REAL TIME FLOOD DETECTION & MONITORING SYSTEM WITH WIRELESS NETWORK SENSORS

NUR AININA ASYRA BINTI ABDUL KADIR

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Bachelor Degree in Computer Science

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University Malaysia Pahang

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ABSTRACT

Real Time Water Level Monitoring System with Wireless Network Sensors for Flood was developed to help population on flood risk area especially for those who live by the riverbank to make early preparation before the flood come. In this system, the sensor will detect distance between the sensor placement and the water surface. The measurement will be collected for every hour. Water monitoring system will receive data from sensors. Data collected will be stored into the database. The data will be used to analyze the pattern of water rising. This analysis will help in predict the flood.

ABSTRAK

Sistem pengesan awal banjir tanpa wayar yang memberi amaran pengesanan banjir telah dibangunkan untuk membantu penduduk di sekitar kawasan banjir terutamanya di kawasan yang berhampiran dengan sungai untuk membuat persediaan awal sebelum berlakunya banjir. Melalui system ini, alat pengesan akan mengesan jarak antara penempatan sensor dengan permukaan air. Paras air akan direkodkan untuk setiap jam. Sistem Pemerhati paras air akan membaca data dari sensor. Data yang diterima akan disimpan ke dalam system pengkalan data. Data akan digunakan untuk menganalisis pola kenaikan air. Analisis tersebut akan membantu dalam meramalkan banjir

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LIST OF ABBREVIATIONS

ABBREVIATION	TITLE
DoID	Department of Irrigation and Drainage
EWS	Early Warning System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
IDE	Integrated Development Environment
LED	Light-emitting diode
PEWS	Pioneering Early Warning System
PVC	Polyvinyl Chloride
RAD	Rapid Application Development
RS/GIS	Remote Sensing and Geographic Information System
SDLC	Software Development Life Cycle
SMS	Short Message Service
WSN	Wireless Sensor Network

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Taken place nearly every year during monsoon season, flood, a regular natural disaster in Malaysia, caused devastation on life and properties. A lot of houses, bridges, roads, crops, automobiles and other facilities were badly damaged. This phenomenon hence brings a nightmare to whom experienced it. Government are required to put a lot of cost and effort to repair the devastation. Although the authorities have taken action to solve this circumstances, such as enhanced the drainage system in critical area, the rate of
devastation increases as the year pass by.

A few research has been conducted on flood mechanics and monitoring system. However, the device that can predict the flood, yet still on papers. In developed countries, such device were already implemented as flood monitoring system, however was not apply in Malaysia due to high cost. Some of the device were designed to detect the presence of water in-house, a simple, mostly cheap, wired and send SMS to the user. By using such system, only registered user can obtain the notification message while others

might not know about the water rising.

Real Time Flood Detection & Monitoring System with Wireless Network Sensors is an Infrared based system that send alert in the form of alarm to Department of Irrigation and Drainage(DoID) whenever the device detect rising of the water level in the river in real time. The system then predict water rising pattern based on the time the sensor detect the water.

1.2 PROBLEM STATEMENT

- Lack of efficient device to trigger flood alert
- Department of Irrigation and Drainage (DoID) could not predict when will the flood happen whether late at night or in a day
- The existing product are expensive, flimsy and wired, which is not suitable outdoor.

1.3 OBJECTIVE

- To develop a system for water depth measurement purpose.
- To collect water depth from river in real time
- To store the water depth that useful for flood prediction in a database.

1.4 SCOPE

Scope of the system will be:

I. Department of Irrigation and Drainage (DoID)
II. Flood researchers
III. Public Authorities (Fireman, RELA etc)
IV. Pahang River

The Department of Irrigation and Drainage will receive data and alert from the device. The DoID will also control the central processing of the data. Therefore, the department can gain information about the water rising pattern and anticipate when the flood might happen.

1.5 SUMMARY

To summarize, chapter 1 discussed about the idea of the whole project, problem statement, project's scopes and objectives to be achieve. The main idea of this project is to develop a system that help unfortunate residents who live by the river to move and save their properties and document rather than be demolished by the flood. The problem is that there are no efficient device to predict and alert the residences about the rising of river water. To resolve this problem, the idea to detect the water rising, flooding time prediction is proposed, that can send alert to the authorities. With the help of this system, the personal belongings, important documents, pets, farm animals, and human life can be save.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Main idea of the project is to develop a devices that alert residences and authorities about the rising pattern of river water's level. The main components of this project are proximity sensor and GSM module which transfer the collected data to the main processing system. The sensor will detect the level of river water first. In case the water reach danger level, the sensor will send data and alert to the central processing. If not, the sensor will only send data for the record.

The captured data are send through Mobile Global System for Communication (GSM) Module. Data collected from the sensor then processed into Arduino and then transfer to the computer from the GSM Module. The central processing which are located at DoID will then generate the graph based on data from the Arduino. Central processing will generate table, graph and report to predict the raising pattern of the water based on time, date and measurement captured by the sensor.

Apart from that, this system will send 3 types of alert to the authorities. First when the water reach warning, second will used to alert the residence when the water

reach cautions increased to dangerous level. The authorities will use this information to alert the residence so that they can save their life and important documents and stuff.

2.2 OVERVIEW OF PROXIMITY SENSOR AND GSM TECHNOLOGY

Proximity sensor is used to detect ferrous the non-ferrous metal object which comes in high-frequency oscillation. It usually resistance to heat, water and chemical. Unlike other sensor, proximity sensor can perform non-contact detection. It also convert information on the movement or presence of certain object in front of it into electrical signal.

Infrared is one example of proximity sensor. Infrared sensor have two main component that are launch and receive. Launch will beam light to the targeted object. When the light meet the object, it will be reflected and reception will catch the beam hence read the measurement. The infrared sensor, SHARP range from 0-100 cm and beam an analog signal. It is very suitable to use inside the PVC rod.

GSM module is a module that can be integrated within an equipment and embedded piece of hardware. This is a technology of digital cellular that transmit mobile voice and data services. Started in early 70's the concept was materialized from a cell-based mobile radio system. It is the widest accepted telecommunication standard and it is used globally.

2.3 BENEFITS AND DISADVANTAGES OF USING GSM TECHNOLOGY

Every technologies comes with pro and cons. In GSM technology, it benefits the user with the technologies growth that been promoted by worldwide competition. It is

leading to a reliable cell-phone and messaging services. Therefore, improve the quality in connection stability and ease of use. The GSM technologies also allow reliable and more efficient data transfer. Moreover it allows text and picture to be sent across the network. Better connection for cell phone because it carries digital signal and can filter background noise. Despite the distance, it is easier to communicate. GSM also has an international connection capabilities. Although it cost more depending on the region, but it still remains a valuable benefits to the users.

Apart from the benefits, GSM technologies have some issues that encounter which is dropped and missed cell. According to the Cellular News, cell quality problem are very common issues in GSM. These problem resulted from the existing technology which is unable to assist as many caller as possible within a single cell tower. Regarding on the security issue, a report from ZDNet UK says that GSM technology has very serious security flaw. This is because hackers are able to cut off phone call from a number of cell phones that uses GSM.

2.4 RELATED SYSTEMS

From the research and the analysis, there are many similar system have been developed and apply around the world. However, those system are expensive and some of them are not suitable for equatorial climate such Malaysia. If exist that kind of system that meet our climate, it would be extremely expensive.

2.4.1 SERVIR's Wireless Sensor Network (WSN) Flash Flood Warning System

Figure 2.1 show the current WNS for Flash Flood Warning System that are implemented along the Jhulikhali River in Bangladesh in order to collect river level data periodically into a central server for analysis and processing purpose. The result will give early warning to the public so that they can move to a safer location. On the other hand, early responders also can move rescue supplies and equipment as quickly as possible. Whenever the river level reaches a certain level anywhere along the river, the server will give instruction to the sensor to increase the frequency of observation. If the river level rising and reaches a pre-determined 'warning level', the server then will activate the siren which are places in an endangered downstream community automatically.

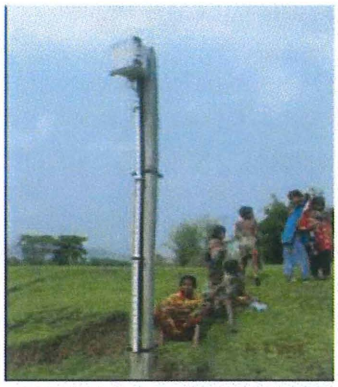


Figure 2.1: SERVIR's (WSN)

The idea of the Flash Flood Early Warning System were came from the information from the local community, and a siren was installed in a single village first. For the future, the systems may be include sirens in every village in affected areas.

2.4.2 Early flood detection system by Noven Project

The project was developed to observe a flood situation and then the observation record will send danger alerts text messages form. Because of shortage of flood detection system, many developing countries facing a lots of loss in life and properties.

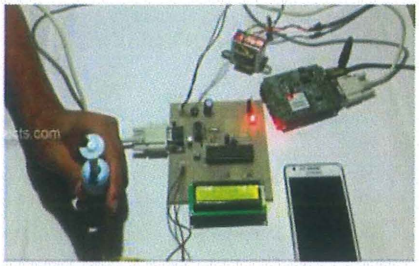


Figure 2.2: Early flood detection system

In this project, the electrodes will be connected at different level and the interfaces will be embedded with C through comparator as seen in figure 2.2. The embedded C then will be connected with modem containing a SIM card while on the other end is a mobile used to receive the data. Mobile number that are stored in the embedded C coding will send SMS whenever the water touch the electrode.

2.4.3 Early warning system (EWS)

Unlike those project, an authority in Philippine has established a budget yet effective Early Warning System (EWS). The system was designed for flood and landslide. Due to climate change, heavier rain, landslides and flood has destruct many residents in those landslide and flood prone area. Previously, there were such system and have caused a devastation to these communities. In order to decrease the devastation the authorized party has research to develop this project for flood or landslides which seems to be suitable and effective in that area.

