schistosomiasis (bilharziasis)	Parasite
Blackflies		Onchoceriasis (river blindness)	Parasite
Fleas		Plague (transmitted from rats to humans)	Bacteria
		Tungiasis	Ecto parasite
Lice		Typhus	Bacteria
		Louse-borne relapsing fever	Bacteria
Sandflies		Leishmaniasis	Bacteria
		Sand-fly fever (phlebotomus fever)	Virus
Ticks		Crimean-Congo haemorrhagic fever	Virus
		Lyme disease	Bacteria
		Relapsing fever (borreliosis)	Bacteria
		Rickettsial diseases (eg spotted fever and Q fever)	Bacteria
		Tick-borne encephalitis	Virus
		Tularaemia	Bacteria
Triatome bugs		Chagas disease (American trypanosomiasis)	Parasite
Tsetse flies		Sleeping sickness (African trypanosomiasis)	Parasite

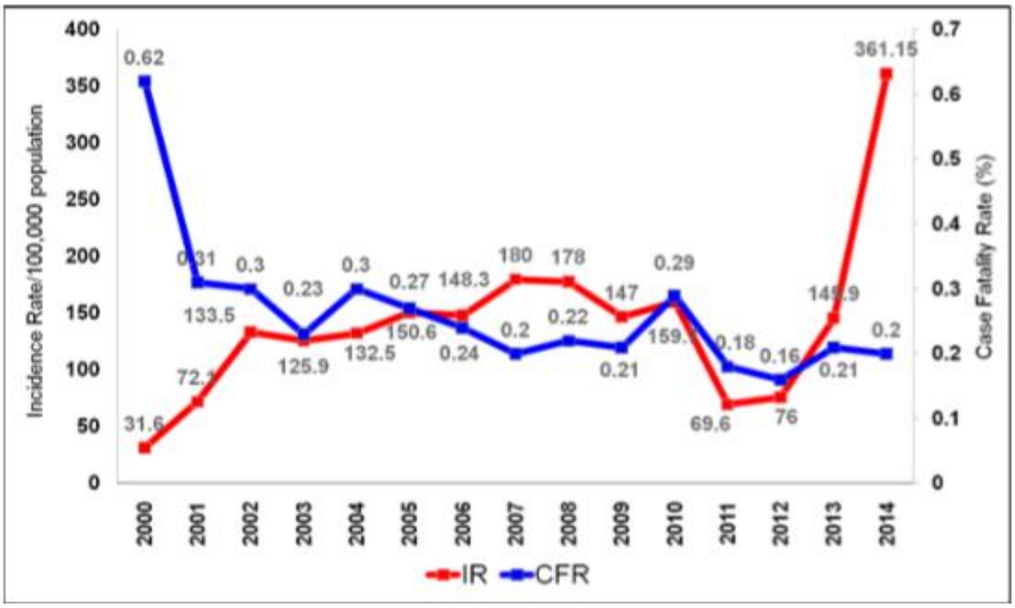


Figure 2.6: Dengue incident and case fatality rate in Malaysia (Mudin, 2015)

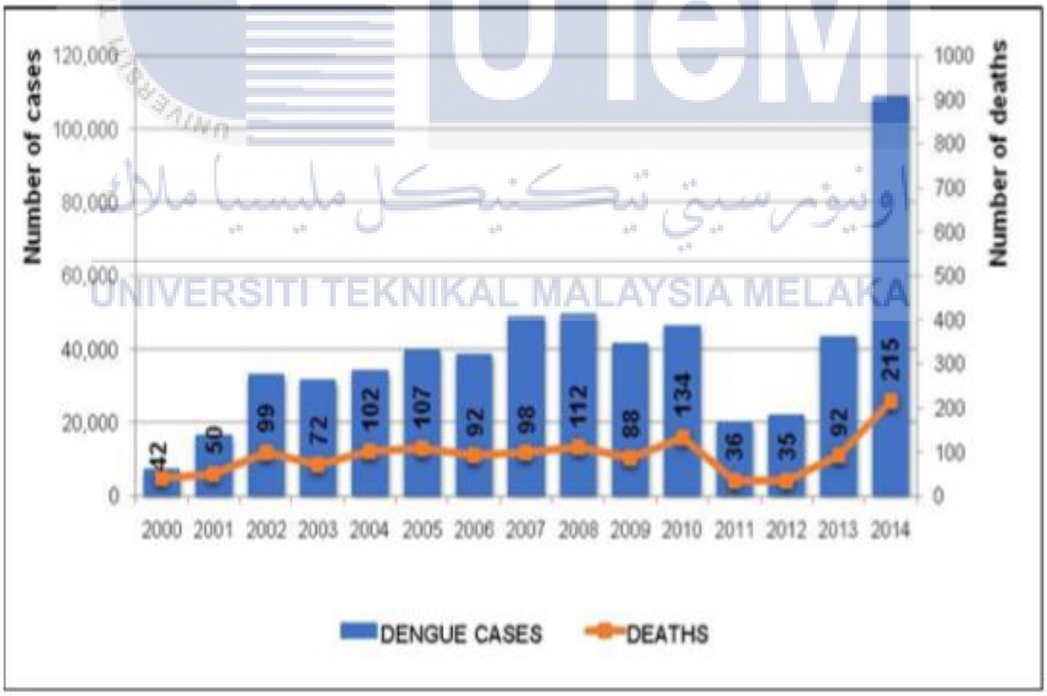


Figure 2.7: Number of dengue cases and deaths in Malaysia (Mudin, 2015)

2.3 Vector Control for Rainwater Harvesting Tank.

(Moglia, Gan and Delbridge, 2016) had published an article on discovering the most effective methods to reduce the risks of mosquitoes in the rainwater harvesting system. This article is all about an inspection of rainwater harvesting system in 417 sites at Melbourne in the year 2014. The questions that they have been asked are attached in table 2.5.

Table 2.5: Types questions that have been used to complete the research (Moglia, Gan and Delbridge, 2016)

No	Questions
1	Does mosquito meshing on inlets provide effective protection against mosquito breeding in systems?
2	Do installation practices influence the rate of mosquito presence in systems?
3	Does the reason for installation influence the rate of mosquito presence in system?
4	Do maintenance practices help reduce the rate of mosquitoes in system?
5	Do the overflow provision and effectiveness influence the rate of mosquitoes in the systems?
6	Does the type of system (dry or wet) influence the rate of mosquitoes?
7	Can mosquitoes enter the tank when both inlet and outlet pipes are adequately sealed or covered by mesh?

2.3.1 Risk alleviation by using mosquito meshing.

Table 2.6: Presence of mosquito larvae depending on the condition of mosquito meshing (Moglia, Gan and Delbridge, 2016)

Mosquito meshing	Condition of mosquito meshing	Presence of mosquito larvae
Yes	Good	15% (31/205)
Yes	Poor	33% (19/58)
No	N/A	46% (12/26)

The above table shows the result from the survey that had been carried out by (Moglia, Gan and Delbridge, 2016). From the table, it can be concluded that when meshing is in good condition the reproduction of mosquito is very low (15%). While when the mosquito meshing is in poor condition the presence of mosquito larvae is 33% and to about a similar degree as when no mosquito meshing the presence of mosquito larvae is 46%. Although used a good meshing result in presence of some larvae, this is due to water ponding in blocked gutters, ill-fitting mesh screens, and physical damage to the tank body (Moglia, Gan and Delbridge, 2016).

2.3.2 Sealed inlets and overflows

Table 2.7: Presence of mosquito larvae depending on the condition of overflow and inlet pipe (Moglia, Gan and Delbridge, 2016)

Mosquito meshing on inlet	Condition of meshing on inlet	Sealed overflow	Presence of mosquito larvae
Yes	Good	No	57%(4/7)
Yes	Good	Yes	4%(3/73)
Yes	Poor	No	60%(6/10)
Yes	Poor	Yes	21%(3/14)
No	N/A	No	63%(5/8)
No	N/A	Yes	14%(1/7)

The table above shows the result from the survey that had been carried out by (Moglia, Gan and Delbridge, 2016). This survey focuses on the inlet and overflow pipes. From the table, it can be concluded that when mosquito meshing on the inlet is in good condition and overflow pipes are sealed the presence of mosquito larvae is only cause 4%. If the overflow is not sealed but the mosquito meshing on the inlet is in good condition still a lot of larvae can be seen in the tank. Besides, even when there is no meshing at the inlet but have a sealed overflow pipe the presence of larvae is only 14%. This shows that sealed overflow pipe is a more required technique to overcome the larvae population in tank than mosquito meshing at the inlet.

2.3.3 Relation to overflow and overflow effectiveness.

Table 2.8: Presence of mosquito larvae depending on the overflow provision (Moglia, Gan and Delbridge, 2016) .

Overflow provision	Overflow effectiveness	Presence of mosquito larvae
Adequate	Yes	18% (32/176)
Adequate	No	17% (7/53)
Inadequate	Yes	32% (10/31)
Inadequate	No	44% (8/18)

The above table shows the result from the survey that had been carried out by (Moglia, Gan and Delbridge, 2016). From the table, adequate overflow means overflow water is directed to drains while inadequate overflow means the overflow water are directed to grass or other areas. The system with adequate overflow has low rates of mosquitoes present. While inadequate overflow causes higher rates of mosquitoes present. This is because inadequate overflow creates a wet environment that is stagnant. This environment will create breeding habitat for mosquitoes, which then it would be a source for mosquito for entering the rainwater harvesting tank.

2.3.4 Risk related to wet system

Table 2.9: Presence of mosquito larvae depending on the way of rainwater entry (Moglia, Gan and Delbridge, 2016)

Rainwater entry	Presence of mosquito larvae
Wet system	25% (18/73)
Downpipe	20% (45/224)

The table above shows the result from the research that has been conducted to identify the presence of mosquito in a wet system and downpipe. In the downpipe rainwater entry system, water runs directly from the gutter to the tank. In a wet system, water runs from the gutter down to the pipe concealed inside the wall then only reaches the tank. The wet system has more mosquitoes production than downpipe because in wet system water can stay stagnant between rain events and became a suitable place for mosquito breeding.

2.3.5 Summary

From the study that has been carried out by (Moglia, Gan and Delbridge, 2016) it can be concluded that 21% of the rainwater harvesting tank has the presence of mosquito. Even though mosquito meshing is present in most of the rainwater harvesting tank inlet still there is presence of mosquito. The major reason for the presence of mosquito is the poor condition of meshing. About 22% of the rainwater harvesting tank has a poor meshing at the inlet pipe. A poor meshing will increase the presence of mosquito as similar to when meshing is not applied. However, there is presence of mosquito even when the meshing is in good condition this is due to the presence of another entry point for mosquitoes like at the overflow. 60% of the water tank has the presence of mosquito due to unsealed overflows, even though the water tank has a good meshing applied. Mosquito reproduction can be reduced to 67% by just sealing the overflow even when the meshing at the inlet is in poor condition. Other than that, adequate overflow provision and downpipe systems will reduce the mosquito's reproduction effectively. Lastly, this study shows that it more important to have a good meshing and sealed overflow installed in a rainwater harvesting tank with adequate overflow provision and downpipe system to protect from deadly vector diseases.

2.4 Related Previous Project.

2.4.1 Automatic Water Level Control System by Asaad Ahmed Mohammedahmed Eltaieb and Zhang Jian Min

2.4.1.1 Introduction

To smartly manage water flow and detect the water level (Eltaieb and Min, 2015) have proposed a design which uses Arduino as a processor. Figure below shows the block diagram of the prototype and the system flowchart.

2.4.1.2 System Description

A conductive strategy is utilized to measure the level of water. 5 aluminium wires arranged from bottom to the top of the tank which acts as a sensor. 4 aluminium wire is connected with analog input pins of Arduino. The fifth aluminium wire which is placed at the base of the tank is connected with +5 V DC. Since +5 V is connected with fifth wire, whenever the water touches any other wire than the fifth wire electric connection is built up. The developed current is converted into voltage by resistor. Arduino reads the voltage dropped across resistor to detect the amount of water in the tank. For measure, the level of water in the sump tank similar conductive method is used. Buzzer, pump unit, and LCD are connected with the output pin of Arduino. When the sump tank is empty buzzer will star to buzz. Pump unit will be turned on automatically by Arduino when the water in the water tank is low to start fill up water till it full the tank. LCD will display the real time level of the water in both the water tank.

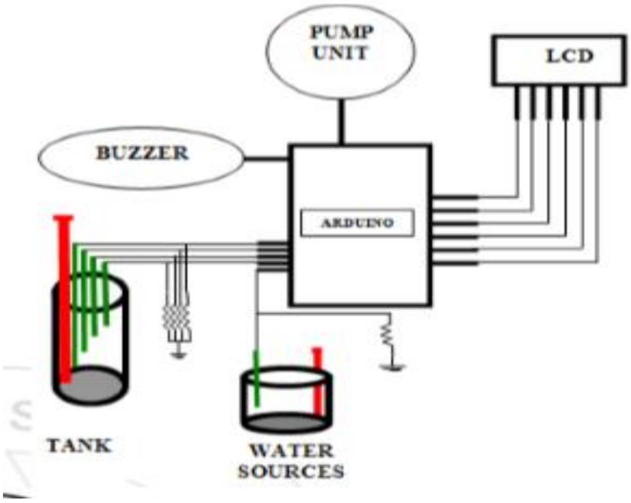


Figure 2.8: Block diagram of the prototype (Eltaieb and Min, 2015)

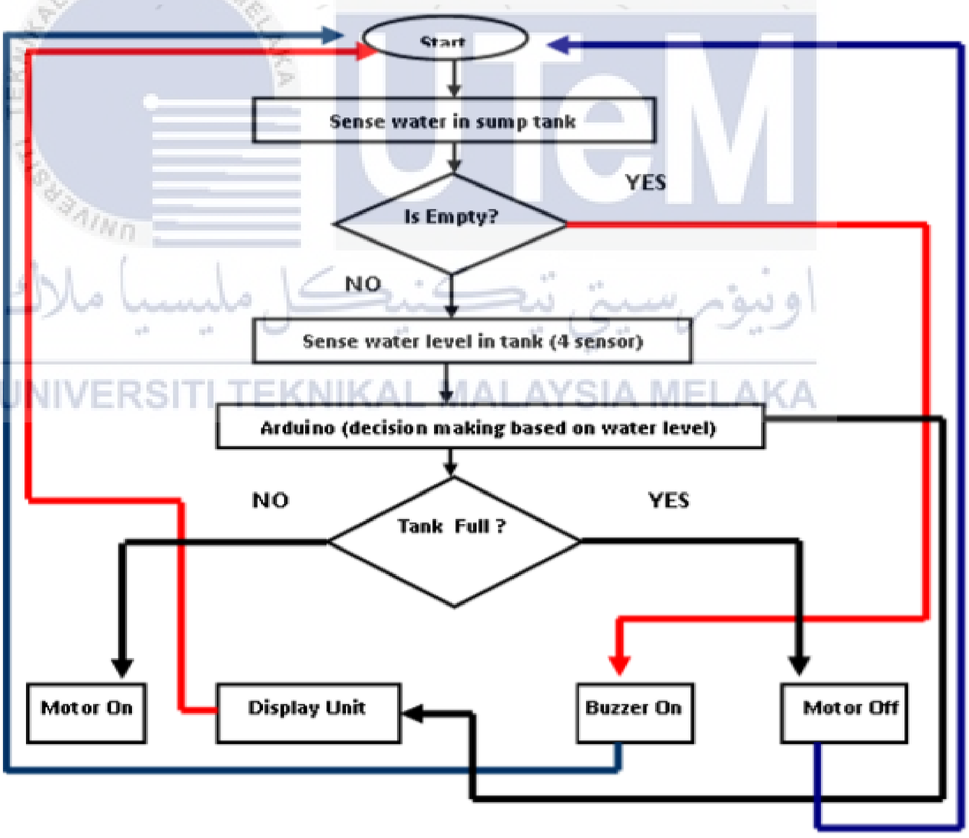


Figure 2.9: System Flowchart (Eltaieb and Min, 2015)

2.4.2 Raspberry Pi based Liquid Flow Monitoring and Control by N.Suresh , E.Balaji , K.Jeffry Anto and J.Jenith.

2.4.2.1 Introduction

This article is all about a prototype design to monitor and control the flow rate of liquid via web server. The equipment used to build the prototype is solenoid electro-valve, hall-effect flow sensor, microcontroller, and web server. The solenoid electro valve is an electromechanically operated valve. The operating voltage for this equipment is 12 V. Solenoid electro-valve is shown in figure 2.11. Flow rate is measured using of hall effect sensor. Hall effect sensors are utilized for flow detecting applications, speed recognition, and positioning. This equipment is able to measure 1 to 30 litres per minute.

Figure 2.10: Flow meter sensor (N.Suresh, et al., 2014)

Figure 2.11: Solenoid electro-valve (N.Suresh, et al., 2014)

2.4.2.2 System Description

The figure below shows the block diagram of the project. Arduino and raspberry pi used as a microcontroller in this project. The hall effect sensor will measure the flow rate. The flow meter is connected with the electro valve. The flow sensor will send an analog signal to the Arduino once it measures the flow of liquid. After Arduino receives the analog signal it will interpret the signal and send another signal to the raspberry pi. Arduino is connected to raspberry pi via serial bus port. Raspberry pi will control the electro valve once it receives a signal from Arduino. Solenoid electro-valve can be controlled using an internet connection because raspberry pi is integrated with web server. Python language is used to program the raspberry pi to receive data from Arduino and upload the data to the server. Solenoid electro-valve and raspberry pi is connected using GPIO. Raspberry pi is the one who supplies the +12 V to the solenoid electro-valve. Therefore, the power supply and control to the solenoid electro-valve is provided by raspberry pi. The prototype model is shown in figure 2.13.

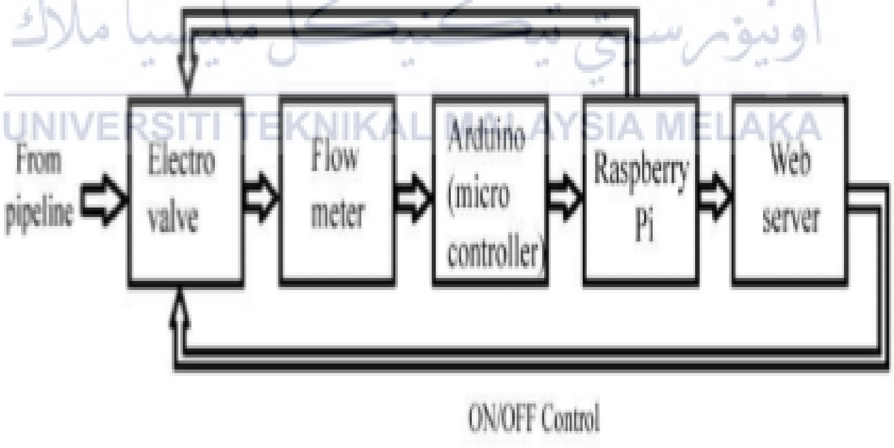


Figure 2.12: Proposed system for liquid flow control *(N.Suresh, et al., 2014)*

Figure 2.13: Prototype model *(N.Suresh, et al., 2014)*

2.4.3 The Application of Fuzzy Control in Water Tank Level Using Arduino by Faycal Chabni, Rachid Taleb, Abderrahmen Benbouali and Mohammed Amin Bouthiba.

2.4.3.1 Introduction

In industries, the fluid level control issue is regularly experienced. In these days, PID is the most popular controller used due to its effortlessness, strength and it can be effectively executed on any processor but still utilizing a PID controller isn't completely helpful with regards to managing nonlinear frameworks. In such case, fuzzy logic control can be utilized. A comparison of performance between the PI (Proportional Integral) and fuzzy logic controllers had been done in this article.

2.4.3.2 System Description

The equipment used to build the prototype are water tank, water pump, liquid level sensor, dc/dc converter power supply and Arduino (microprocessor). The prototype model and the block diagram of the prototype is shown in figure below.Water pump is used to pump water to the water tank from water reservoir tank.A valve is placed to adjust the flow rate of water leaving the reservoir tank. The Arduino is utilized as a microcontroller in this project. A PC is used to show signals and to force set focuses for the controller.

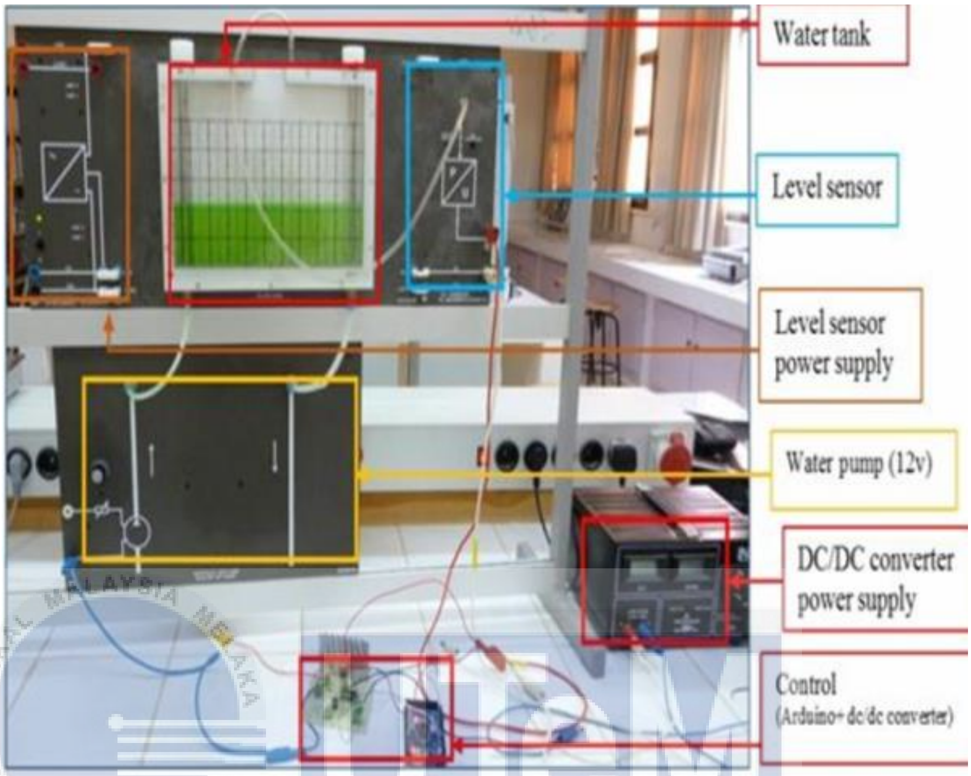


Figure 2.14: Prototype model *(N.Suresh, et al., 2014)*

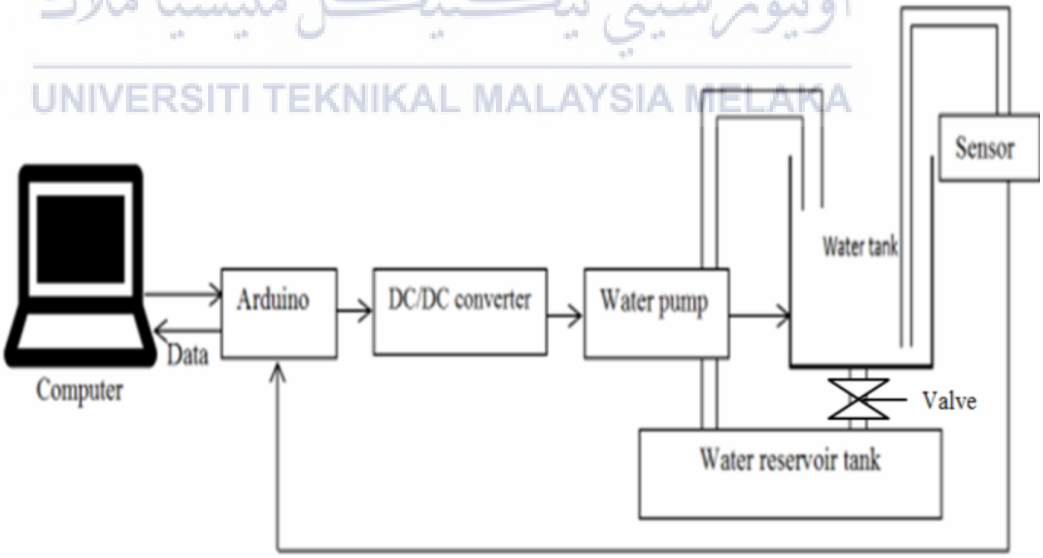


Figure 2.15: Block diagram of the project (CHABNI *et al.*, 2016)

2.4.3.3 Comparison between Fuzzy Logic Controller and Pi Controller

Based on the mathematical model from the identification phase two design of these controllers had been made on Matlab. The simulation of the two designs shown in figure 2.16 and 2.17. The simulation had been done to identify which is the better perform controller. To identify the performance from simulation gain Kp and Ki were calculated. Figure 2.18 and 2.19 shows the results obtained from the simulation. After that, the function of the controller had been applied on Arduino to check it performance. The result was shown in figure 2.20 and 2.21. From all of the results, it can be concluded that fuzzy logic control performs better and had great stability for every set point and have fast fault compensation.

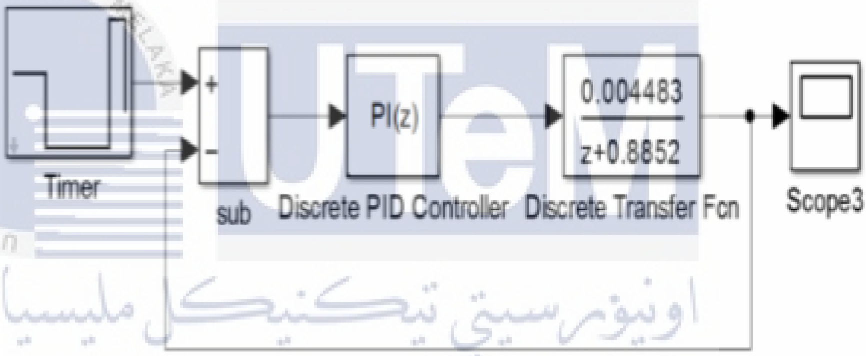


Figure 2.16: Simulation design of Pi Controller (CHABNI *et al.*, 2016)

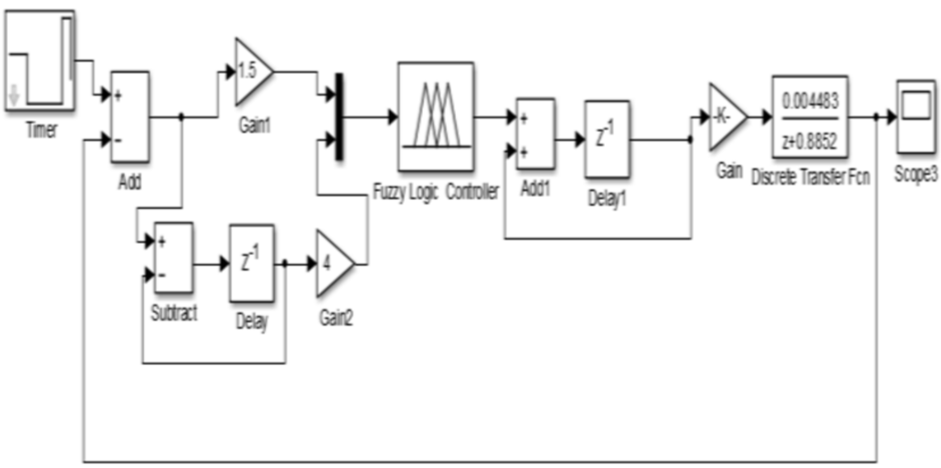


Figure 2.17: Simulation design of Fuzzy Logic Controller(CHABNI et al., 2016)

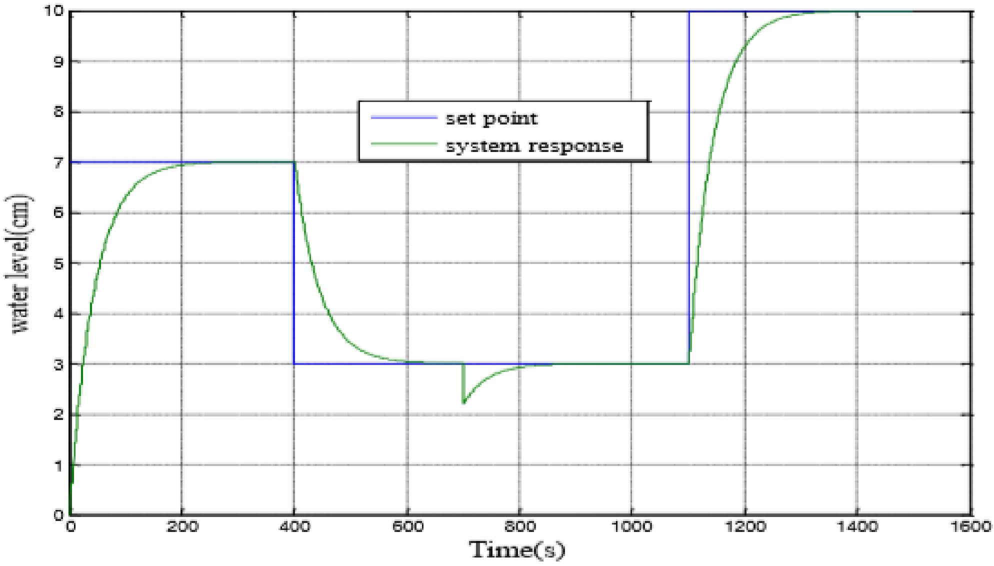


Figure 2.18: Simulation result of Pi Controller (CHABNI et al., 2016)

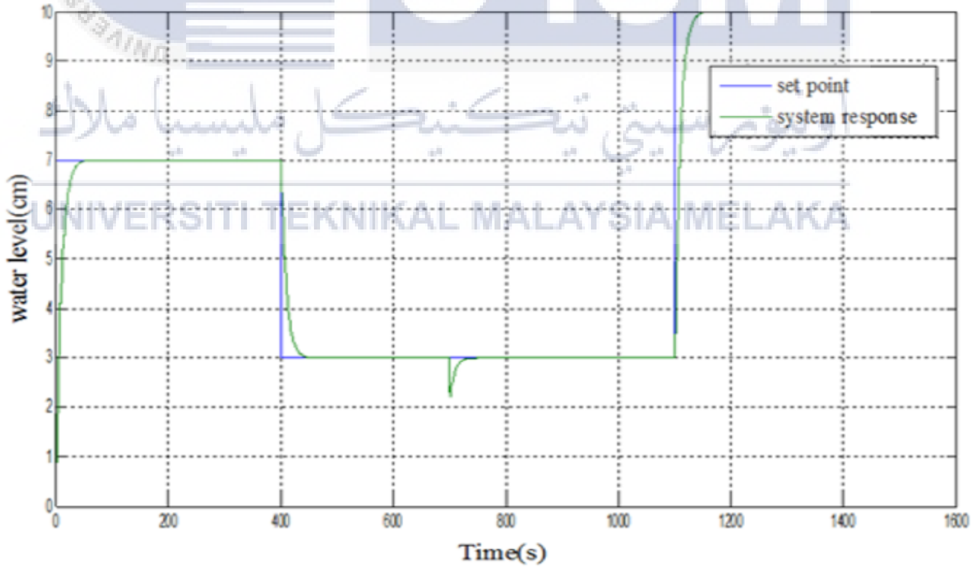


Figure 2.19: Simulation result of Fuzzy Logic Controller (CHABNI *et al.*, 2016)

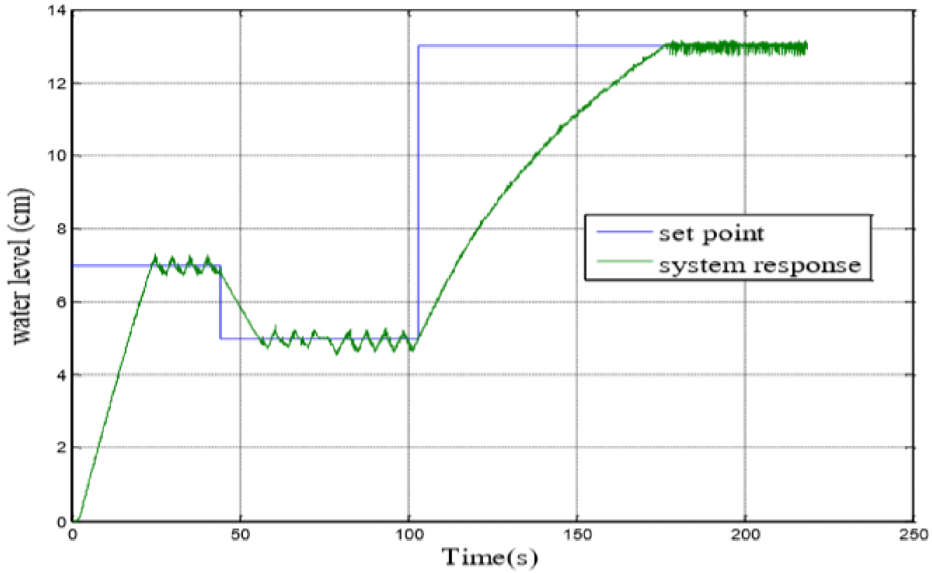


Figure 2.20: Experimental result of Pi Controller (CHABNI et al., 2016)