Figure 2.3: Early Warning System (EWS)

On the other hand, the project is aim to enhance other authorities responses towards natural disaster such as flood and landslides by provide the information that supports their activities and reducing their exposure to vulnerabilities. The Bell and Bottle EWS are very ingenious since it merge hi-tech and creative procedures to make it suitable with the remote areas where there are no other advanced system that can gives warning.

The project will be using a remote sensing technique to determine landslides and flood prone areas. The rainfall will be measure by soda bottle. The bottle also function as a measurer and warning for possible landslide and flood. Bells are used to spread the warning for the residences to prepare or evacuate.

In this project, Remote Sensing and Geographic Information System (RS/GIS) technologies are used as well as computer model which is used to recognize the landslide and flood spot. The results of the analysis will be used by the residents and Flood and Landslides expert to validated and refined through a ground survey. A Pioneering Early Warning System (PEWS) are bounced to be established. This project will initiate a creative yet, low cost EWS which is practical and suitable for poor and remote communities. It also use bells that can spread the warning within the community quickly. The bell ringing's code will be different to establish the alert status at different level.

In some scenario, the bottle rain measuring system will be set off by other local measurements for more accurate evaluation of flood or landslides situation including examines the river's water level when the reading of bottle rain measuring system shows high volume of rainfall. SMS system were used to send the early warning however, due to some connection problem in remote villages and no power supply, it has become one of the big problem. Because of those problem, SMS less effective in spread the warning to the villagers.

2.5 COMPARISON OF TECHNOLOGY

Based on the study of the existing system, a comparison have been made in term of detection method, cost, technology that used and the communication tools. The existing system also being compare with the proposed system to identify the similarities

and differences. Table below show the comparison among three existing product with the product that are proposed.

Specifications	Products			
	SERVIR's Wireless Sensor Network (WNS) Flash Flood Warning System	Early Flood Detection System by Noven Project	Early Warning System (EWS)	Real Time Flood Detection & Monitoring System with Wireless Network Sensors
Detection Method	Distance sensor	Electrode	Soda bottle to measure rainfall and serve as indicator	Infrared Sensor
Cost	Very Expensive	RM1142.30	Low-cost	RM 500.00
Technology used	Wireless network sensor	Electrode that interfaced with embedded C through comparator	Remote sensing & Geographic Information System (RS/GIS)	Arduino that equipped with Infrared sensor and GSM module
Alert medium	Alarm	Phone	Alarm	Phone and computerized system
Communication tools	GSM	GSM	GSM	GSM
Field	Riverbank	N/A	Riverbank & Landslide	Riverbank

Table 2.1: Comparison between existing products and proposed product

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Process of software development may have many acceptable approaches of methodology for example, Agile Methodology, Rapid Application Development (RAD), spiral, Waterfall, Software Development Life Cycle, (SDLC), Extreme Programming and so on. In this project, Rapid Application Development (RAD) methodology will be utilize. It will focus on the design, prototype, research and related software and hardware for the whole development process. All the information in Chapter 1 & 2 are collected and analyzed before implement to Chapter 3.

Several advantages of using RAD methodology. It is convenient as well as flexible. Therefore it help to make the system easier to modify or resolve if any issues of the phases occur. RAD is best used for developing system based on existing prototype. The key to this methodology is to reuse the prototype hence, reduce the duration of development process and testing. Apart from reduce time, highly reusability of its components also increase the quality of the project. Moreover, it provide system that offer minimal maintenance cost. The involvement of user in the analysis and design stage also improve the good quality of final product.

3.2 RAPID APPLICATION DEVELOPMENT (RAD) METHODOLOGY

System development methodology is a standard steps used by most organization in developing a system. A methodology can be define as a complete step by step approaches in the development process. The main idea of methodology is to control and guide the progress of developing the system.

Methodology are embraced by organization will be consistent with the general management style. RAD methodology is very flexible and adjustable to be change, therefore, it is very ideal for this kind of project since this project require a short period of time to accomplish. Figure 3.1 below show the stages of RAD:

1. Requirement Planning
2. System Design
3. Implementation and prototyping
4. Testing
5. Maintenance

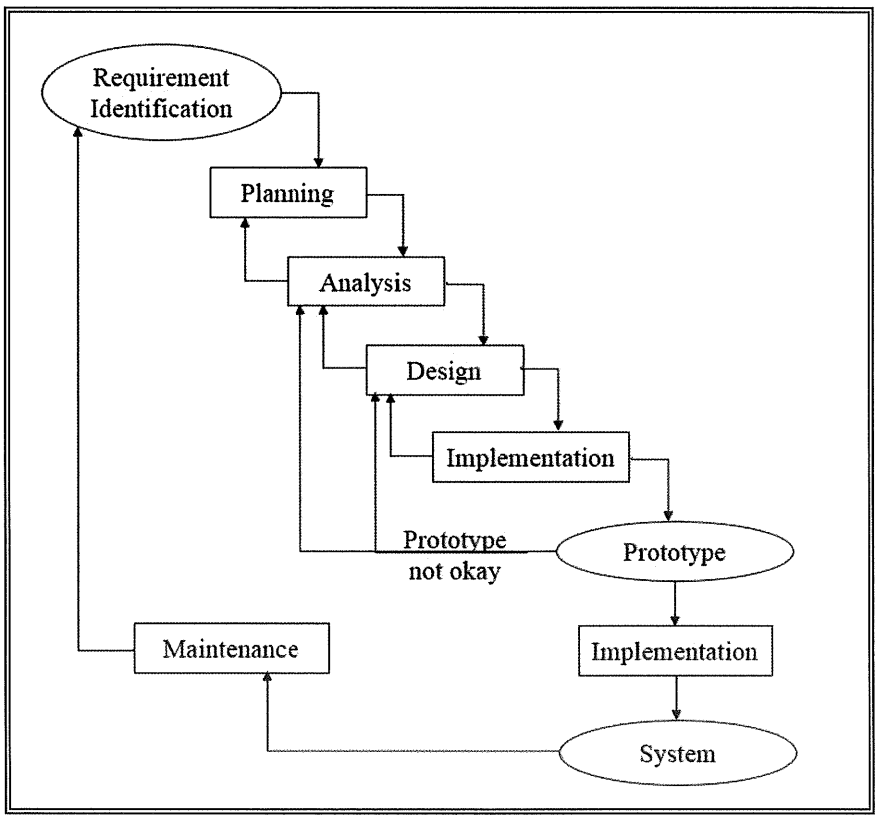


Figure 3.1: Rapid Application Development (RAD) Methodology

3.2.1 Planning

Planning process are taken place before the analysis. In this stage, the scope and objective of the project are defined. Discussion among client also takes place in this stage to determine how this project are going to be develop precisely. The requirement planning are going to discuss thoroughly to avoid misconceptions among the person involved with this project. The meeting between developers and client about the project should be done in a proper office environment. Meanwhile, the system provider will certainly show the particular part to go into details along with the developers about the existing operating system.

3.2.2 Analysis

The lifecycle of this project are begin. In this stage, the deliverables are broken down from the high-level Project Chapter into the more specific business requirements. The system analyst may discover desired system needs, whether the analysis process will fulfil the system requirements that supports the system outcome. The standard of performance need to be improve to complete the whole process.

In this project, the actual analyses are accomplished to obtain information regarding the current flood monitoring and prediction system. System Analyst also discover issues and problem to obtain information and specific data needs to find out what a weakness related with the current system.

In order to resolve the issues, some system that uses proximity sensor and GSM technology has been analyzed and explained in Chapter 2. The research and study about the presence technology were explained in details at the beginning of the chapter.

3.2.2.1 Analysis on the developing system

Further analysis on developing this system are taken place in this section. The technique, tools, materials and idea of this system will be discuss and explain in deep. The hardware, software and user requirement also have been analyzed. Below are steps that have been analyzed in developing this system.

a) Setup the detection device

This is the first phase of developing process. Developer need to setup the device by connecting the sensor with Arduino board, GSM module, power supply and some electrical components. The device need to be test first before seal in a waterproof box.

b) Device placement

In this phase the device that are sealed, will be place on top of a pole by the riverbank. The pole height about 10m, so the sensor probably about 9 meter from the water surface depending on the depth of the river.

c) Detect the distance between water surface and device

In order to get data, the device will be operate 24 hours. The distance will be capture for every hour, 30 minutes and 10 minutes depending on the level of the water.

d) Sending data to central processing

When the measurement was captured, the data will be send to central processing through GSM module.

e) Analyze the data

The data will then be save into the database. From the database, the data will used to predict the flood.

3.2.4 Design

The design stage focuses on system design based on associated data analysis along with information which has been collected during the analysis stage. The design include physical and logical design, cost and time estimate until this project are ready to be deployed.

3.2.4.1 Flowchart

Figure 3.2 below show the flow of the system from the beginning until the result is established. Firstly, the sensor will detect the distance of water level from the device it attached to. After that, the Arduino will send the record to Central Processing at DoID through GSM Module. Then, data will be generate in the form of graph and alarm will be activate if the water level reach a specific levels (cautious, warning, danger). From the graph, user may know how fast the water is increasing, therefore can save the residence nearby the river.