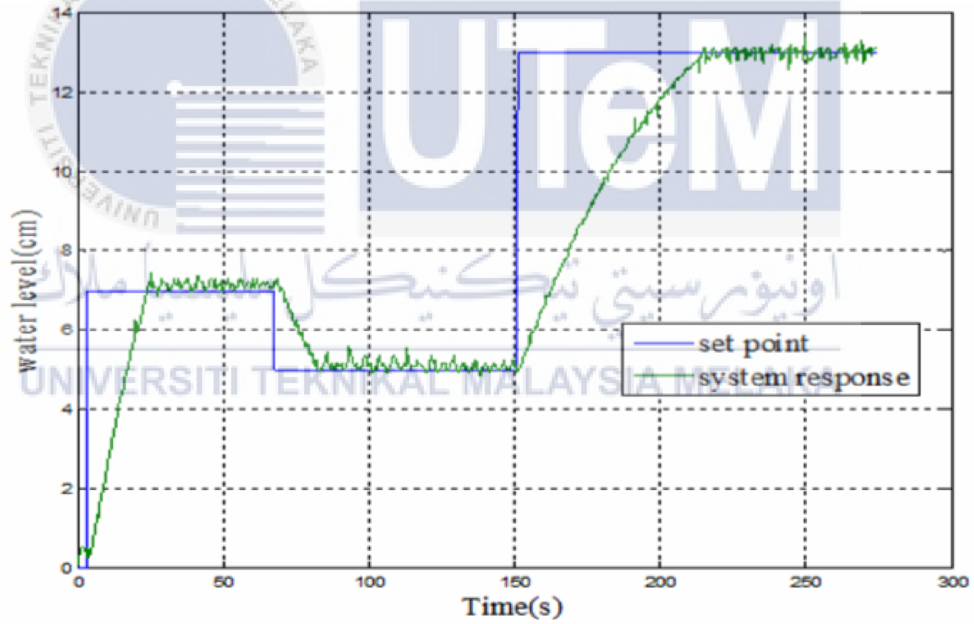


Figure 2.21: Experimental result of Fuzzy Logic Controller (CHABNI *et al.*, 2016)

2.4.4 Smart Water Management using Iot by Sayali Wadekar, Vinayak Vakare, Ramratan Prajapati, Shivam Yadav and Vijaypal Yadav

2.4.4.1 Introduction

The main objective of this article is to build a water management system for urban areas using IoT. An increase in population has caused the demand for clean water to increase. Therefore, the author proposed a prototype that can smartly manage usage of water. Resistor, CC3200 Wi-Fi module, led, single-stranded wire, and BC 547 transistor are the equipment used to build the prototype. The conductive strategy is used to detect the level of water. The block diagram of the prototype is shown below.

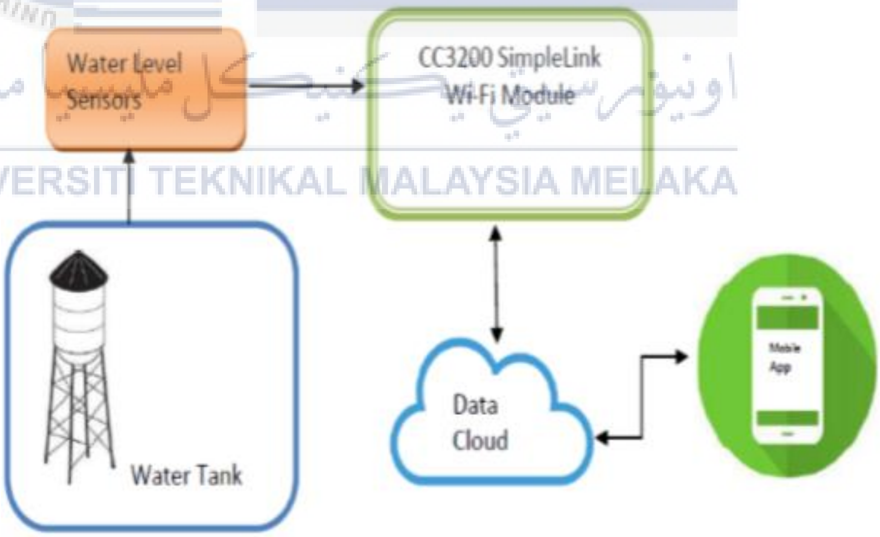


Figure 2.22: Block diagram of prototype (Wadekar et al., 2017)

2.4.4.2 System Description

Four sensors were placed at the water tank to detect four levels of water presence. The sensor is connected with +VCC supply and NPN transistor. Signal would be sent by the sensor to transistor whenever water came in contact with the sensor. Transistor then will send a signal to CC3200 launchpad GPIO pins. Coding for CC3200 is written using Energia software. CC3200 works in client mode where user needs to allocate hotspot so that a device will able to connect to it. Motor will be turned on to fill water in the tank and the message "Motor on" will be displayed at app whenever the water level in the tank is very low. Also, the real-time level of water is shown in the app. The motor will stop automatically and will display a "high" message to the application whenever the tank is full. CC3200 will send this information to a particular server. The server used in this prototype is "Dweet". The information can be fetched through a smartphone by using a programmed application. The mobile application will display the real-time water level with the exact time. Figure 2.23 shows the prototype and figure 2.24 shows the flow chart.

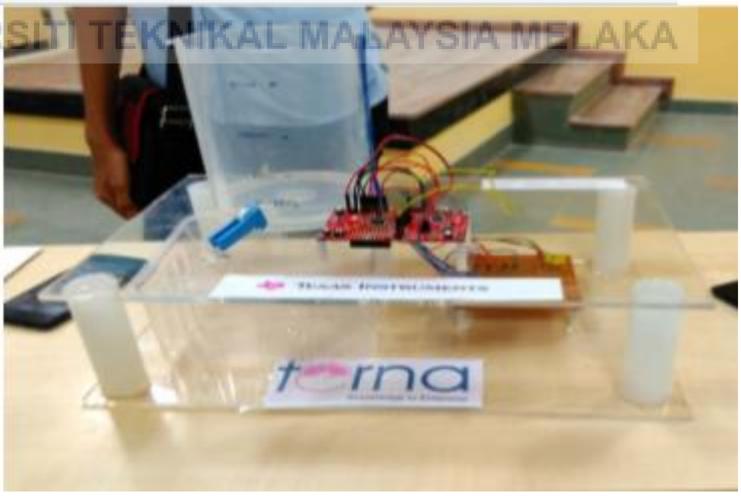


Figure 2.23: Prototype (Wadekar et al., 2017)

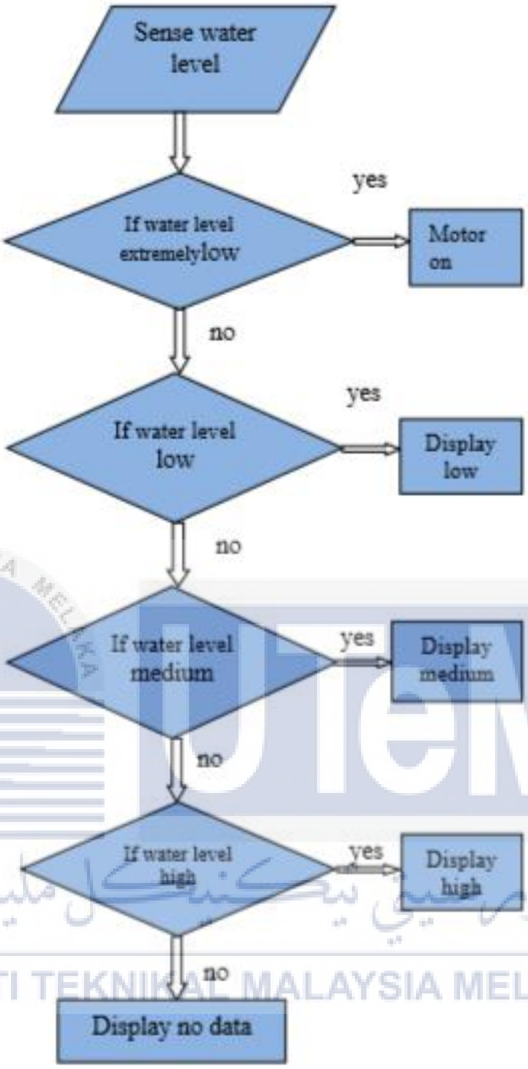


Figure 2.24: Flowchart of the prototype (Wadekar *et al.*, 2017)

2.4.5 Automatic Water Level Indicator and Controller by using Arduino by P.Nancy Rachel, D.Sophia, G.Sandhya Rani, J.Jahnavia Rishika, P.Sai Annapurna.

2.4.5.1 Introduction

The clean water crisis in Asia is arriving at disturbing extents. Subsequently, it is of most extreme significance to safeguard water for people. Water scarcity happens due to poor water flow management. The main aim of this project is to overcome this problem by implementing a proper water flow management system.

2.4.5.2 System Description

Arduino UNO, submersible water pump, ultrasonic sensor, buzzer, relay module, LCD 16 x2, battery, and wires are the equipment used to build the prototype. The water level in the tank is measured using the ultrasonic sensor. The ultrasonic transmitter will send an ultrasonic wave to the tank. The wave will travel until it hits the water surface and will be reflected back to the ultrasonic receiver. The time taken for the wave to reflect back will be computed by the ultrasonic sensor. Arduino is used compute the distance between the water and sensor by utilizing the formula $S = (V \times t)/2$ where S is the distance, t is the duration it took for the ultrasonic wave to be reflected back to ultrasonic receiver and V is the speed of sound and display the distance in LCD. Arduino also will control the relay to turn on and off the water pump. The relay will turn on when the height is more than 100 cm and will turn off when the height is below 20cm. Since the sensor is attached on top of the tank when the height reduce it indicates that tank going to be full. Whenever the water pump turns on or off buzzer will start to buzz for a while. The figure below shows the block diagram and schematic diagram of this project.

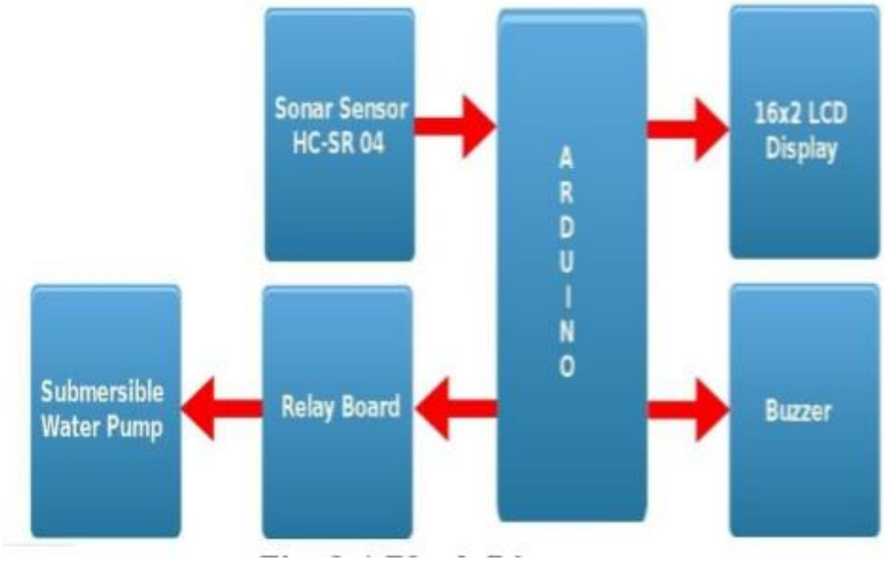


Figure 2.25: Block diagram of the prototype *(Rachel, et al., 2018)*

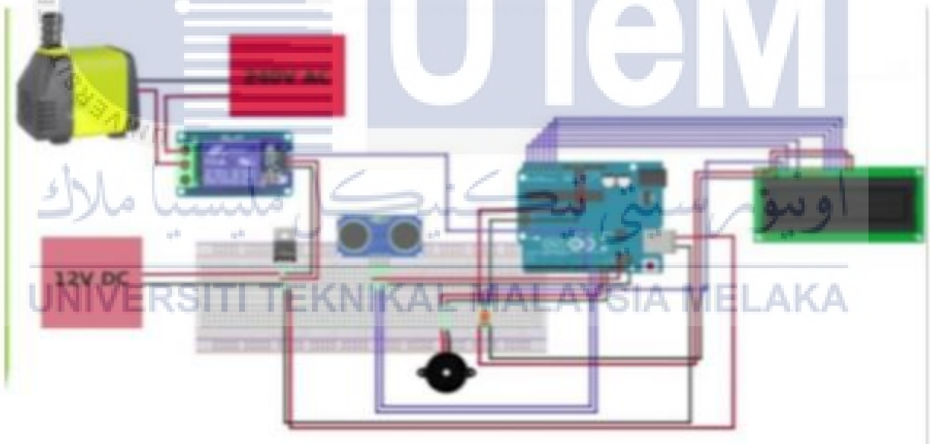


Figure 2.26: Schematic diagram of the prototype *(Rachel, et al., 2018)*

2.4.6 Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue by S.M.Khaled Reza, Shah Ahsanuzaman d.Tariq and S.M. Mohsin Reza.

2.4.6.1 Introduction

Now days, water shortage becoming a biggest problem all over the nation. This is due too poor water management. To overcome this issue the author of this paper builds a prototype to smartly manage water flow. PIC 16F84A(microcontroller), transistor, inverter, crystal oscillator, led, capacitors, water level sensor, inductor, and resistor are the equipment used to build the prototype. Water level sensor was made by using rubber, iron rod, resistance and nozzles. The rod and nozzle will be bind together with rubber to create a sensor.

2.4.6.2 System Description

Figure 2.27 shows a complete circuit diagram. In this prototype presence of water in the sump tank is detected by pin RA4 from microcontroller while the presence of water in the water tank is detected by pin RA0 to RA3. Microcontroller is connected with a crystal oscillator along with 2 capacitors to execute the instruction from the coding. If there is no water in the water tank all the four pins will receive ground signal (0v) and led will turn off. Due to this the water pump will be turned on automatically. The water pump will stop only when all the pins receive positive signal (+5v) because when all pins receive +5v it means that the water tank is full. When the tank is full all led will light up automatically. Besides, when the water level decreases, the LEDs will turn off one after another but when the water level increase the LEDs will turn on one after another. Figure below shows the flowchart of the prototype.

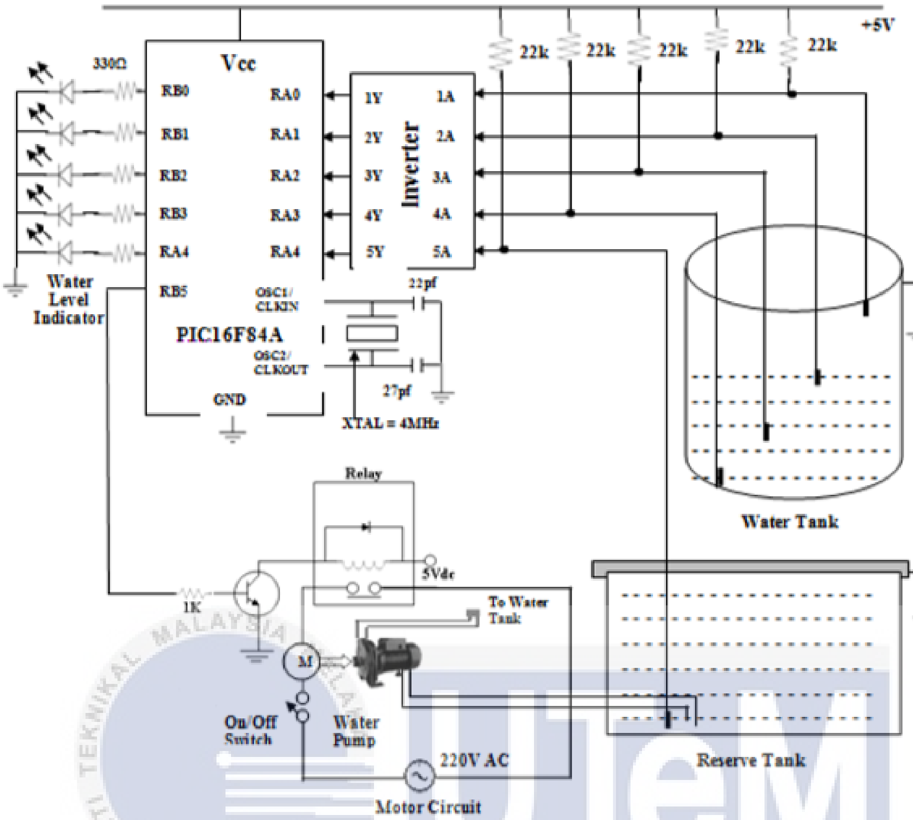


Figure 2.27: Circuit diagram of the prototype (Reza, Tariq and Reza, 2010)

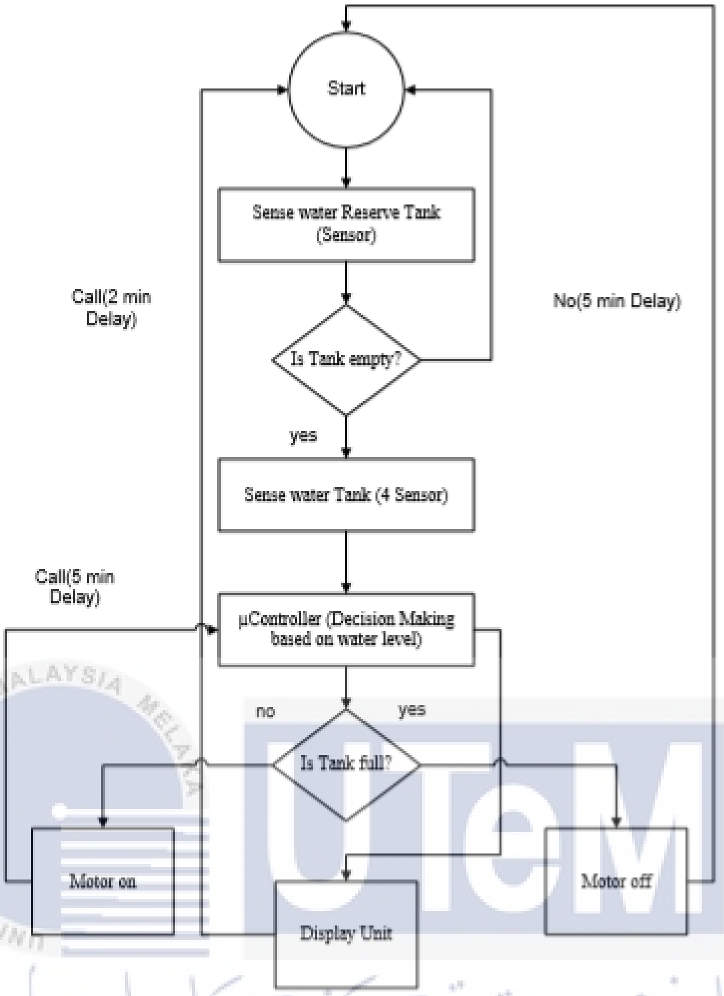


Figure 2.28: Flowchart of the prototype (Reza, Tariq and Reza, 2010)

2.4.7 Logical Automatic Water Control System for Domestic Applications by Hassan Jamal.

2.4.7.1 Introduction

Pakistan faced a big problem to supply clean water to its growing population. To overcome this problem (JAMAL, 2016) had created a water management system to control the wastage of clean water by overflow in overhead tank present in every household. The equipment used to build the prototype is dry battery, 555 timer IC, solar panel, LEDs, power supply, gates, relays, buzzer, resistors, probes, and invertors.

2.4.7.2 System Description

The water level is detected by using the conductivity method. Water level will be detected when the metallic contacts touch the water surface, instantly water pump will turn on or off depends on the condition that had been set. When metallic contact touches water it will send a signal to AND gate. Green colour will light up when the water level is at 30% respectively when the water level is 90% white LED will light up and when the tank is full red colour LED will light up. This system operates on solar energy provided by solar panel. This system also will shift from solar energy to backup power from storage battery whenever the intensity of sunlight is low. This system only requires 0.84 Watts which directly indicates that this system is economical and efficient. The schematic diagram of this project is attached in figure 2.29.

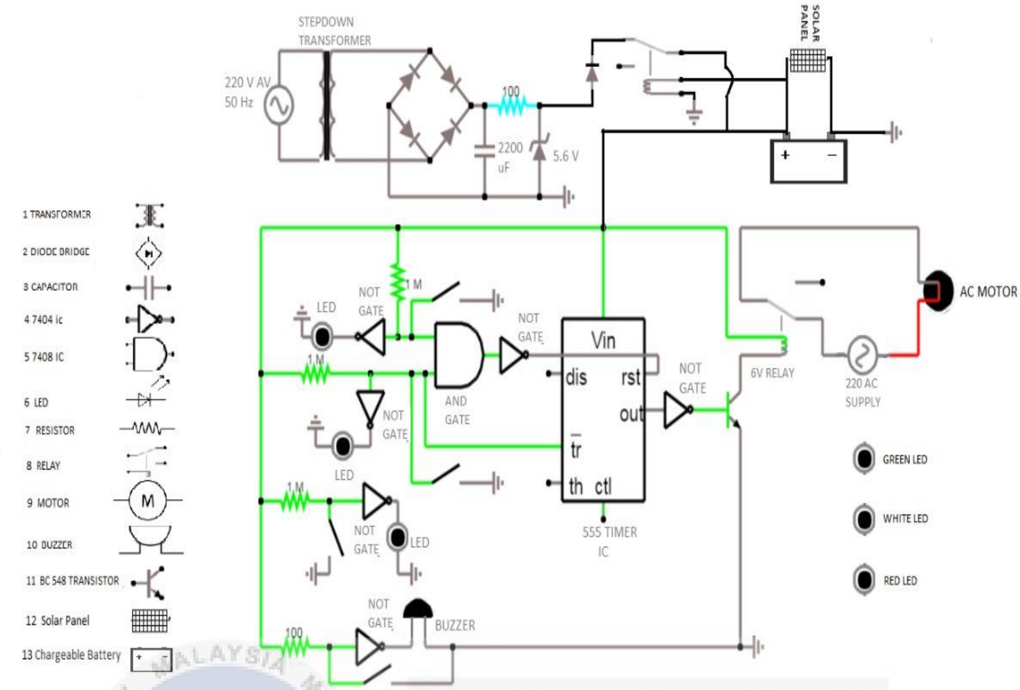


Figure 2.29: Schematic diagram of the project (JAMAL, 2016)

2.4.8 Construction of Automatic Water Level Controller for Both Overhead and Underground Tanks by Ogbidi Joseph Abang and E.Amorji-Nike.

2.4.8.1 Introduction

To overcome the problem of poor water management (Abang & Amorji, 2013) had built a prototype to smartly manage the flow of water in the overhead and underground tank. This project can be divided into 5 different parts which are the power supply unit, sensor unit, pump control unit, display unit, and control unit.

2.4.8.2 System Description

The power supply unit provide power to the prototype by converting 230 AC voltage to 5 DC voltage by using transformer, rectifier, capacitor, voltage regulator and Zener diode. Next, the display unit will display the level of water in the seven-segment display. The sensor unit will detect the level of water and send the signal to the microcontroller (AT89S50). The water level is detected by a conductive method, where when water touches the probe the transistor is switched on and change the logic from 1 to 0. This change will be detected by microcontroller. The control unit is all about the microcontroller (AT89S50). The microcontroller is the brain of the project it will perform all the action in this prototype. It will control the display unit, sensor unit and pump control unit. Lastly, the pump control unit consist of water pump, relay, and transistor. When the water in the tank is low, microcontroller will send logic 1 to the base of the transistor, then the transistor will turn on the water pump by using relay while when the tank is full, the microcontroller will send logic 0 to the transistor and the water pump will be turned off with the help of relay.

2.4.9 Comparison of Related Previous Project.

Table 2.0.10: Comparison of previous project.

No	Author	Title	Component	Advantage	Disadvantage
1	(Eltaieb and Min, 2015)	Automatic Water Level Control System	Aluminium wires (water level sensor), Arduino.	Low cost	Hard to implement. No vector control implemented
2	(Suresh et al., 2014)	Raspberry Pi based Liquid Flow Monitoring and Control	Hall effect type sensor, raspberry pi	Can control water flow via smartphone	High cost. No vector control implemented
3	(CHABNI *et al.*, 2016)	The Application of Fuzzy Control in Water Tank Level Using Arduino	MATLAB, Arduino.	Low cost	No vector control implemented
4	(Wadekar *et al.*, 2017)	Smart Water Management using Iot	Single stranded wire (water level sensor), CC3200	Can view the real time water level.	Hard to implement No vector control implemented
5	(Rachel, et al., 2018)	Automatic Water Level Indicator and Controller by using Arduino	Ultrasonic sensor (water level sensor), Arduino	Low cost	Not precise measurement No vector control implemented
6	(Reza, Tariq and Reza, 2010)	Microcontroller Based Automated Water Level Sensing and Controlling	Home-made water level sensor, Microcontroller	Low cost Precise measurement	Hard to implemented No vector control implemented
7	(JAMAL, 2016)	Logical Automatic Water Control System for Domestic Applications	555 timer IC, solar panel, Single stranded wire (water level sensor)	Low cost No coding required	Old method of implementation. No vector control implemented
8	(Abang & Amorji, 2013)	Construction of Automatic Water Level Controller for Both Overhead and Underground Tanks	Single stranded wire (water level sensor), microcontroller (AT89S50)	Precise measurement.	Hard to implemented No vector control implemented

2.5 Summary

Water shortage is being a bigger problem all over the nation. Rapid economic and industrialization development increase the demand of water supply. To overcome this problem the rainwater harvesting system had been introduced. But the introduced rainwater harvesting system does not have a proper water management system and vector control system. Hence, it is necessary to overcome this problem to avoid water wastage and vector reproduction. Therefore, a project was proposed to overcome this problem and aims to display the total amount of water in the tank, control water flow precisely, and with proper vector control.

CHAPTER 3
METHODOLOGY

3.0 Introduction

This chapter is all about the method on how this project will be completed to achieve the stated objective. In order to ensure the flow of project is uninterrupted a detail research on the hardware was made to have a better knowledge regarding the best equipment to use. Besides, in order to get an overall view on this project, flowchart was created. This chapter can be divided into 3 main parts which is planning, design, hardware specification and summary.

3.1 Planning

Planning was made to ensure the project can be completed within the given time frame successfully. Without proper planning, this project cannot be completed successfully.

3.1.1 Work plan of the project

The total duration given to complete this project is exactly 2 semesters. Where it starts on February 2020 till January 2021. Progress of this project is shown through a Gantt chart in appendix. Gantt chart is used to arrange the task accordingly. It is also used to track the progress of work from time to time to ensure the project is completed within the given time. Flowchart of "Project Sarjana Muda" is shown in figure 3.1

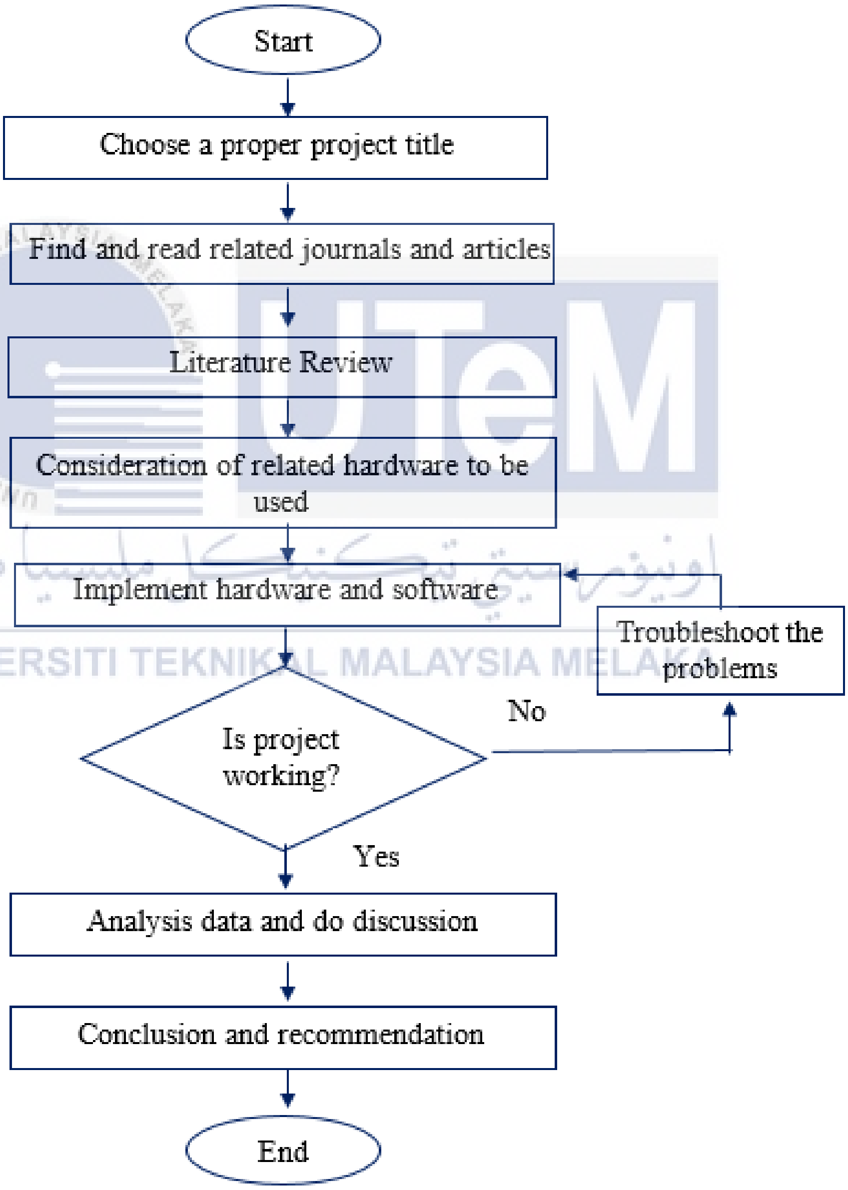


Figure 3.1: Flowchart for PSM

3.1.2 Data collection

Data collection is an essential method that must be done to get an overall view about the project. Data collection is done by collecting all the information regarding the project through journal and articles. The sources searched for this project can be divided into 4 parts which are the water issues in Malaysia, vector-borne issues in rainwater harvesting tank, vector control for rainwater harvesting tank and water flow management system. Data is gathered using Google Scholar and Mendeley. Once the prototype is completed, data will be again collected regarding the effectiveness of the prototype and the possibility of vector infestation in the rainwater tank.

3.2 Design

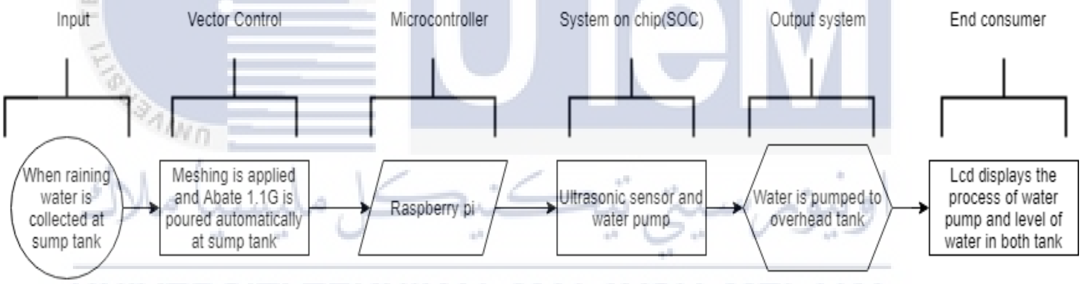


Figure 3.2: Block diagram of the project

The above figure shows the block diagram of the project.There are three essential elements required to run the project successfully. The three elements are the vector control, microcontroller, and system on chip(soc). Rainwater will be stored in the sump tank which had been implemented with vector control. The vector control implemented is meshing applied at the inlet and overflow of the tank. Besides, abate 1.1 G is poured weekly once into the tank. Raspberry pi will open the valve for 2 seconds using linear solenoid actuator for the abate 1.1 G to be poured in the tank and close the valve back. Ultrasonic sensor is used to measure the water level at the sump tank and header tank. Then the sensor will send the information signal to raspberry pi to interpret the signal. After the interpretation, Water will be pumped from the sump tank to the header tank to fill it up whenever the water amount is low in the header tank. Water pump will later turned off when the header tank is full. Water pump also will be turned off when sump tank has lower volume of water or empty. The LCD 16 x2 displays the status of process which is “ header tank is full”, “sump tank empty”, “sump tank is full” and “header tank being filled”. Figure 3.3 show the flow of the project and figure 3.4 shows the flowchart of the project.