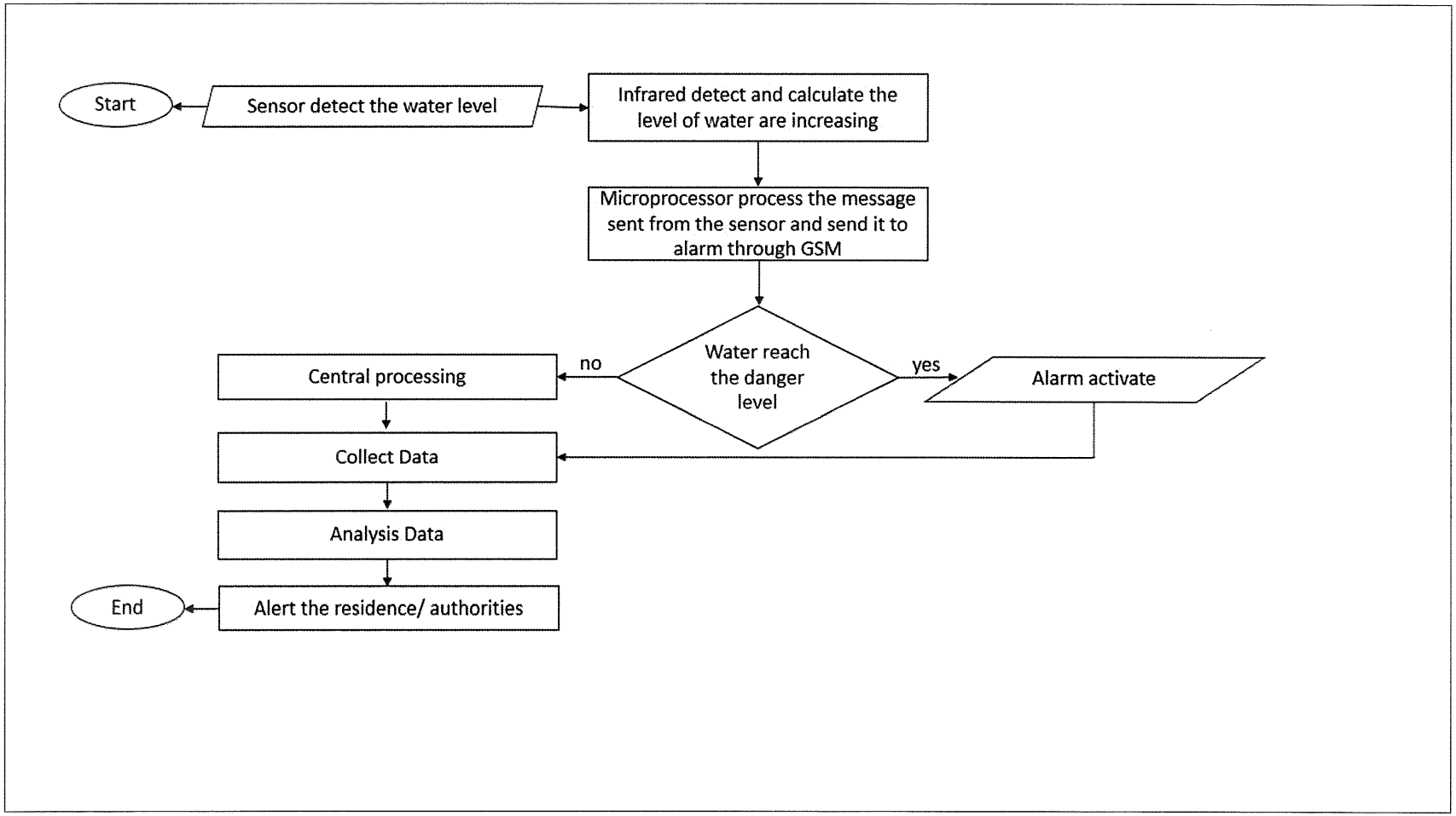


Figure 3.2: Flowchart

3.2.4.2 Logical Design

Before develop the actual device is developed, the design must first be structured. The arduino ground port will be connected to ground on terminal on the sensor. Voltage port on the arduino also will be connected to volt terminal on the sensor. Meanwhile the trigger and echo pin will be redirect to port number 8 and 9 0n the arduino. The resistor are used to lower the current flow in the circuit. Figure 3.3 show the logical design of the device.

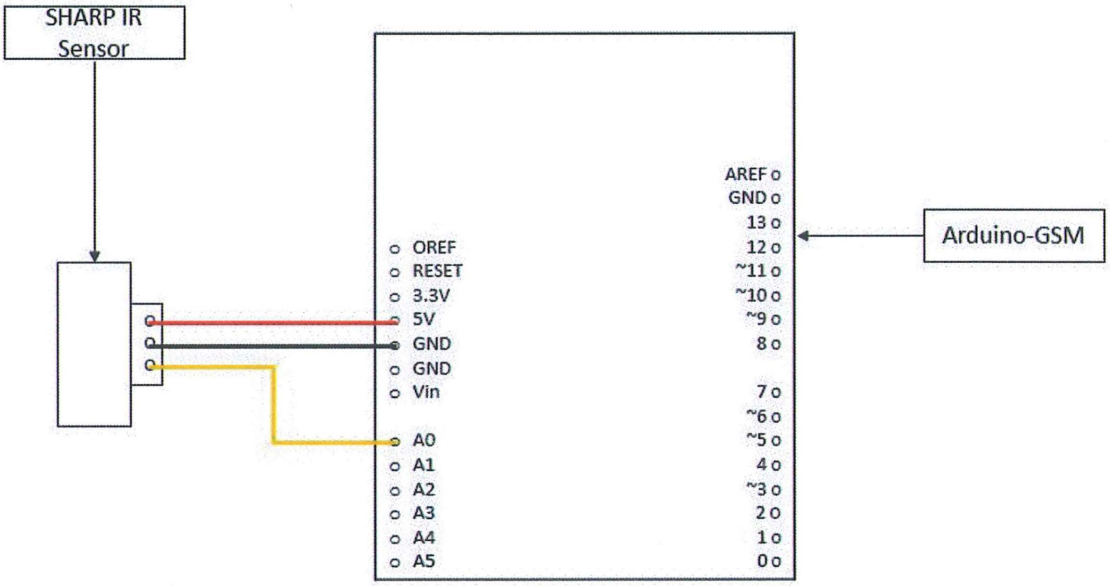


Figure 3.3: Logical Design

3.2.4.3 Physical Design

When the logical design is confirmed, the phase of designing continue with the physical design. The physical design require a complete image of final product. It also give big impact on the performance of final product. Figure 3.4 show the physical design for this project.

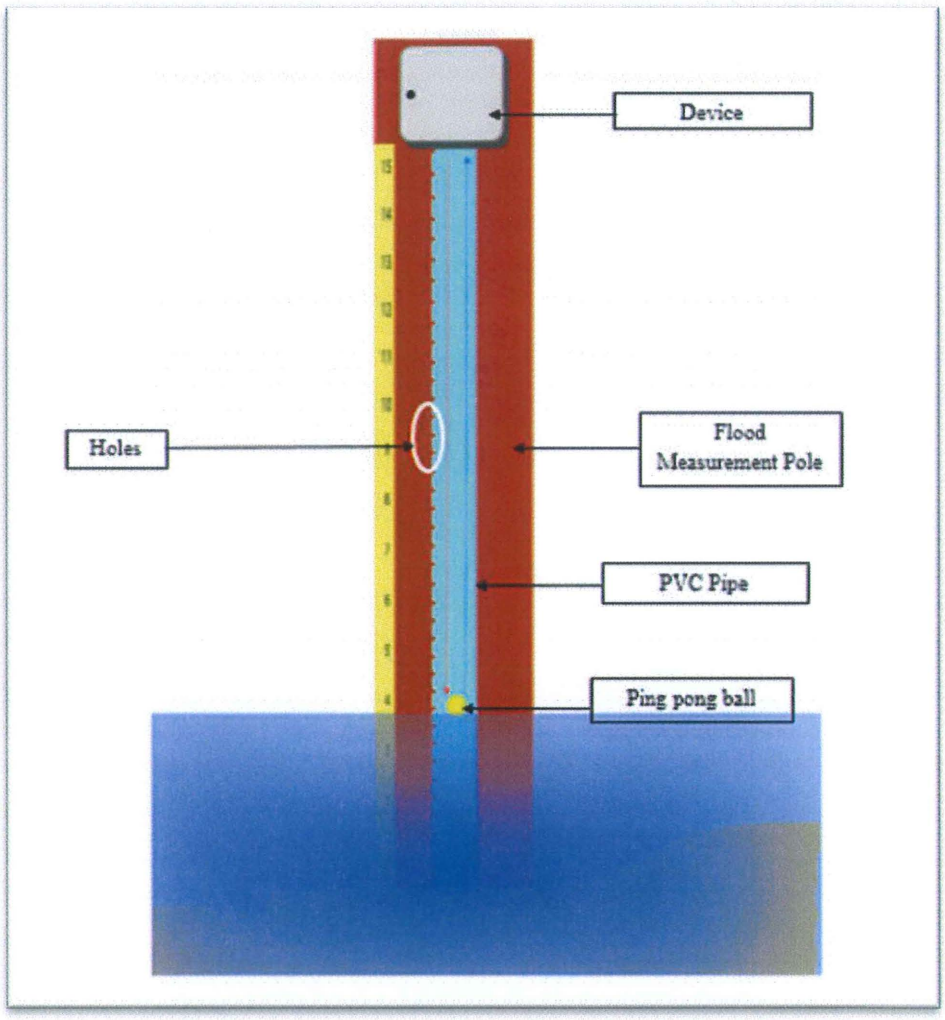


Figure 3.4: Physical Design

3.2.4.4 System Architecture

Figure below shows how this system interacts and communicate to get the data from the device and predict the flood.