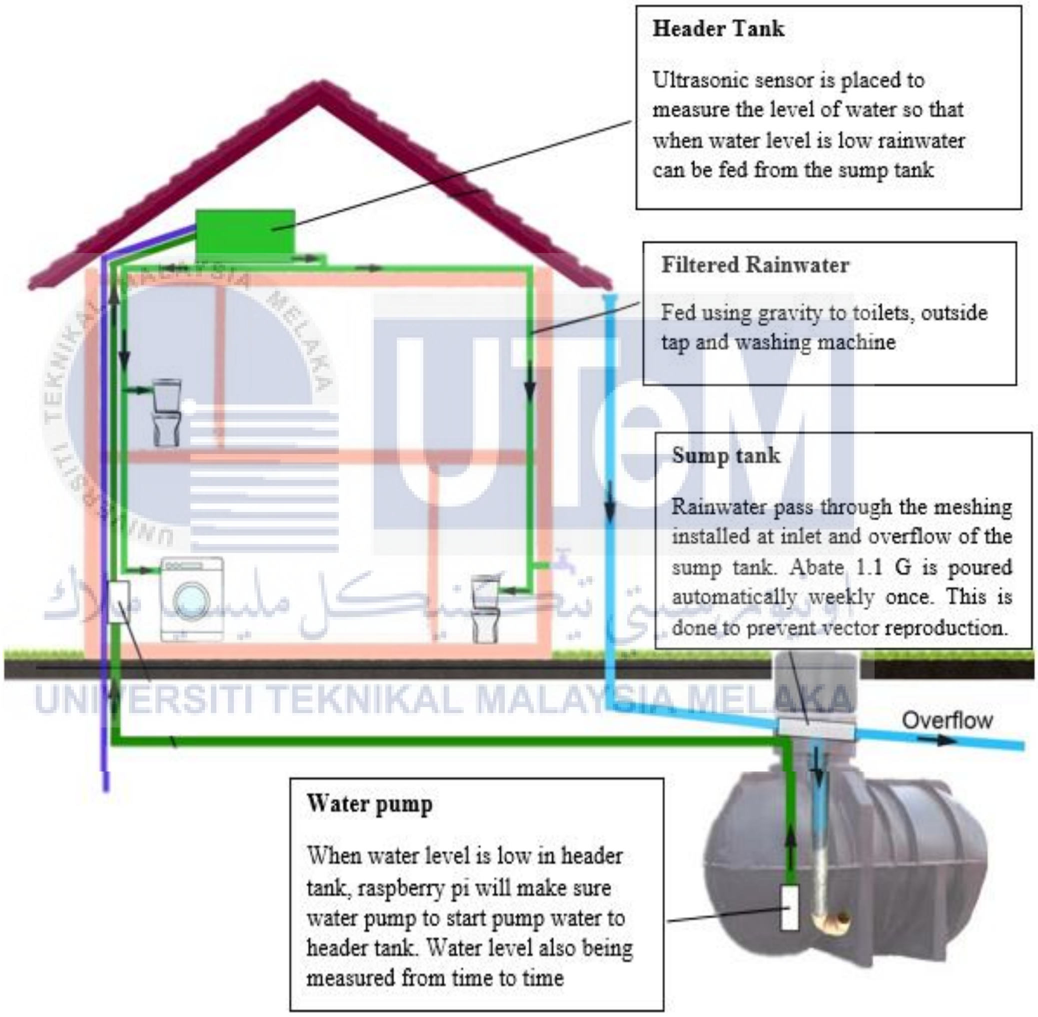


Figure 3.3: Overall view of the project.

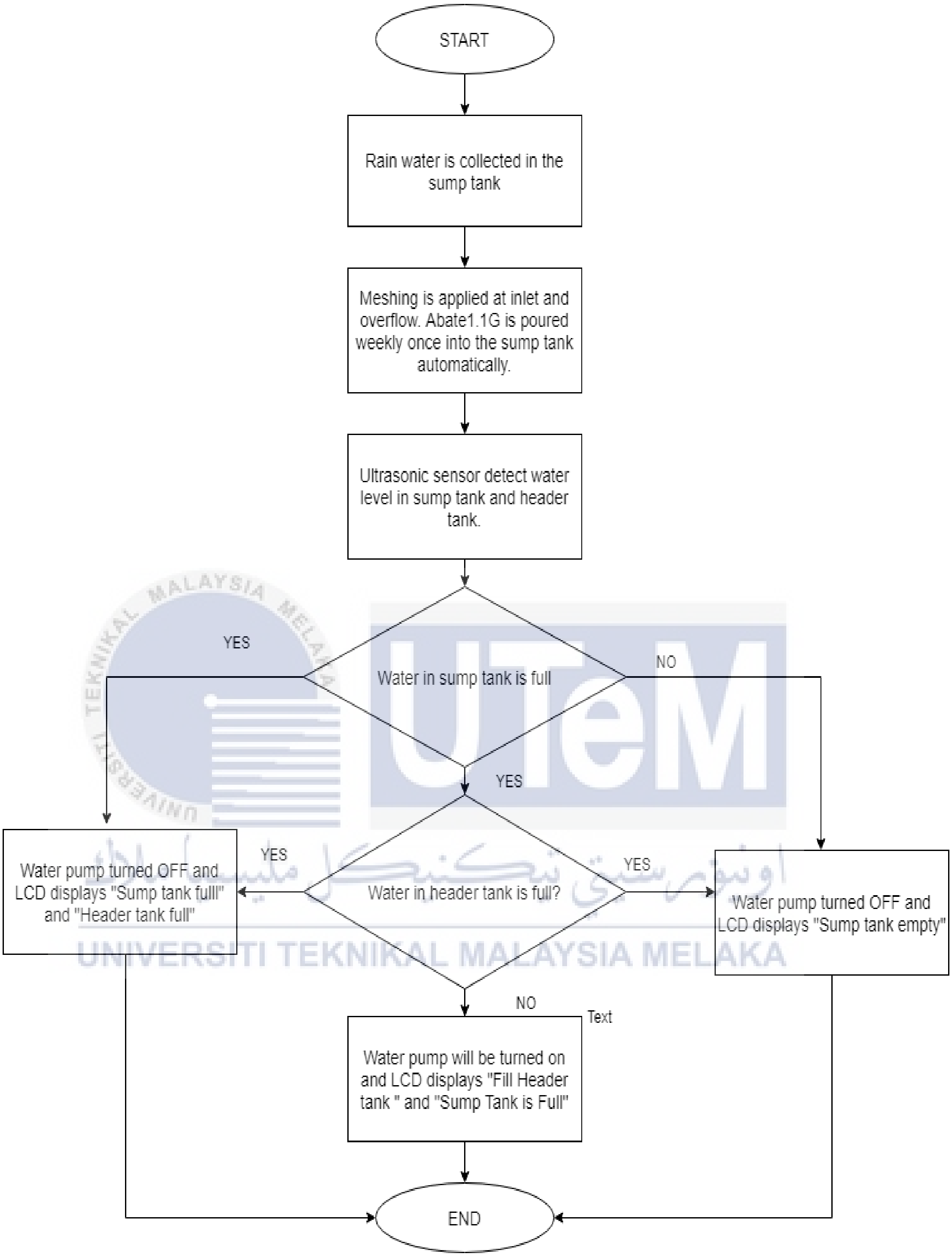


Figure 3.4: Process of the project

3.3 Hardware specification

3.3.1 Raspberry Pi Zero WH

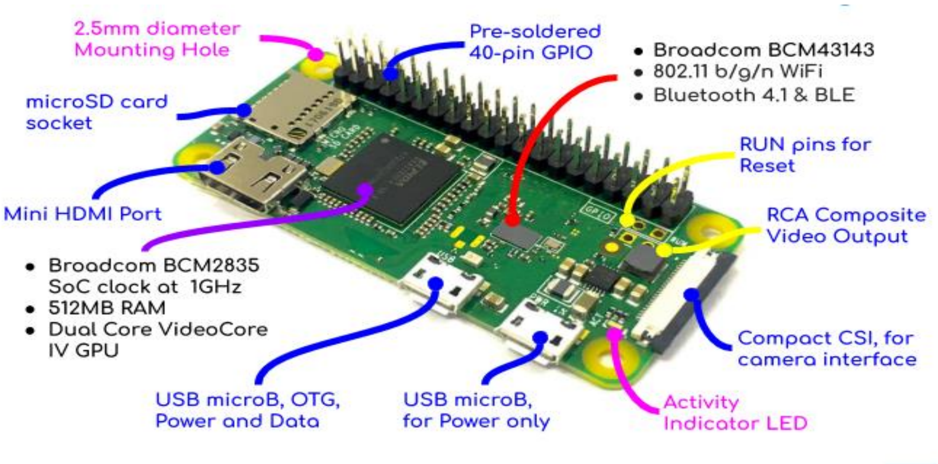


Figure 3.5: Raspberry Pi Zero WH

The Raspberry Pi Zero WH (Wireless with Header) comes with built in Wi-Fi and Bluetooth. These two features are important for a future upgrade in the project. The dimension of Pi Zero WH is 65mm x 30mm x 5mm. The processor used is BCM 2835 SOC and the clock speed is 1GHz. It contains 512MB RAM and a micro SD can be used for external memory. Mini-HDMI port is used for display and audio. The board consists of 2 USB ports, where one is used for power and the other one is used for data. Besides, it has 40 GPIO pins connector which is used for inputs and outputs. The raspberry is powered up by micro USB.

Comparing Raspberry Pi with Arduino, Raspberry Pi is more powerful than Arduino because the clock speed is 40 times faster than Arduino. Arduino is a microcontroller, whereas Raspberry Pi is a mini-computer. Besides, this raspberry pi cost less than an Arduino control board. In Arduino, only one program is executed again and again, contrarily, multiple programs are able to be executed at a time. Since this project requires real-time notification of water level, Raspberry Pi is better than Arduino.

3.3.2 LCD Display

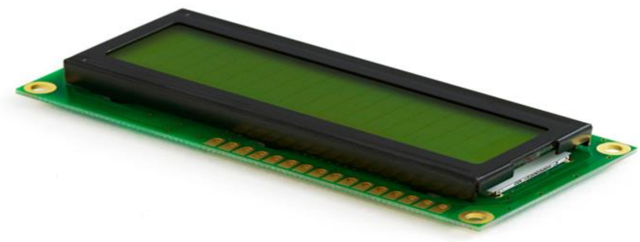


Figure 3.6: 16x 2 LCD Display

LCD (Liquid Crystal Display) modules are ordinarily utilized in wide range of circuits and devices due to its lower price, accessibility and programmer friendly. This LCD is called 16 x 2 LCD because it has 2 rows and 16 columns. There are many types of LCD with different numbers of rows and columns like 8×1, 10×2, 16×1, and so on but still the commonly used one is 16×2 LCD. In 16×2 LCD it will have 32 characters altogether (16×2=32). A single character with every one of its Pixels is appeared in the underneath picture. Each character has 40 Pixels and for 32 Characters there will be 1280 Pixels. Interface IC like HD44780 is mounted on the backside of the LCD 16x2. The use of the IC HD44780 is to get the instruction from the microcontroller and display the message at the exact position the instruction stated.

Table 3.1: LCD Pin Description

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply Voltage (5V)	Vcc
3	Contrast Adjustment through a Variable Resistor	Vee
4	Selects Command Register when Low, Data Register when High	Register Select
5	Low to write to the register, high to read from the register	Read/Write
6	Sends Data to Data Pins when a High to Low Pulse is Given	Enable
7-14	8-bit data pins	DB0-DB7
15	Backlight Vcc (5V)	LED+
16	Backlight Ground (0V)	LED-

3.3.3 Ultrasonic sensor

Figure 3.7: Ultrasonic sensor

The main purpose of ultrasonic sensor is to measure distance without any physical contact. When ultrasonic sensor is connected to 5V and initialize the input pin, ultrasonic transmitter will send the ultrasonic wave which at that point travel through the air and hit an object. The wave will hit and reflect back from the object and afterward collected by the ultrasonic receiver. The time taken for the wave to reflect back is directly proportional to the distance. Therefore, the distance can be calculated by using the formula S = (V x t)/2 where S is the distance, V is the speed of sound and t is the duration it took for the sound wave to be reflected back to ultrasonic receiver.

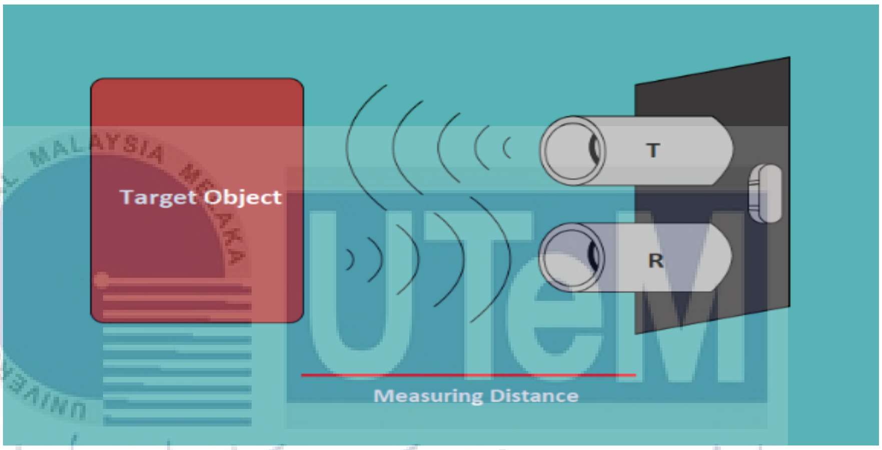


Figure 3.8: Working principle of ultrasonic sensor

Table 3.2 : Ultrasonic sensor parameter

Parameter	Value
Main Parts	Transmitter & Receiver
Technology Used	Non-Contact Technology
Operating Voltage	5 V
Operating Frequency	4 MHz
Detection Range	2cm to 400cm
Measuring Angle	30°
Resolution	3mm
Operating Current	<15mA
Sensor Dimensions	45mm x 20mm x 15mm

3.3.4 Submersible water pump

Figure 3.9: submersible water pump

A submersible water pump, can be completely submerged in water. Water will never enter to the motor because, the motor is tightly enclosed with the body of the pump. This water pump pushes water to the surface by changing over rotational energy into kinetic energy and then into pressure energy. This pump is too efficient because they consume only low power

Table 3.3: Submersible water pump parameter

Parameter	Value
Operating Voltage	6V
Maximum lift	40cm-110cm
Flow rate	80-120 liters/hour
Dimension	25mm x 46mm
Continuous working life	500 hours

3.3.5 6 V DC Linear Solenoid Actuator

Figure 3.10: Linear Solenoid Actuator

Linear solenoid is basically an electromagnet device, where it converts electrical energy into mechanical motion (push-pull). The conductor inside the solenoid will generate magnetic field when current is applied to it. The direction of the current flow will determine whether it is a push-type or pull-type. For this project, solenoid is used to open and close the valve containing abate 1.1G.

Table 3.4: Linear solenoid actuator parameter

Parameter	Value
Operating Voltage	6V
Rated current	300 mA
Material	Metal
Dimension	20mm x 12mm x 11mm
Holding force	200N

3.3.6 Mosquito meshing

Figure 3.11: Mosquito meshing

Mosquito meshing was made using stainless steel screen. Stainless steel screen is used because it would not rust easily. This meshing will prevent from vector entering the tank via the overflow and inlet. This meshing also would not close the tank completely and allow some air to flow in the tank. If the meshing is fully closed water would not able to flow out or into the tank.

3.3.7 Abate 1.1G

Figure 3.12: Abate 1.1G

Abate 1.1 G commonly applied for stagnant water like drains, water tank and flower pots to kill larvae before they even developed into an insect. The abate 1.1 G is in brown and looks like sand granules. The main component in Abate 1.1 G is temephos. Temephos is an active ingredient that kills many types of disease-causing insects like a mosquito by preventing enzyme production from larvae that will eventually disturb their nervous system and lead to death.

3.3.8 2 Relay modules

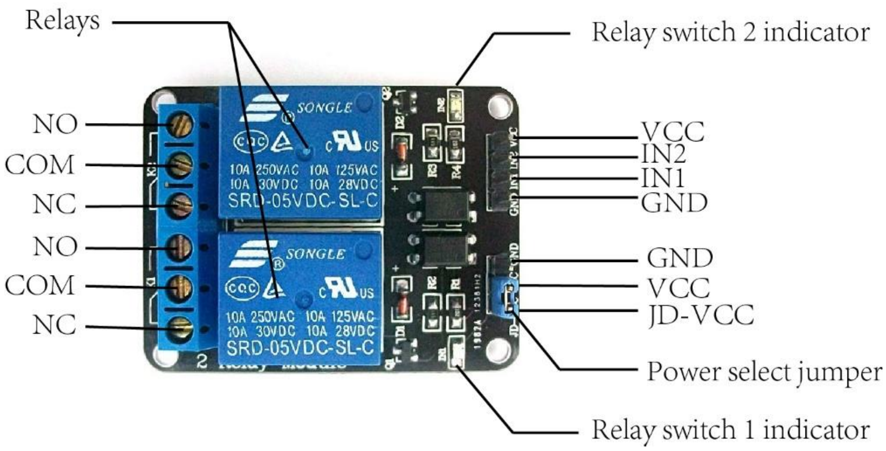


Figure 3.13 : 2 channel relay modules

A relay module is a switch that functions with the help of an electromagnet. When current is being supplied to the relay it will function to control the circuit contacts to either open or close. In this project relay module is used to control the water pump and solenoid. Th relay module will turn on the switch off the water pump, whenever the amount of water at the header tank is low and turn off when the amount of water at header tank is full. The relay module also will turn on the switch of solenoid weekly once to pour the abate 1.1G into the water tank.

3.3.9 Power supply adapter (12V)

Figure 3.14 : 12V Adapter

A 12 Volt adapter is used to give power to the solenoid in this project. Since the raspberry pi can only supply 5v and the solenoid requires 12v, an external power source of 12v is needed, so to fulfill the voltage need of the solenoid a 12v adapter is been used. The 12 v adapter is bounded with a plastic case to protect it from any damage and it comes with an AC cord.

3.4 Summary

In this chapter, planning is the first thing to be achieved because, without proper planning, the project will not be accomplished in the given time. In order to avoid such issues, Gantt chart and project flow chart were created. Furthermore, the design and block diagram were created to understand the flow of the project in detail. Lastly, all the equipment needed to use in the prototype is analysed to ensure the prototype works as desired and reduces the cost.

CHAPTER 4
RESULT AND DISCUSSION

4.0 Introduction

This chapter will explain the outcomes and analysis from both the hardware and software. Along with the result and analysis, the software and hardware configuration are being explained as well. Besides, prototype development is been explained in this chapter. The analysis is carried out on the efficiency of water pump, solenoid, and vector control technique. Lastly, the discussion on the project results is also explained.

4.1 Software and Coding development

4.1.1 Coding for ultrasonic sensor.

The coding development begins with the ultrasonic sensor since it is the main component in this project. Figure 4.1 shows the coding that was used to program the ultrasonic sensors. When an ultrasonic sensor is connected to a supply and initialize the input pin, ultrasonic transmitter will send the ultrasonic wave which at that point travel through the air and hits the water surface. The wave will hit and reflect back from the water surface and afterward collected by the ultrasonic receiver. The time taken for the wave to reflect back is directly proportional to the distance. Therefore, a calculation was made on coding to convert the ultrasonic sensor wave duration into distance which is Distance = (Speed *Time)/ 2. The speed of ultrasonic wave at sea level is 34300 cm/s but the value needs to divide by two since the duration of the ultrasonic wave is the time taken for the sensor to hit the water surface and back. Therefore, the speed used in coding was (34300/s ÷ 2 = 17150 cm/s).

```
PIN_TRIGGER = 16
PIN_ECHO = 12
GPIO.setup(PIN_TRIGGER, GPIO.OUT)
GPIO.setup(PIN_ECHO, GPIO.IN)


def distance():
      GPIO.output(PIN_TRIGGER, GPIO.HIGH)

      time.sleep(0.00001)

      GPIO.output(PIN_TRIGGER, GPIO.LOW)

      while GPIO.input(PIN_ECHO)==0:
            pulse_start_time = time.time()
      while GPIO.input(PIN_ECHO)==1:
            pulse_end_time = time.time()

      pulse_duration = pulse_end_time - pulse_start_time
      distance = round(pulse_duration * 17150, 2)
      print ("Distance:",distance,"cm")
      return distance
```

Figure 4.1 : Coding for ultrasonic sensor

4.1.2 Coding for LCD Display

The LCD display is used in this project to show the real-time process of the project. The figure below shows the coding that was programmed for the LCD display. The type of LCD display that has been used in this project is I2C. Therefore, I2C_LCD_driver had been imported into the coding at first. The coding was made in the way that when the water level at both sump tank and header tank is full the LCD will display the message “sump tank full” and “header tank full”, while when the level of water is low at header tank and high at sump tank LCD will display the message “fill header tank”. Besides, when water level is low at sump tank the LCD will display “sump tank empty”

```
import I2C_LCD_driver
from time import *
mylcd = I2C_LCD_driver.lcd()

if dist < 100:
        mylcd.lcd_display_string("sumptankfull    ", 1)

        if dist1 > 100:
        mylcd.lcd_display_string("fillheadertank   ", 2)

          else:
            mylcd.lcd_display_string("headertankfull    ", 2)

    else:
        mylcd.lcd_display_string("sumptankempty    ", 1)
        mylcd.lcd_display_string("                 ", 2)

    time.sleep(1)
```

Figure 4.2 : Coding for LCD display

4.1.3 Coding for Submersible Water Pump

The submersible water pump is being controlled by a relay. The figure below shows the coding that was programmed for a relay to control the water pump. The coding was made in the way that when the level of water is low at the header tank and high at the sump tank the water pump will be turned on by the relay. The relay will be turned off whenever the sump tank and header tank are full or when the sump tank is empty.

```
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
relay2 = 25
con = 0
GPIO.setup(relay2, GPIO.OUT)

         if dist < 100:
         if dist1 > 100:
            GPIO.output(relay2, GPIO.LOW)

         else:
            GPIO.output(relay2, GPIO.HIGH)

     else:
         GPIO.output(relay2, GPIO.HIGH)

     time.sleep(1)
```

Figure 4.3 : Coding for Submersible Water pump

4.1.4 Coding for Solenoid

Similarly, as submersible water pump the solenoid also being controlled by a relay. Figure below shows the coding that was programmed for the relay to control the solenoid. The relay will only be turned on the solenoid weekly once to allow the Abate 1.1G to flow into the sump tank. The function of "time.sleep (2)" is used in the coding to make sure the solenoid open for only 2 seconds.

```
import RPi.GPIO as GPIO
import datetime
import time
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
relay1 = 23
con = 0
GPIO.setup(relay1, GPIO.OUT)

try:
    while True:
     now = datetime.datetime.now()
     #now.strftime("%a %d-%m-%Y @ %H:%M:%S")
     k = now.strftime("%d")#change to &d for date
     dist = distance()
     time.sleep(0.5)
     dist1 = distance1()

     if k == "3" or k == "10":#change to specific date(for open solenoid)
       if con == 0:
           GPIO.output(relay1, GPIO.LOW)
           print("open")
           time.sleep(2)
           GPIO.output(relay1, GPIO.HIGH)
           print("close")
           con = 1
     else:
        GPIO.output(relay1, GPIO.HIGH)
        con = 0
```

Figure 4.4 : Coding for Solenoid

4.2 Hardware Development

The vector control and rainwater harvesting system was developed successfully according to the objectives. Besides, the hardware functionality also had been verified before the software is being implemented. The figure below shows the preliminary prototype that has been done, where the raspberry pi act as the microcontroller to control the flow of the system.

In this section, the way to configure the hardware was being explained. The main hardware that is used in this project is a solenoid, submersible water pump, LCD display, and ultrasonic sensors. The data from ultrasonic sensors will be recorded in raspberry pi. Then raspberry pi will process the information and control the flow of water to the header tank simultaneously raspberry pi will display the processes at the LCD display.

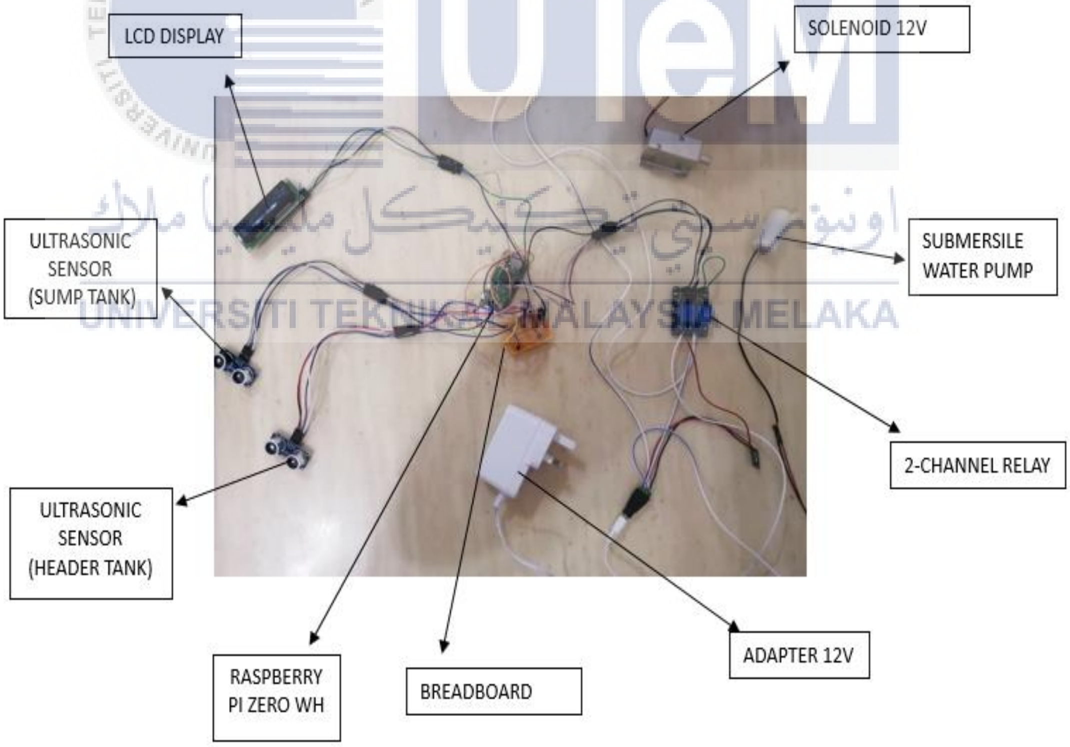


Figure 4.5 : Hardware Development

4.2.1 Water Level Detection

In this project to detect water level at the sump tank and header tank, two ultrasonic sensors are used. The figure below shows the connection diagram of the ultrasonic sensors and raspberry pi zero wh. The ultrasonic sensor only requires 5v as input power and output power, this 5v can be supplied from raspberry pi but raspberry pi can only receive a max of 3.3V from any component. Therefore, voltage divider was applied using 220 ohm and 560 ohm to reduce the output power of the ultrasonic sensor from 5v to 3.3v. From the figure below the green wire indicates the ground, the red wire indicates the +5v supply, the orange wire is for the trigger pin and lastly, the blue wire is for the echo pin. Once the water level is detected, data will be sent to raspberry pi to control the water flow.

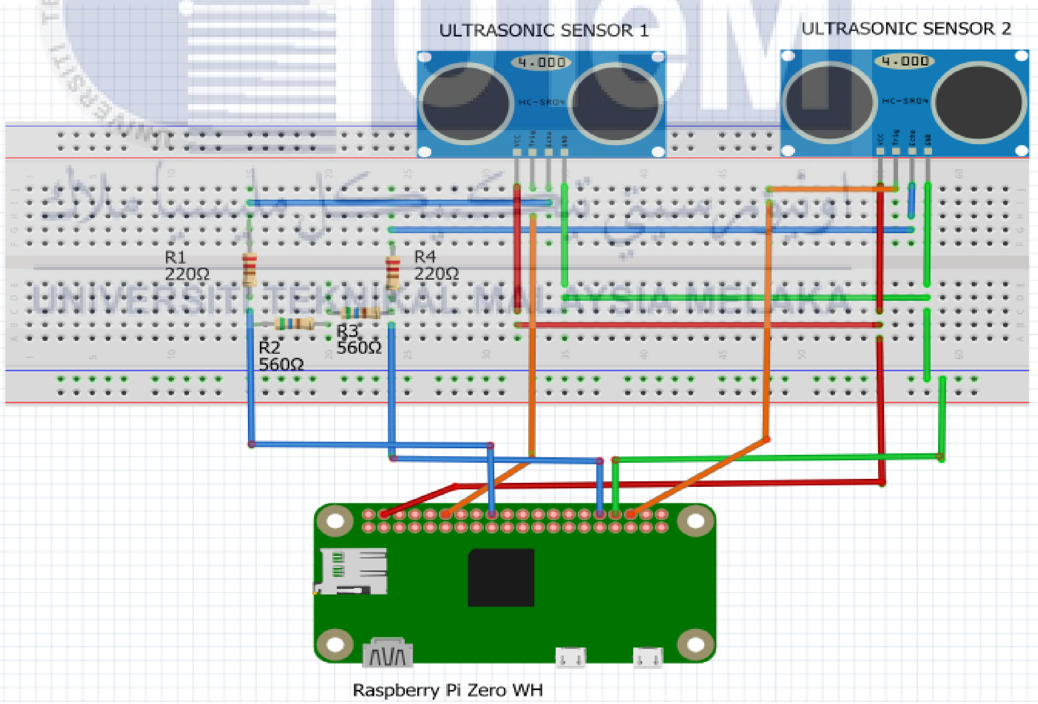


Figure 4.6 : Ultrasonic sensor connection diagram

4.2.2 Water Flow Management

Once the water level is detected, raspberry pi will control the flow of water by using a relay and submersible water pump. The submersible water pump will only turn on when the water level at sump tank is at least 10cm and at the header tank is less than 10cm. The water pump will be turned off when water level at sump tank is lower than 10 cm or when water level at header tank is at 10cm. The water pump is turned on and off by relay. The figure below shows the connection diagram between water pump, relay and raspberry pi zero wh. The supply for the water pump requires voltage between 3 to 5 V. The supply of 3.3 V is being supplied from raspberry pi (pin2) via relay (NO). Furthermore, the supply 5v for relay is being supplied from the raspberry pi zero wh too.