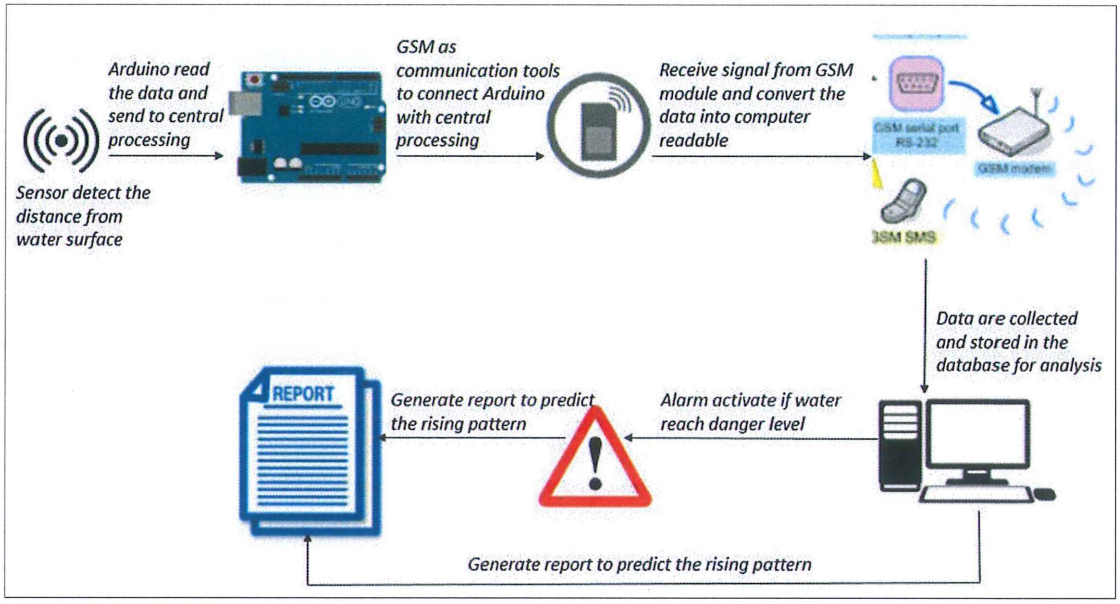


Figure 3.5: System Architecture

Based on the figure for the system architecture, the sensor will first detect the distance between the water surface and the device. After the data are captured, Arduino will send the data to central processing through GSM module. GSM modem that are connected to central processing will receive the message transmitted from the arduino and transfer the message to the database. Alarm will active if the water reach danger level. Then the data will be used to generate report and predict the flood.

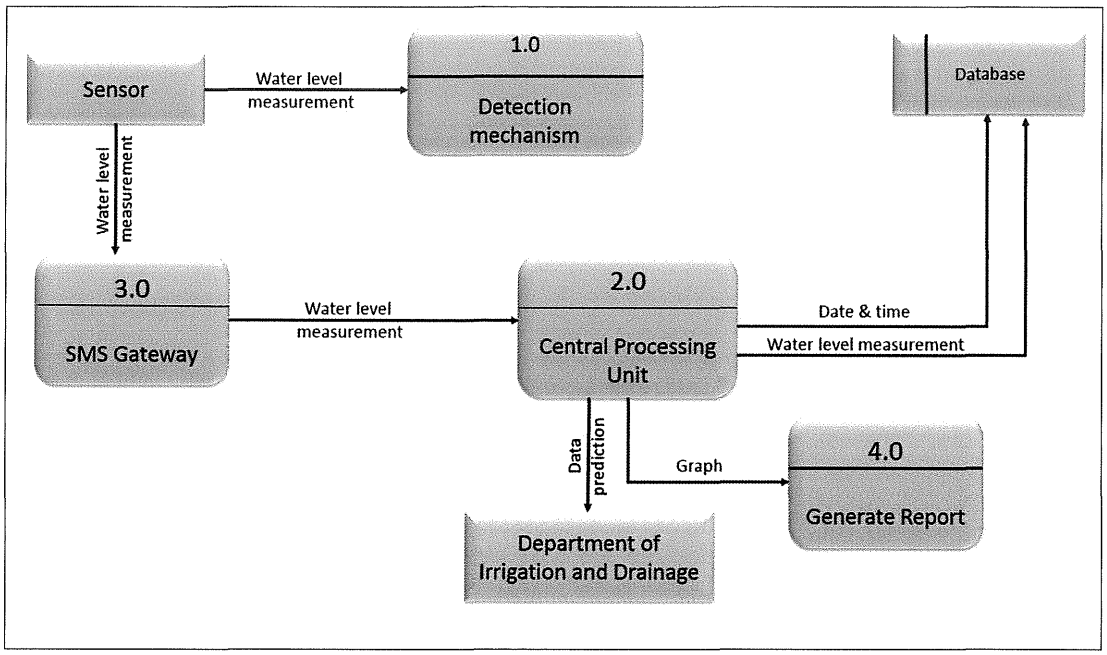


Figure 3.7: Data Flow Diagram

The DFD show the whole flow for the system. The sensor will send water level measurement to the detection mechanism which is Arduino. It also send the water level measurement to activate the alarm that are installed at DoID. Detection mechanism will send the data it received from sensor as well as time and date of the data collected into the database. From the database, all data will be used by central processing to predict the flood for DoID. Central processing also generating graph for further review and flood prediction.

3.2.4.7 Use case Diagram

Use case diagram will be regarded as an interaction between user and developing system in the simplest form. Figure 3.8 show the user-system interaction for this system

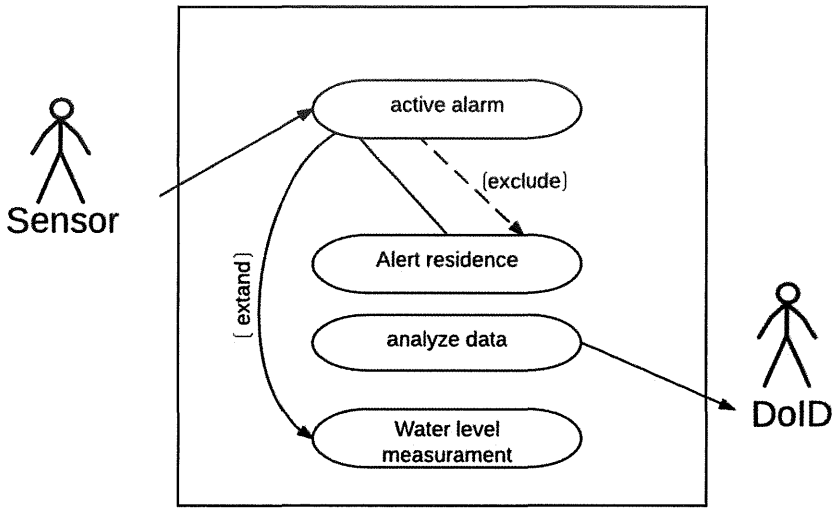


Figure 3.8: Use case Diagram

This diagram tells about the interaction between the user and the system. Sensor will interact directly with the alarm system. The DoID will use analyzed data to predict the flood.

3.2.5 Implementation

This stage also known as a deployment stage. All programming code and command will be implement to the device. In this stage, the design developed in the previous phases will be actualize. The process will be focus on each phases to figure out the best way in developing the system. At this stage, developers will test and enforcing the system in order to get the best result.

3.2.6 Testing

In order to cope with the requirement needs, the system will be test to make sure it running without any error. The system also will be debug to eliminate any existing error. The system only can be deploy after it is free from error.

3.2.7 Maintenance

This phase is the final phase of the methodology. Maintenance phase take place after the project deploy. In this phase, the developer team will give support to the user. Any changes of the software and the hardware will be subject to this phase. The team will also monitor the performance of the system, bugs and manage the errors that exist after the deployment of the project. The key to this phase are to make sure to keep the system alive, to maintain the code running and to update the software and hardware whenever required.

3.3 HARDWARE & SOFTWARE

In actualize this system, a suitable hardware and software are required. The hardware and software requirement also very important to make sure the system can be run as it is planned. The following subtopic will discuss about the hardware and software necessary for the development stage.

3.3.1 Hardware Requirements

In the developing of process, the requirement hardware are Arduino Uno, Board, Electronic components (resistor, capacitor, LED, etc.), Proximity sensor (laser sensor), GSM module, alarm, PVC clear pipe and ping pong ball. Table below show the hardware that use in this project and also the specification and description. It is also state what each hardware use for.

Table 3.1: Hardware and its Description

Hardware	Description
Arduino Uno	- To communicate with GSM module and the sensor.
SHARP-IR sensor	- To detect the distance between the ping pong ball and the sensor
Jumper wire	- To connect the Arduino to board
Breadboard	- To place an actual electronic components test the component connectivity
Adapter	- Intended for connection between the software and hardware
GPRS Shield	- Used to communicate the Arduino sensor to central processing hence activate the alarm
GSM modem	- Connected to a computer to receive signal from GPRS shield
Battery	- To supply power to the device.
Battery holder	- To hold the battery.

Electronic components (resistor, capacitor, LED, etc.)	- To support electricity in the circuit
Alarm	- To notify the DoID when water reach danger level.
PVC pipe with 3" diameter	- Use to locate ping pong ball and to let water fill inside to float the ball.
Ping pong ball.	- Use to stop the light beam from the laser.

3.3.2 Software Requirements

Meanwhile, software uses in this project are Windows 7, Arduino Integrate Development Environment (IDE), Java, Notepad, Microsoft Office (Microsoft Word; Project; Power Point; and Access) Adobe Reader and Adobe Illustrator. Table below show what software has been use to program this system and what software has been use for complete the thesis.

Table 3.2: Software and description

Software	Description
Windows 7	• To run the software and the platform for this system • Used to developed system

Arduino Integrate Development Environment (IDE)	• Run and allow to write code for Arduino using C
Visual Basic	• To write the code to generate report from the data collected
Notepad	• To write the water level measurement for result purpose
Microsoft Office • Microsoft Words • Microsoft Projects • Microsoft Power Points • Microsoft Access	• To prepare the documents • To prepare the Gantt Chart • For the presentation slides • For the database
Adobe Reader Adobe Illustrator	• To read articles related to this project • To design the model figure

3.3.3 User Requirement

Comparing with the existing system is one of the user requirement technique that are implement to develop the system to avoid developing same features with the existed. On the other hand, observing the particular process in manual system also help to get the user requirement. This is because, we can create a system that can help user to simplify their work.

3.4 GANTT CHARTS AND TASKS

To reach the milestone, a Gantt chart has been construct to keep track of the flow of the system. The Gantt chart start from session 1 until deployment at session 2. The milestone of this project is 196 days starting from 11th September 2015 until 24th of March 2016.