Table 4.1 : Condition that makes water pump to turned on and off

CONDITION	WATER PUMP
Sump tank >= 10cm & Header tank <=10cm	ON
Sump tank <= 10cm & Header tank >=10cm	OFF

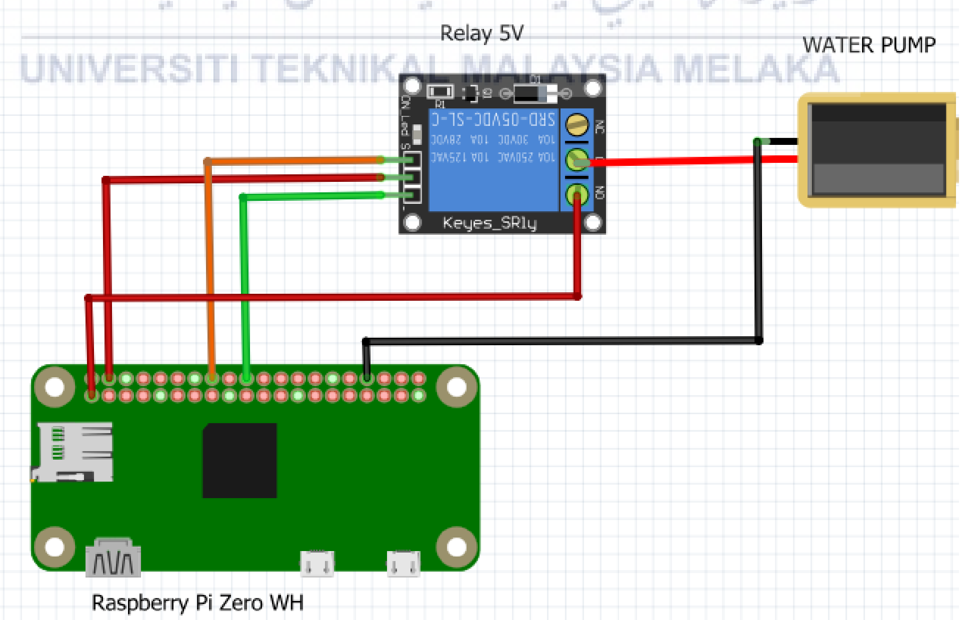


Figure 4.7 : Connection diagram of Water Pump

4.2.3 Abate 1.1G Flow

Abate 1.1G flow is controlled by a solenoid. Abate 1.1G will only flow into the sump tank weekly once. Weekly once the solenoid will open for about 2 seconds to make sure abate 1.1 G is poured into the sump tank. A 5v relay is used to control the opening and closing of the solenoid. The supply 5V for the relay is provided by the raspberry pi (pin 2). Since the solenoid requires 12v, a dc female jack is fixed so a 12 v adapter can be easily connected to power up the solenoid

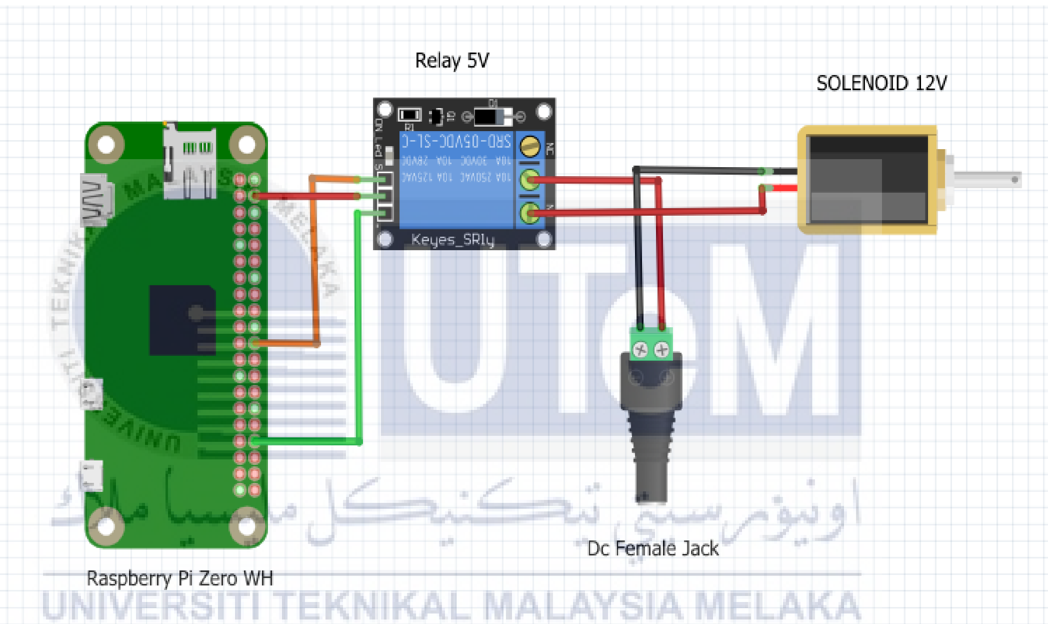


Figure 4.8 : Connection diagram of Solenoid 12V

4.3 Prototype Development

A complete prototype was developed for this project. Most of the materials used to develop the prototype were recycled materials like plastic containers and boxes. Recycled material was used to reduce greenhouse gas emissions. Besides the recycled material hot-melt adhesive, wire tape, screws, and filter funnel were used to complete the prototype.

4.3.1 Main system prototype

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Figure 4.9 : Main system prototype

The figure above shows the prototype that was developed for the main system. This part of the prototype is called the main system since raspberry pi has been fitted inside the box. Besides, the microcontroller the relay, and Lcd display has been placed here. All these components are placed in this small box to ensure the project is portable and compact.

4.3.2 Sump Tank Prototype

Figure 4.10: Sump Tank side view

Figure 4.11: Sump Tank top view

Figure 4.10 and 4.11 shows the prototype model for the sump tank. Meshing is applied at the inlet, overflow and to close the top part of the container. The solenoid is fixed with a filter funnel to pour abate 1.1 G inside the sump tank. An ultrasonic sensor is used to measure the water level and water pump to pump water to the header tank. This both component is placed inside the sump tank.

4.3.3 Header tank prototype

Figure 4.12 : Header Tank

The easiest part of creating the prototype was for the header tank. Ultrasonic sensor is placed at top of the container to measure the water level. A durable silicone tube from the sump tank is connected to the header tank. This silicone tube is used for pumping the water from the sump tank up to the header tank.

4.3.4 Interface of the system

The water management and vector control for rainwater harvesting tank using raspberry pi can be used in the housing area only. It is not made for industrial purposes. This system is able to run continuously if the right amount of power is supplied. The workflow of this project is stated in this section.

At first, the consumer needs to turn on the system by connecting it to a laptop. Once the system is turned on consumer need to wait few seconds for the raspberry pi to connect automatically to the previously configured Wi-Fi signal. After that, consumer can turn on VNC viewer on the laptop to run the system. The figure below shows the Raspbian OS when we turn on the VNC viewer.

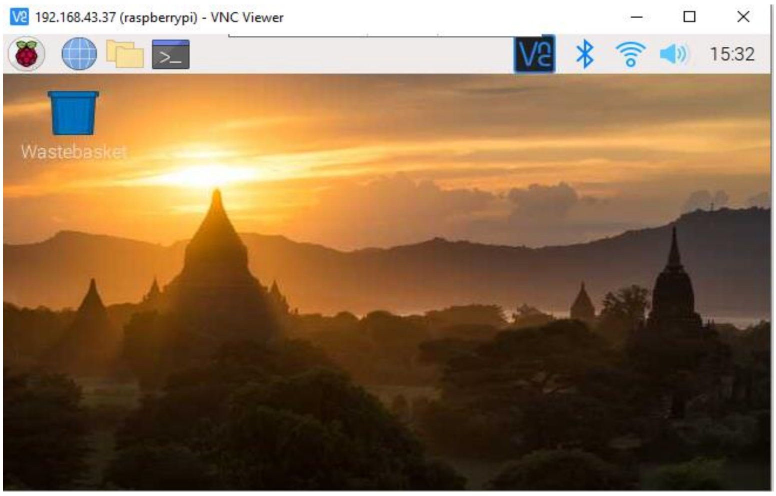

Figure 4.13: Raspbian OS

Once the Raspbian OS is turned on consumer have to run the coding stored in the files section. Once coding has started to run, simultaneously the project will start to run automatically. First of all, ultrasonic sensor will start to detect the level of water at both sump and header tank. The level of water can be viewed through the Raspbian OS. The figure below shows the level of water displayed at Raspbian OS.

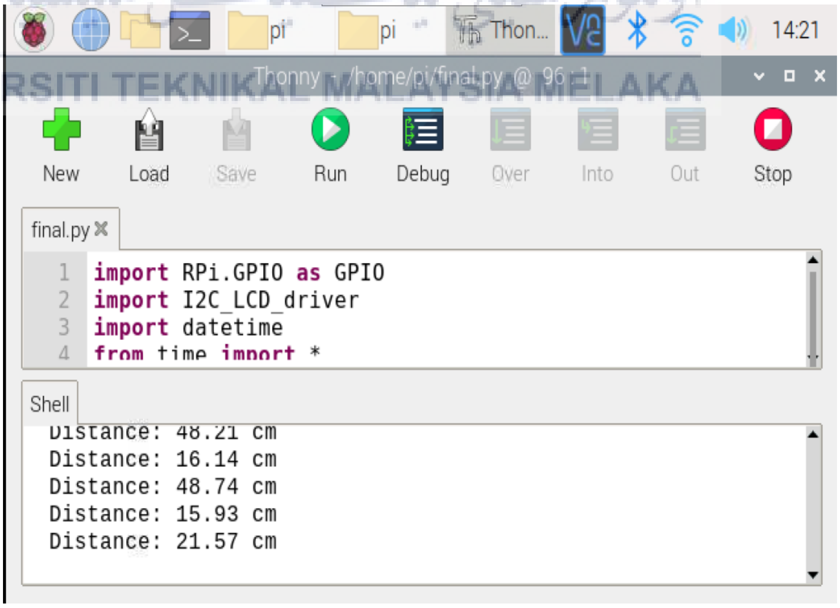

Figure 4.14 : Water level display at Raspbian OS

Once the level of water is detected by the ultrasonic sensor, the raspberry pi will then start to run according to the level of water at both tanks. If the level of water at sump tank higher and level of water at header tank is lower water pump will be turned on to pump water from sump tank to header tank. A consumer can view the process that going through via the LCD display. The figure 4.15 below shows the message that will displayed at LCD screen

Figure 4.15: LCD display

The water pump will be turned off whenever the ultrasonic sensors detect three types of situations. The first situation is when water level at sump and header tank is low. The second situation is when water level at sump tank is low but at header tank is full. Third situation is when water level at both sump tank and header tank is full. A consumer can view the process that going through via the LCD display. Figure 4.16 shows the LCD display for situation 1 and 2 while figure 4.17 shows the LCD display for situation 3.

Figure 4.16 : LCD display for situation 1 and 2

Figure 4.17: LCD display for situation 3

Besides that, the solenoid is connected with a filter funnel filled with Abate 1.1G. The solenoid will be opened automatically weekly once to allow the abate 1.1G to flow into the header tank. The opening and closing of the solenoid can be viewed at the Raspbian OS.

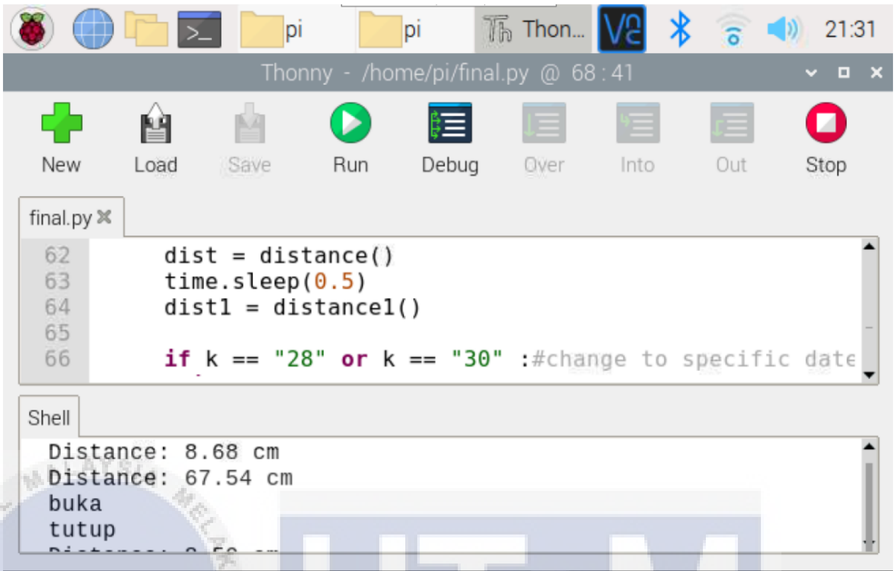

Figure 4.18 : Opening and Closing of solenoid viewed from Raspbian OS

Lastly, the development of the overall vector control and water flow management system for the rainwater harvesting tank is shown in figure 4.19 below.

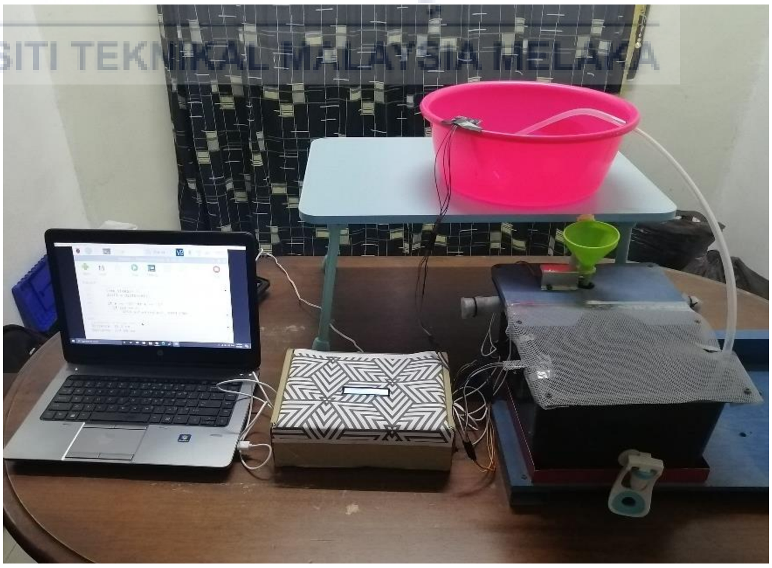

Figure 4.19: Overall prototype of the project

4.4 Data Analysis

Data analysis was taken in this project to make sure the prototype is working as the objective required, able to be used by customers and marketable. The experiments were carried out in home environment only. This analysis was able to examine the output of the system in real time application. Thus, several data were collected and analyzed using graph. Therefore, three experiments were carried out for this project which was an analysis of the time taken for the water pump to fill the header tank when the height of the header tank is increased. The second analysis is on the amount of abate 1.1G poured into the sump tank. The third experiment is to identify vector and debris presence in the sump tank for a period of 14 days.

4.4.1 Time taken for the water pump to full the header tank when the height of header tank is increased.

In this analysis, the height of the header tank is increased from 5cm to 25cm. Data is recorded for every 5cm increment. The table below shows the data collected from the experiment conducted. This experiment was conducted to identify the efficiency of the water inflow.

Table 4.2: Time taken to full the header tank when the height is increased.

No. of Test	Height of header tank (cm)	Time taken (min)
1	5	1.4
2	10	2.5
3	15	3.8
4	20	5
5	25	6.3

Based on the data collected above, a line graph was plotted using excel. From the graph plotted it can be seen that the graph looks linear where, as the height of header tank is increased the time taken to full the header tank also increases linearly. Highest time of 6.3 minutes was recorded to pump the water when the height of header tank is at 25cm. Meanwhile, the lowest time taken for water pump to pump water is when the height of header tank is 5cm. Therefore, it can be concluded that water inflow system works efficiently because the only factor that effect the water inflow system is the height of the header tank.

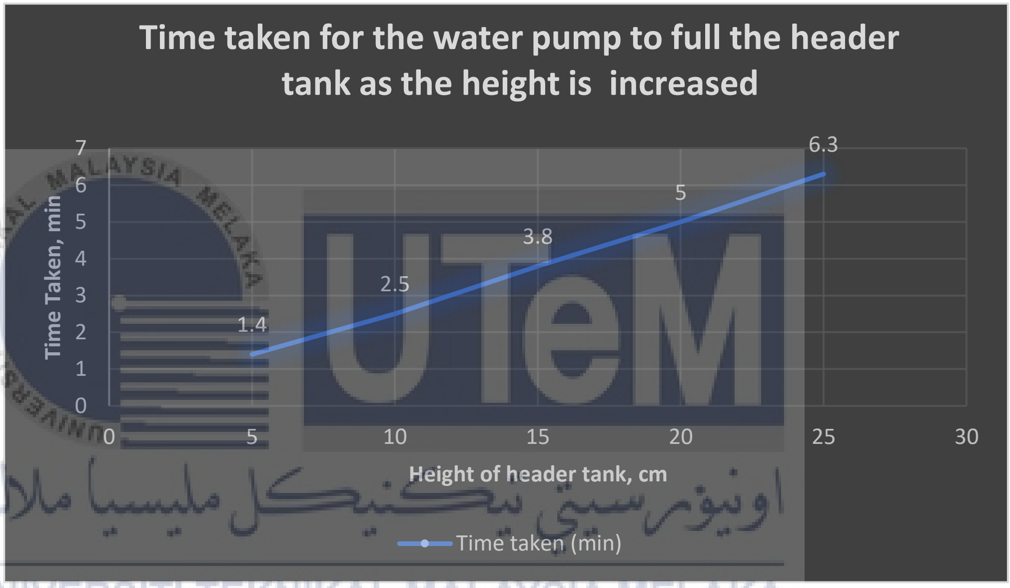

Figure 4.20: Time taken to full the header tank when the height is increased.