3.4.1 Gantt Chart for Overall Project

The overall project will be run from September 2015 to May 2016 (249 days). The Gantt chart will show the main process which is planning, analysis, design, implementation and testing. The maintenance phase are not included in the Gantt chart because it takes longer period of time to proceed.

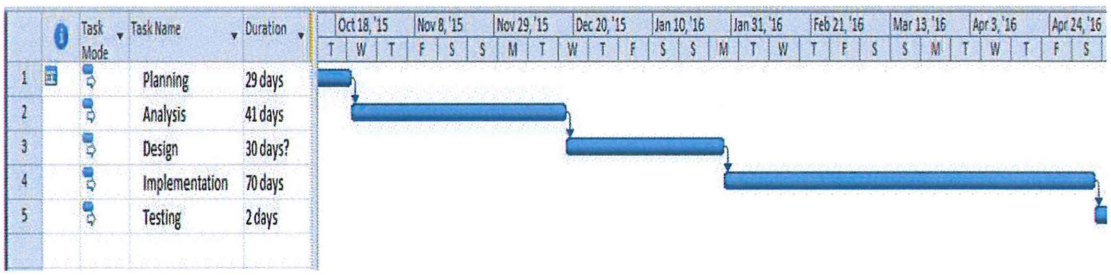


Figure 3.9: Gantt chart for overall project

3.4.2 Task and Duration for Overall Project

This section will show the tasks and duration for the whole project in general. Figure below will give better picture of task for the project.

	Task Mode	Task Name	Duration	Start	Finish
1		Planning	29 days	Fri 9/11/15	Wed 10/21/15
2		Analysis	41 days	Thu 10/22/15	Thu 12/17/15
3		Design	30 days?	Fri 12/18/15	Thu 1/28/16
4		Implementation	70 days	Fri 1/29/16	Thu 5/5/16
5		Testing	2 days	Fri 5/6/16	Mon 5/9/16

Figure 3.10: task and duration for overall project

3.4.3 Gantt Chart for Session 1 (PSM 1)

Gantt chart for PSM 1 show the step by step accomplished to complete the first session of the project as shown in figure 3.11.

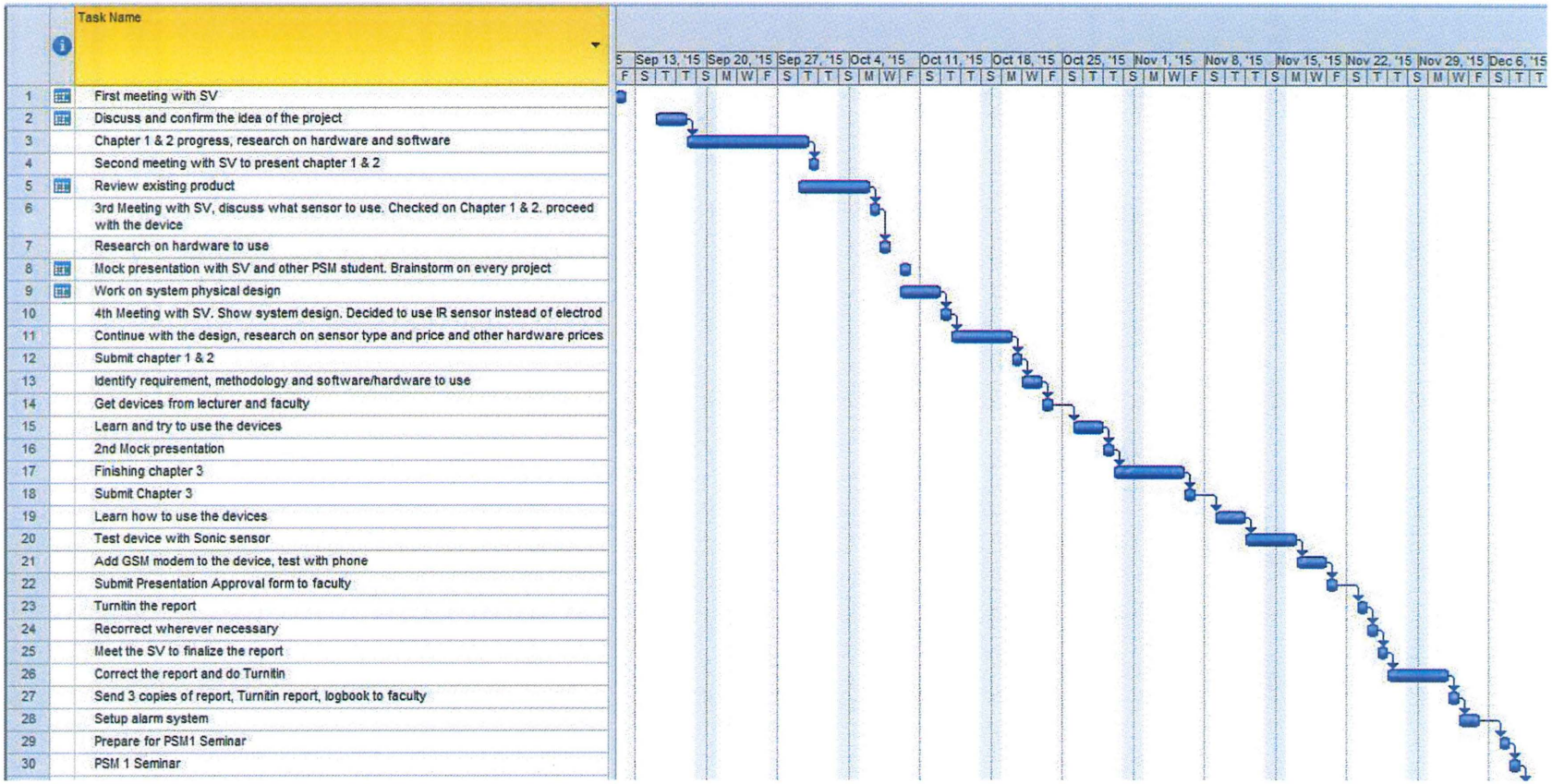


Figure 3.11: Gantt chart for PSM 1

3.4.4 Task and Duration Session 1 (PSM 1)

The task and duration for PSM 1 are defined in figure below.

	Task Name	Duration	Start	Finish
1	First meeting with SV	1 day	Fri 9/11/15	Fri 9/11/15
2	Discuss and confirm the idea of the project	3 days	Tue 9/15/15	Thu 9/17/15
3	Chapter 1 & 2 progress, research on hardware and software	8 days	Fri 9/18/15	Tue 9/29/15
4	Second meeting with SV to present chapter 1 & 2	1 day	Wed 9/30/15	Wed 9/30/15
5	Review existing product	5 days	Tue 9/29/15	Mon 10/5/15
6	3rd Meeting with SV, discuss what sensor to use. Checked on Chapter 1 & 2. proceed with the device	1 day	Tue 10/6/15	Tue 10/6/15
7	Research on hardware to use	1 day	Wed 10/7/15	Wed 10/7/15
8	Mock presentation with SV and other PSM student. Brainstorm on every project	1 day	Fri 10/9/15	Fri 10/9/15
9	Work on system physical design	2 days	Fri 10/9/15	Mon 10/12/15
10	4th Meeting with SV. Show system design. Decided to use IR sensor instead of electrod	1 day	Tue 10/13/15	Tue 10/13/15
11	Continue with the design, research on sensor type and price and other hardware prices	4 days	Wed 10/14/15	Mon 10/19/15
12	Submit chapter 1 & 2	1 day	Tue 10/20/15	Tue 10/20/15
13	Identify requirement, methodology and software/hardware to use	2 days	Wed 10/21/15	Thu 10/22/15
14	Get devices from lecturer and faculty	1 day	Fri 10/23/15	Fri 10/23/15
15	Learn and try to use the devices	3 days	Mon 10/26/15	Wed 10/28/15
16	2nd Mock presentation	1 day	Thu 10/29/15	Thu 10/29/15
17	Finishing chapter 3	5 days	Fri 10/30/15	Thu 11/5/15
18	Submit Chapter 3	1 day	Fri 11/6/15	Fri 11/6/15
19	Learn how to use the devices	3 days	Mon 11/9/15	Wed 11/11/15
20	Test device with Sonic sensor	3 days	Thu 11/12/15	Mon 11/16/15
21	Add GSM modem to the device, test with phone	3 days	Tue 11/17/15	Thu 11/19/15
22	Submit Presentation Approval form to faculty	1 day	Fri 11/20/15	Fri 11/20/15
23	Turnitin the report	1 day	Mon 11/23/15	Mon 11/23/15
24	Recorrect wherever necessary	1 day	Tue 11/24/15	Tue 11/24/15
25	Meet the SV to finalize the report	1 day	Wed 11/25/15	Wed 11/25/15
26	Correct the report and do Turnitin	4 days	Thu 11/26/15	Tue 12/1/15
27	Send 3 copies of report, Turnitin report, logbook to faculty	1 day	Wed 12/2/15	Wed 12/2/15
28	Setup alarm system	2 days	Thu 12/3/15	Fri 12/4/15
29	Prepare for PSM1 Seminar	1 day	Mon 12/7/15	Mon 12/7/15
30	PSM 1 Seminar	1 day	Tue 12/8/15	Tue 12/8/15

Figure 3.12: task and duration for PSM 1

3.4.5 Gantt Chart for Session 2 (PSM 2)

For PSM 2, the milestone are shorter compare to PSM 1 because the task only focusses on development of the project and to do documentation for the project.

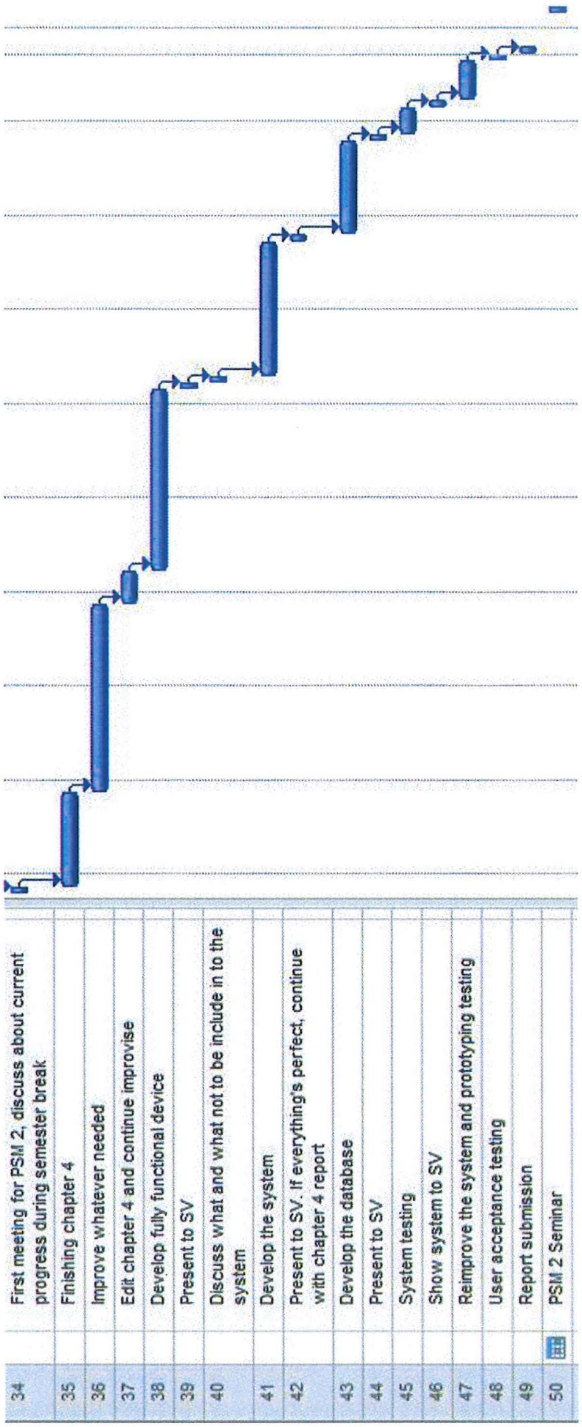


Figure 3.13: Gantt chart for PSM 2

3.4.6 Task and Duration Session 2 (PSM 2)

Figure below shows the task and duration for PSM 2 which takes place from 14/4/2016 until 24/05/2016.

34		First meeting for PSM 2, discuss about current progress during semester break	1 day	Thu 1/14/16	Thu 1/14/16
35		Finishing chapter 4	10 days	Fri 1/15/16	Thu 1/28/16
36		Improve whatever needed	20 days	Fri 1/29/16	Thu 2/25/16
37		Edit chapter 4 and continue improvise	3 days	Fri 2/26/16	Tue 3/1/16
38		Develop fully functional device	19 days	Wed 3/2/16	Mon 3/28/16
39		Present to SV	1 day	Tue 3/29/16	Tue 3/29/16
40		Discuss what and what not to be include in to the system	1 day	Wed 3/30/16	Wed 3/30/16
41		Develop the system	14 days	Thu 3/31/16	Tue 4/19/16
42		Present to SV. If everything's perfect, continue with chapter 4 report	1 day	Wed 4/20/16	Wed 4/20/16
43		Develop the database	10 days	Thu 4/21/16	Wed 5/4/16
44		Present to SV	1 day	Thu 5/5/16	Thu 5/5/16
45		System testing	2 days	Fri 5/6/16	Mon 5/9/16
46		Show system to SV	1 day	Tue 5/10/16	Tue 5/10/16
47		Reimprove the system and prototyping testing	4 days	Wed 5/11/16	Mon 5/16/16
48		User acceptance testing	1 day	Tue 5/17/16	Tue 5/17/16
49		Report submission	1 day	Wed 5/18/16	Wed 5/18/16
50		PSM 2 Seminar	1 day	Tue 5/24/16	Tue 5/24/16

Figure 3.14: Task and duration for PSM 2

3.5 Expected Result

After design the devices and the application to predict the flood, this is the expected outcome from the project.

The device will be able to detect the water level increased

- An alarm notification could be send to DoID to alert the department that water have reached a danger level
- The central processing could predict the water rising pattern based on data collected at every point as shown in table 3.5 and figure 3.5

WMS

ID	Mobile	Message	Tarikh	Masa
60	+60199615140	68	5/17/2016	15:29:03
61	+60199615140	68	5/17/2016	15:30:02
62	+60199615140	70	5/17/2016	15:31:02
63	+60199615140	68	5/17/2016	15:32:02
64	+60199615140	68	5/17/2016	15:33:02
65	+60199615140	68	5/17/2016	15:34:02
66	+60199615140	70	5/17/2016	15:35:02
67	+60199615140	68	5/17/2016	15:56:02
68	+60199615140	68	5/17/2016	15:57:02
69	+60199615140	68	5/17/2016	15:58:02
70	+60199615140	68	5/17/2016	15:59:03
71	+60199615140	68	5/17/2016	16:00:02
72	+60199615140	68	5/17/2016	16:01:02
73	+60199615140	68	5/17/2016	16:02:02
74	+60199615140	68	5/17/2016	16:03:01
75	+60199615140	68	5/17/2016	16:04:02
74	+60199615140	68	5/17/2016	16:03:01
77	+60199615140	69	5/17/2016	16:06:01
78	+60199615140	68	5/17/2016	16:07:01
79	+60199615140	68	5/17/2016	16:08:01

Table 3.2: Expected data collected from the device

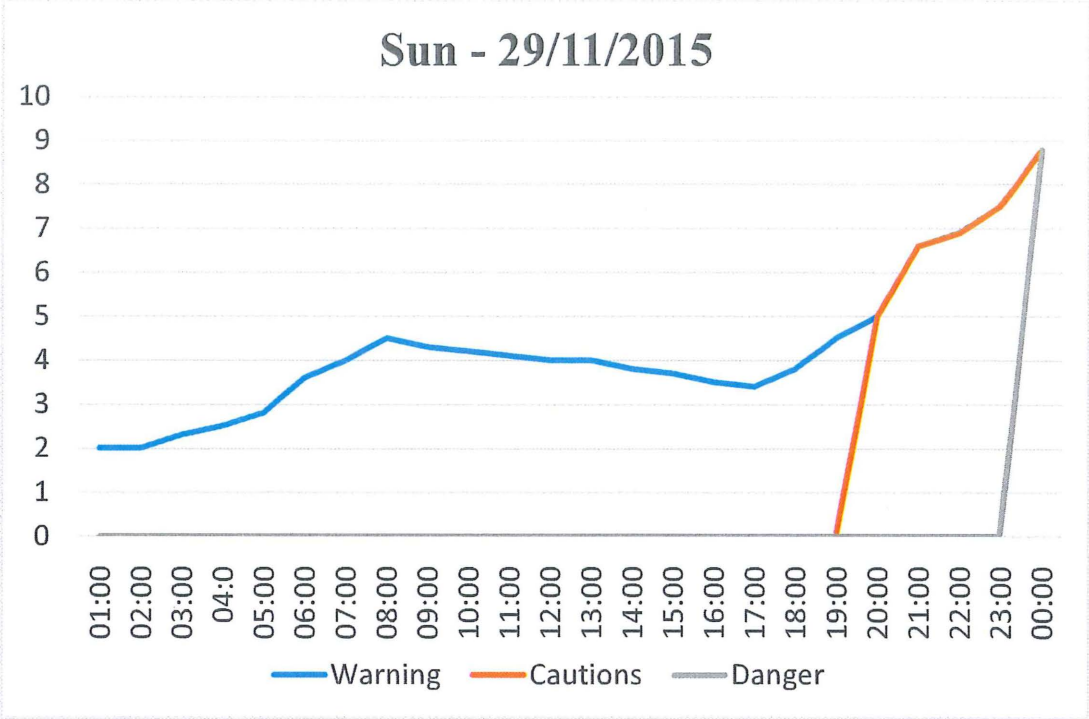


Figure 3.15: Expected graph to show water rising pattern

3.6 Summary

Rapid Application Development (RAD) methodology was chosen due to its flexibilities and adaptabilities. By using this methodology, the system can be updated easily from time to time. Moreover, this methodology is very suitable for small system that require a brief developing period.

In order to develop the system, the best and reliable hardware and software was listed and chose. The process of selecting the best hardware and software are very important to make sure the requirement that was chosen best meet the system design.

CHAPTER 4

IMPLEMENTATION

4.1 INTRODUCTION

In this chapter, the process of implementation will be discuss further. It will also include the documentation of process in the project development. This chapter will cover the implementation of the project which are using Arduino Uno, SHARP IR sensor and GSM shield including the code, debug and documentation. The code consists of different classes that help to operate the different processes. The interaction between Arduino and sensor are using the code programmed to Arduino using Integrated Development Environment (IDE). This compiler make it easier to write the code and control the sensor on Arduino board.

In this chapter also discuss about central processing system. The system will receive messages which basically the water level measurement from GSM modem attached to the computer. Data from the messages will be store in the database for flood prediction.

4.2 IMPLEMENTATION REQUIREMENTS

There are two stages need to be completed for this system; the hardware installation and the software installation. The project requires proper software installation and hardware configuration to facilitate the system run smoothly. In order to implement the prototype of this system, all hardware must be installed correctly with the right instruction. A few mistakes may cause the malfunction to the system. All precautions must be taken before started the installation to avoid any problems in the future.

First, set up the Arduino, GSM, and sensor before start the programming. The pin should be connected to port Analogue0, ground and voltage because IR sensor use analogue signal to send and receive signals. The program will allow GSM to send data collected from the sensors to central processing through SMS. The data then will be store into database through a program, Water Management System.