4.4.2 The amount of Abate 1.1G flow into the sump tank.

In this analysis, the amount of Abate 1.1G flow into the sump tank when the solenoid opens for two seconds is recorded. The experiment was repeated five times to identify the variance in the amount of Abate 1.1G flow. The table below shows the data collected from the experiment conducted. This experiment was conducted to identify the efficiency of the solenoid and filter funnel design.

Table 4.3 : The amount of Abate 1.1G flows into the sump tank

No. of Test	Amount of Abate 1.1G (mg)
1	51.2
2	49.7
3	53.3
4	49.5
5	50.4

Based on the data collected above, a bar graph was plotted using excel. From the graph plotted it can be seen that the amount Abate 1.1G poured for all five tests is in the range of 49.5mg to 51.8mg. The required amount of Abate 1.1G to flow in the tank is 50mg. Therefore, it can be concluded that the solenoid and filter funnel design work as required because from all five tests the amount of Abate 1.1G flow into the tank is in the range of 50mg.

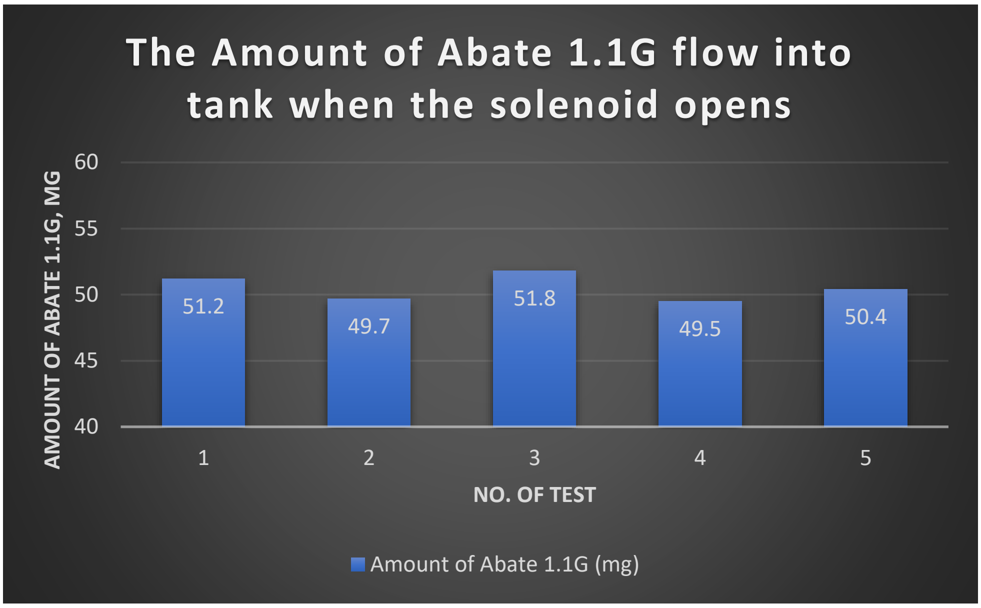

Figure 4.21 : The amount of Abate 1.1G flows into the sump tank

4.4.3 Presence of vector and debris at sump tank

In this analysis, the presence of vector and debris at the sump tank was recorded. The experiment was conducted with two different conditions. In the first condition, the experiment was conducted with a sump tank applied with vector control while in the second condition the experiment was conducted with a sump tank applied without vector control. The vector control technique applied in this experiment was the flow of Abate 1.1G into the tank and meshing is applied at the inlet and overflow of the tank. The table below shows the data collected from the experiment conducted. This experiment was conducted to identify the efficiency of the vector control technique applied in the prototype

Table 4.4 : Presence of vector and debris at sump tank with vector control and without vector control

Days	Sump Tank with vector control		Sump Tank without vector control	
	Presence of Vector	Presence of debris	Presence of Vector	Presence of debris
1	X	X	X	X
2	X	X	X	✓
3	X	X	X	✓
4	X	X	✓	✓
5	X	X	✓	✓
6	X	X	✓	✓
7	X	X	✓	✓
8	X	X	✓	✓
9	X	X	✓	✓
10	X	X	✓	✓
11	X	X	✓	✓
12	X	✓	✓	✓
13	X	✓	✓	✓
14	X	✓	✓	✓

From the table above it can be seen that there is no vector infestation at the sump tank with vector control for the past 14 days, but vector infestation can be seen as early as on the fourth day on the sump tank without vector control. The presence of debris also can be seen on the tank only after day twelve on the sump tank with vector control while, debris can be seen as early as on the second day in the sump tank without vector control. Therefore, it can be concluded that the vector control technique applied at the sump tank in this project is efficient.

4.4 Discussion

The main aim of this project is to design a prototype that could smartly manage water supply from a sump tank to header tank, besides preventing vector reproduction by implementing the right vector control method. The idea to implement this project begins with the problem statement and later leads to the development of an actual prototype. Few challenges had been faced before successfully develop a prototype model that achieved the objectives stated. The main challenges are when it is required to develop coding in python language as it was new for learning. The next challenge faced was to configure the solenoid with relay. Besides that, the challenge that was faced was when it is required to modify a filter funnel to make sure the Abate 1.1G flow only about 50milligram. All these challenges were able to solved by referring to previous articles and journals.

Although there are numerous rainwater harvesting system available in the market, most of them have their own limitation like cost, durability, and vector control. Based on previous research, many researchers never implement a proper vector control method to prevent vector reproduction into their rainwater harvesting system. They tend to underestimate the importance of vector control in a rainwater harvesting tank but, in this project, a proper vector control method is being implemented alongside rain water harvesting system.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter discusses how the stated objectives in chapter 1 were achieved. Besides, the overall project prototype development is concluded. Furthermore, future recommendations are suggested in this chapter to improve this project to be more efficient in future work.

5.1 Conclusion

In the recent time, Malaysia faces a lot of water scarcity issues, particularly from Selangor state. Rainwater harvesting would be the best solution to encounter such a problem. But the problem arises when there is no proper vector control method in a rainwater harvesting tank is implemented. Lack of proper vector control method in rainwater harvesting tank will cause vector infestation and later will lead to serious health issues to humans. In addition, a lack of proper water flow management will cause water wastage.

To overcome such issues, this project prototype was designed based on the objectives stated. The objectives of this project are achieved as the water flow management and vector control system for rainwater harvesting tank using Raspberry Pi is successfully developed. The developed project is able to detect the level of water and at the same time will smartly manage the water flow besides preventing vector reproduction. The performance of the developed prototype is analyzed by observing the time taken for the water pump to pump water, the amount of Abate 1.1G flow into the tank and the presence of vector at the sump tank. Lastly, all the results obtained are collected and attached.

5.2 Future Recommendations

Although the developed system, will effectively manage water flow, detect water level and prevent vector reproduction there are still room for improvements. The Raspberry Pi Zero WH used in this project is an older version it has only 512 MB ram which will reduce the performance of the project. Therefore, it is recommended to use the latest version of Raspberry PIs to enhance the performance of the project.

Besides, it is recommended that future prototypes have water level sensor to detect the level of water. The water level sensor will measure water level even more precisely than an ultrasonic sensor. In addition, it suggested to use Aquatain AMF solution as a vector control method. Aquatain AMF is a chemical free solution where the water with Aquatain AMF can be used for drinking. Lastly, it is recommended to improve the prototype by implementing the Internet of Things (IoT), where the prototype can be designed to view the water level via an application and able to control the opening and closing of the solenoid through the application.

REFERENCES

Abang, O.J. and AMORJI-NIKE, E.N.U.G.U (2013) 'Construction of Automatic Water Level Controller for both Overhead and Underground Tanks', *Department of Electrical/Electronic Engineering, Faculty of Engineering. Caritas University, Amorji-Nike: Enugu, Nigeria*.

Ayob, S. and Rahmat, S. N. (2017) 'Rainwater Harvesting (RWH) and Groundwater Potential as Alternatives Water Resources in Malaysia: A Review', *MATEC Web of Conferences*, 103. doi: 10.1051/matecconf/201710304020.

CHABNI, F. *et al.* (2016) 'The Application of Fuzzy Control in Water Tank Level Using Arduino', *International Journal of Advanced Computer Science and Applications*, 7(4), pp. 261–265. doi: 10.14569/ijacsa.2016.070432.

Che-Ani, A. I. *et al.* (2009) 'Rainwater harvesting as an alternative water supply in the future', *European Journal of Scientific Research*, 34(1), pp. 132–140.

Darus, A. Z. M. (2009) 'Potential development of rainwater harvesting in Malaysia', *Proceedings of the 3rd WSEAS International Conference on Energy Planning, Energy Saving, Environmental Education, EPESE '09, Renewable Energy Sources, RES '09, Waste Management, WWAI '09*, pp. 158–164.

Eltaieb, A. A. M. and Min, Z. J. (2015) 'Automatic Water Level Control System', *International Journal of Science and Research (IJSR)*, 4(12), pp. 1505–1509.

Hunter, P. R. (2003) 'Climate change and waterborne and vector-borne disease', pp. 37–46.

Indicator, W. L. (2018) 'Automatic Water Level Indicator and Controller using Arduino', pp. 1–27.

JAMAL, H. (2016) 'Logical Automatic Water Control System For Domestic Applications', (July), pp. 159–162. doi: 10.15224/978-1-63248-109-2-40.

Kumarasamy, V. (2006) 'Dengue fever in Malaysia: Time for review?', *Medical Journal of Malaysia*, 61(1), pp. 1–2.

Lani, N. H. M., Yusop, Z. and Syafiuddin, A. (2018) 'A review of rainwater harvesting in Malaysia: Prospects and challenges', *Water (Switzerland)*, 10(4), pp. 1–21. doi: 10.3390/w10040506.

Lee, K. E. *et al.* (2016) 'Rainwater harvesting as an alternative water resource in Malaysia: Potential, policies and development', *Journal of Cleaner Production*. Elsevier Ltd, 126, pp. 218–222. doi: 10.1016/j.jclepro.2016.03.060.

Moglia, M., Gan, K. and Delbridge, N. (2016) 'Exploring methods to minimize the risk of mosquitoes in rainwater harvesting systems', *Journal of Hydrology*, 543, pp. 324–329. doi: 10.1016/j.jhydrol.2016.10.010.

Mohammed, T. a., Megat Mohd. Noor, M. J. and Ghazali, A. H. (2003) 'Study on Potential Uses of Rainwater Harvesting in Urban Areas', *Department of Civil Engineering, Faculty of Engineering, University Putra Malaysia*.

Mohd-Zaki, A. H. *et al.* (2014) 'Epidemiology of Dengue Disease in Malaysia (2000–2012): A Systematic Literature Review', *PLoS Neglected Tropical Diseases*, 8(11), pp. 1–9. doi: 10.1371/journal.pntd.0003159.

Mudin, R. N. (2015) 'Dengue incidence and the prevention and control program in Malaysia', *International Medical Journal Malaysia*, 14(1), pp. 5–10.

N. S. (2014) 'RASPBERRY PI BASED LIQUID FLOW MONITORING AND CONTROL', *International Journal of Research in Engineering and Technology*. doi: 10.15623/ijret.2014.0307020.

Rahman, S. *et al.* (2014) 'Sustainability of rainwater harvesting system in terms of water quality', *The Scientific World Journal*, 2014. doi: 10.1155/2014/721357.

Rahman, S. A. *et al.* (2013) 'Legal implications of compulsory rainwater harvesting in Malaysia', *Journal of Food, Agriculture and Environment*.

Reza, S. M. K., Tariq, S. A. and Reza, S. M. M. (2010) 'Microcontroller Based Automated Water Level Sensing and Controlling: Design and Implementation Issue', *Lecture Notes in Engineering and Computer Science*, 2186(1), pp. 220–224.

Samat, N. A. and Percy, D. F. (2012) ‘Vector-borne infectious disease mapping with stochastic difference equations: An analysis of dengue disease in Malaysia’, *Journal of Applied Statistics*, 39(9), pp. 2029–2046. doi: 10.1080/02664763.2012.700450

Wadekar, S. *et al.* (2017) ‘Smart water management using IOT’, *2016 5th International Conference on Wireless Networks and Embedded Systems, WECON 2016*, pp. 3–6. doi: 10.1109/WECON.2016.7993425.

APPENDIX

Coding of the project

```
import RPi.GPIO as GPIO

import I2C_LCD_driver

import datetime

from time import *

import time

GPIO.setmode(GPIO.BCM)

GPIO.setwarnings(False)

PIN_TRIGGER = 16

PIN_ECHO = 12

PIN_TRIGGER1 = 18

PIN_ECHO1= 24

relay1 = 23

relay2 = 25

con = 0

mylcd = I2C_LCD_driver.lcd()

GPIO.setup(PIN_TRIGGER, GPIO.OUT)

GPIO.setup(PIN_ECHO, GPIO.IN)

GPIO.setup(PIN_TRIGGER1, GPIO.OUT)

GPIO.setup(PIN_ECHO1, GPIO.IN)

GPIO.setup(relay1, GPIO.OUT)
```

```
GPIO.setup(relay2, GPIO.OUT)

def distance():
GPIO.output(PIN_TRIGGER, GPIO.HIGH)
time.sleep(0.00001)
GPIO.output(PIN_TRIGGER, GPIO.LOW)

while GPIO.input(PIN_ECHO)==0:
pulse_start_time = time.time()
while GPIO.input(PIN_ECHO)==1:
pulse_end_time = time.time()

pulse_duration = pulse_end_time - pulse_start_time
distance = round(pulse_duration * 17150, 2)
print ("Distance:",distance,"cm")
return distance

def distance1():
GPIO.output(PIN_TRIGGER1, GPIO.HIGH)
time.sleep(0.00001)
GPIO.output(PIN_TRIGGER1, GPIO.LOW)
while GPIO.input(PIN_ECHO1)==0:
pulse_start_time = time.time()
while GPIO.input(PIN_ECHO1)==1:
```

```
pulse_end_time = time.time()

pulse_duration = pulse_end_time - pulse_start_time

distance = round(pulse_duration * 17150, 2)

print ("Distance:",distance,"cm")

return distance

try:

while True:

now = datetime.datetime.now()

#now.strftime("%a %d-%m-%Y @ %H:%M:%S")

k = now.strftime("%M")#change to &d for date

dist = distance()

time.sleep(0.5)

dist1 = distance1()


if k == "29" or k == "05" :#change to specific date(for open solenoid)

if con == 0:

GPIO.output(relay1, GPIO.LOW)

print("buka")

time.sleep(2)

GPIO.output(relay1, GPIO.HIGH)

print("tutup")

con = 1

else:

GPIO.output(relay1, GPIO.HIGH)
```

```
con = 0

if dist < 100:

mylcd.lcd_display_string("sumptankfull    ", 1)

if dist1 > 100:

GPIO.output(relay2, GPIO.LOW)

mylcd.lcd_display_string("fillheadertank   ", 2)

else:

GPIO.output(relay2, GPIO.HIGH)

mylcd.lcd_display_string("headertankfull   ", 2)

else:

GPIO.output(relay2, GPIO.HIGH)

mylcd.lcd_display_string("sumptankempty   ", 1)

mylcd.lcd_display_string("                ", 2)

time.sleep(1)

except KeyboardInterrupt:

print("Measurement stopped by User")

GPIO.cleanup()
```

Gantt chart for final year project 1 and 2

PROJECT ACTIVITY	Academic Week of Semester 1															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Selection of PSM title	■								S							
PSM title registration	■								E							
Research on the chosen topic		■	■	■					M							
Collect resources for submit proposal		■	■	■					E							
Proposal submission				■					S							
Implement Introduction and Literature Review				■	■	■	■	■	T							
Identify the hardware component and software used									E	■						
Preparing Flow Chart of the Methodology									R	■	■					
Implement the Methodology									B		■	■				
Complete and Review on PSM 1 Report									R				■			
Presentation									E					■		
Modify and Repair the Report									A						■	
Submit PSM 1 Report									K							■