4.2.1 Hardware Implementation

The hardware required for this system are Arduino UNO, GSM module, GSM Modem, SHARP IR sensor, jumper wires, connectors, real time clock module, and AA batteries. First are steps for the hardware connection, the Arduino and GSM Shield should be attach together before connect the IR sensor on board. As in figure 4.2.2, notice that the sensor have 3 wires attached to it. The red wire indicate a voltage, black wire indicate ground and yellow wire is a wire for analogue to send and receive signals. Real time clock module is connected to Arduino-GSM using jumper wires. GSM modem will be installed with active SIM number and connect to central processing unit. Make sure that all components are correctly connected.

Figure below shows the connection of hardware and coding using Arduino IDE compiler to activate the sensor and send the data to central processing through GSM module.

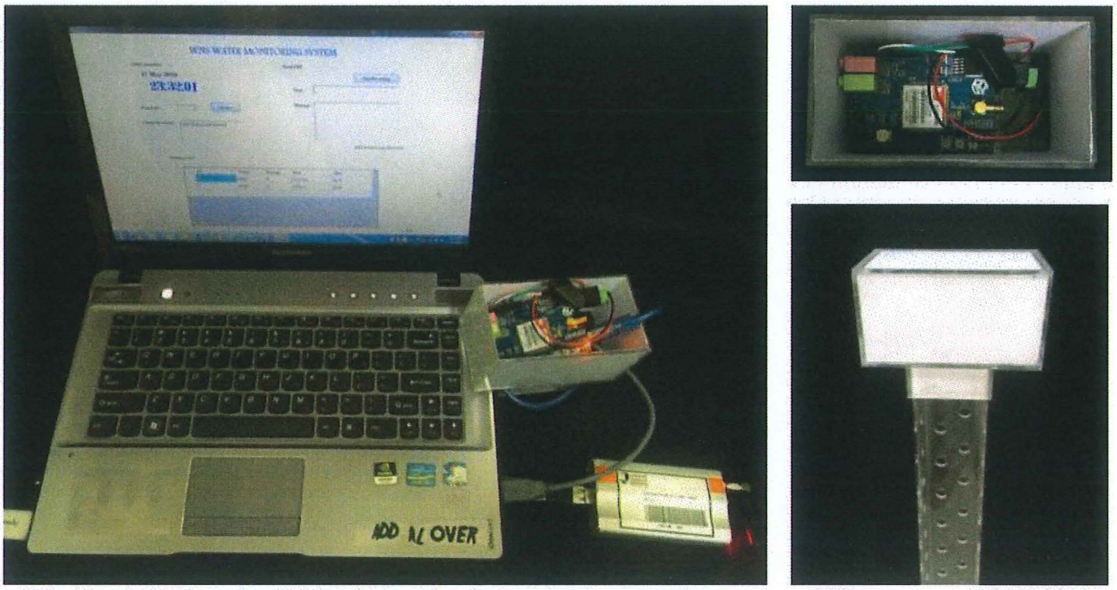


Figure 4.1: Hardware Connection

```
#include "SIM900.h"
#include <SoftwareSerial.h>
#include "sms.h"

SMSGSM sms;

int redpin = 0;                  // analog pin used to connect the sharp sensor
int val;                 // variable to store the values from sensor(initially zero)
int distance;
int maximumRange = 80; // Maximum range needed
int minimumRange = 10; // Minimum range needed

boolean started = false;
char smsbuffer[160];
char sms_position;
char phone_number[20];
char sms_text[100];

void loop()
{
  val =analogRead(redpin);       // reads the value of the sharp sensor
  distance = 80-((6762/(val-9))-5);
  Serial.println(distance);            // prints the value of the sensor to the serial monitor
  delay(10000);                    // wait for this much time before printing next value

  if (started)
  {
```

Figure 4.2: Hardware Configuration (part 1)

```
26
27   if (started)
28   {
29     sms_position = sms.IsSMSPresent(SMS_UNREAD);
30     if (sms_position)
31     {
32       Serial.print("SMS postion:");
33       Serial.println(sms_position, DEC);
34       sms.GetSMS(sms_position, phone_number, sms_text, 100);
35       Serial.println(phone_number);
36       Serial.println(sms_text);
37     }
38     delay(1000);
39   }
40 };
41
42 void setup()
43 {
44   Serial.begin(9600);
45   if (gsm.begin(9600))
46   {
47     Serial.println("\nstatus=READY");
48     started = true;
49     started = loop;
50   }
51   else
52     Serial.println("\nstatus=IDLE");
53   for (;;) {
```

Figure 4.3: Hardware Configuration (part 2)

```
51   else
52     Serial.println("\nstatus=IDLE");
53   for (;;) {
54     if (started)
55     {
56        val =analogRead(redpin);       // reads the value of the sharp sensor
57
58   distance = 80-((6762/(val-9))-5);
59
60       Serial.println(distance);
61
62       delay(10000);
63
64       if ( sms.SendSMS("+60176644339", "Node1", distance));
65       {
66         Serial.println("\nSMS sent OK.");
67       }
68     } else
69     {
70       Serial.println("\nError sending SMS.");
71     }
72
73   }
74 };
```

Figure 4.4: Hardware Configuration (part 3)

4.2.2 Software Implementation

The second stage is software implementation. It requires SMS gateway interface, spreadsheet, Microsoft Access database and Visual basic to get data from hardware devices so that the data can be process and store into the database. By using gateway interface, all data collected from GSM modem will be convert to spreadsheet and imported to MS Access database. With some query, database will be added automatically whenever there are addition to new text file. The visual basic is functioned as an interface for central processing. The interface was programmed using visual basic script. After that, the system is tested. Figures below are interfaces and coding for central processing.

Figure 4.5: Main interface of the project.

```
Imports System.Data
Imports System.Data.OleDb
Imports System.Globalizatio

Public Class Form1
    Dim timercount As Integer = 100
    Public Modem As New MobitekSMSAPI7.Modem
    Public SMS As New MobitekSMSAPI7.SMS

    Private Sub Form1_load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.TextCha
        Dim dt As String = ""
        Dim dtfInfo As DateTimeFormatInfo
        Dim dtfstyle As String = "ddd, dd MMMM yyyy"

        Timer2.Start()
        Me.WMSTableAdapter.Fill(Me.DatabaseDataSet.WMS)
    End Sub

    Private Sub Button1_Click(sender As Object, e As EventArgs) Handles Button1.Click
        RichTextBox1.Text = "Initializing the GSM modem ..."
        InitModem7()

    End Sub
```

Figure 4.6: Coding for main interface (part 1)

```
    Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click
        Form2.Show()
        Timer1.Enabled = True
        'Timer2.Enabled = True
        Me.Hide()
        ' Timer1.Enabled = True
    End Sub

    Private Function myZero(ByVal value As Integer) As String
        Return value.ToString().PadLeft(2, "0")
    End Function

    Private Sub Timer2_Tick(sender As Object, e As EventArgs) Handles Timer2.Tick
        Dim txt As String = ""
        txt &= myZero(DateTime.Now.Hour)
        txt &= ":" & myZero(DateTime.Now.Minute)
        txt &= ":" & myZero(DateTime.Now.Second)
    End Sub

    Private Sub Form1_Load_1(sender As Object, e As EventArgs) Handles MyBase.Load
        Me.WMSTableAdapter.Fill(Me.DatabaseDataSet.WMS)
    End Sub

    Private Sub Timer1_Tick(sender As Object, e As EventArgs) Handles Timer1.Tick
        If DateTime.Now.Second = 0 Then
            timercount = 60
        Else
            timercount = 60 - DateTime.Now.Second
        End If
    End Sub
End Class
```

Figure 4.7: Coding for main interface (part 2)

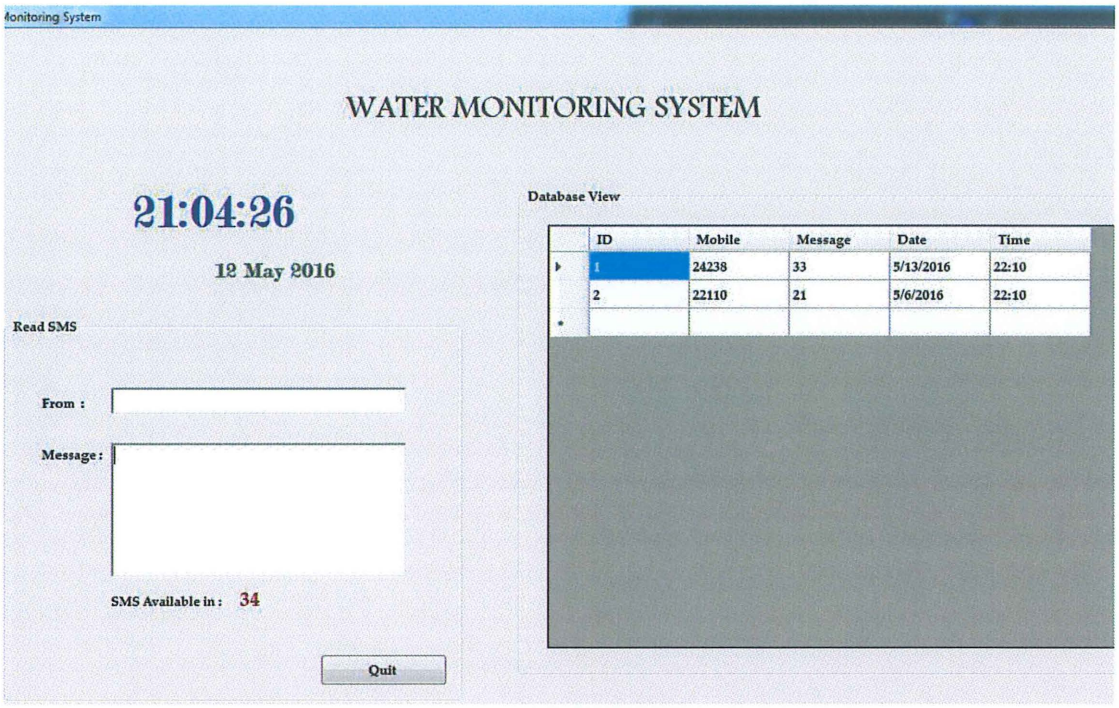
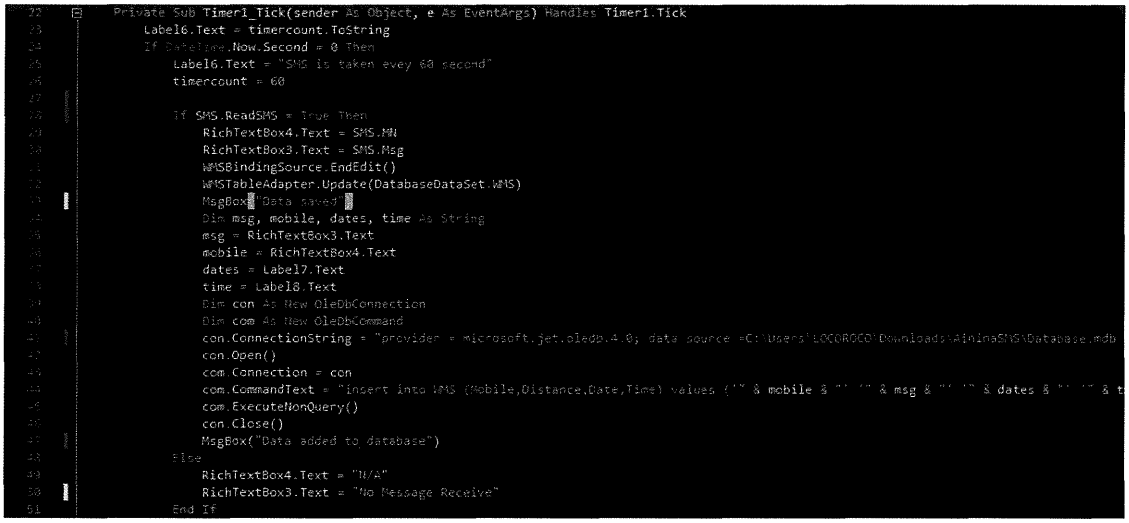


Figure 4.8: Interface for collecting distance and database summary

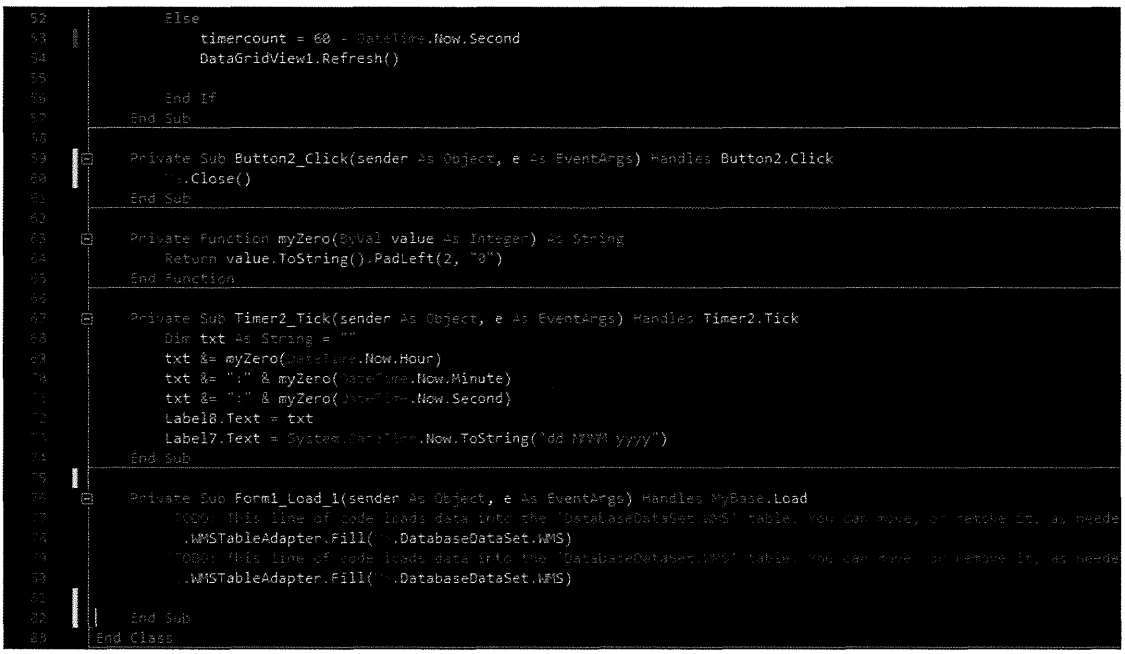
```
Imports System.Data
Imports System.Data.OleDb
Imports System.Globalization

Public Class Form2
    Dim timercount As Integer = 100
    Public Modem As New MobitekSMSAPI7.Modem
    Public SMS As New MobitekSMSAPI7.SMS

    Private Sub Form2_load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.TextCh
        Dim dt As String = ""
        Dim dtfInfo As DateTimeFormatInfo
        Dim dtfstyle As String = "ddd, dd MMM yyyy"

        Label6.Text = "SMS is taken evey 60 second"
        Timer2.Start()
        Timer1.Enabled = True
        Me.WMSTableAdapter.Fill(Me.DatabaseDataSet.WMS)

    End Sub
```

Figure 4.9: Codes for collecting distance and database summary (part 1)



```
    Private Sub Timer1_Tick(sender As Object, e As EventArgs) Handles Timer1.Tick
        Label6.Text = timercount.ToString
        If DateTime.Now.Second = 0 Then
            Label6.Text = "SMS is taken every 60 second"
            timercount = 60

            If SMS.ReadSMS = True Then
                RichTextBox4.Text = SMS.MN
                RichTextBox3.Text = SMS.Msg
                WMSBindingSource.EndEdit()
                WMSTableAdapter.Update(DatabaseDataSet.WMS)
                MsgBox("Data saved")
                Dim msg, mobile, dates, time As String
                msg = RichTextBox3.Text
                mobile = RichTextBox4.Text
                dates = Label7.Text
                time = Label8.Text
                Dim con As New OleDbConnection
                Dim com As New OleDbCommand
                con.ConnectionString = "provider = microsoft.jet.oledb.4.0; data source =C:\Users\LOCOROCO\Downloads\AjinimaSMS\DataBase.mdb
                con.Open()
                com.Connection = con
                com.CommandText = "insert into WMS (Mobile,Distance,Date,Time) values ('" & mobile & "','" & msg & "','" & dates & "','" & t
                com.ExecuteNonQuery()
                con.Close()
                MsgBox("Data added to database")
            Else
                RichTextBox4.Text = "N/A"
                RichTextBox3.Text = "No Message Receive"
            End If
```

Figure 4.10: Codes for collecting distance and database summary (part 2)



```
        Else
            timercount = 60 - DateTime.Now.Second
            DataGridView1.Refresh()

        End If
    End Sub

    Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click
        Me.Close()
    End Sub

    Private Function myZero(ByVal value As Integer) As String
        Return value.ToString().PadLeft(2, "0")
    End Function

    Private Sub Timer2_Tick(sender As Object, e As EventArgs) Handles Timer2.Tick
        Dim txt As String = ""
        txt &= myZero(DateTime.Now.Hour)
        txt &= ":" & myZero(DateTime.Now.Minute)
        txt &= ":" & myZero(DateTime.Now.Second)
        Label8.Text = txt
        Label7.Text = System.DateTime.Now.ToString("dd MMM yyyy")
    End Sub

    Private Sub Form1_Load_1(sender As Object, e As EventArgs) Handles MyBase.Load
        'TODO: This line of code loads data into the 'DataBaseDataSet.WMS' table. You can move, or remove it, as needed.
        Me.WMSTableAdapter.Fill(Me.DatabaseDataSet.WMS)
        'TODO: This line of code loads data into the 'DataBaseDataSet.WMS' table. You can move, or remove it, as needed.
        Me.WMSTableAdapter.Fill(Me.DatabaseDataSet.WMS)

    End Sub
End Class
```

Figure 4.11: Codes for collecting distance and database summary (part 3)

4.3 TESTING

Testing process is very important during the development process. As the last phase before deployment, this process ensure the system will not has any problem in the future. All the error detected is solved so that the system works perfectly.

In addition, a user acceptance test have been conducted to prove that this project is reliable, user friendly, have no error and can be deploy to commercialize. The test was conducted by the potential client (researcher for flood mechanics from Civil Faculty, Ms Jacqaline). Figure below shows a user acceptance test filled by the client.

4.3.1 Testing Report and System Testing Approval

Event	Test Data	Test Steps	Expected Results	Actual Results	Pass / Fail	Comment
Message Receive on Phone	Connection between device and mobile	Configure user's phone number. Connect the device and start sending distance	Receive message (distance) on phone			
Message Receive on PC	Connection between device and central processing	Configure GSM modem's phone number. Connect the device and start sending distance	Receive message (distance) on computer			

Distance Received Accuracy	Get accurate data from the device	Check distance received and compare with manually measurement technique	Accurate measurement of water level			
Data viewed	To show that the data can be read on PC	View from Water Management System	Message (distance) shown in the box provided			
Database	To test the data store into the database	The data automatically inserted into database. The row in Access will increase every time message received	All message saved into database			
View database	to view saved data	Data saved will automatically viewed after being saved into Access database.	Display all data retrieved from database			

Table 5.1: User Acceptance Test Form

	Name	Date
Verified by: _____ Developer		
Approved by: _____ Client		

Figure 5.2: System Testing Approval Form

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

This chapter discussing the summary of the whole project. It also describes the achievements of the objective, the effectiveness of the methodology applied and timeline. In this particular chapter, also discuss the details regarding constraints and ways to overcome, and also future works for future enhancement of the project.

5.2 RESEARCH CONSTRAINTS

In completing this project, many limitation had occurred. In term of hardware, the budget is the biggest issue. The hardware used is limited up to make the device functional. There are many function have to cut off to satisfy the budget. For example, the timer, relay that can on off the device automatically, rechargeable battery and solar panel to recharge the battery, proper casing and GSM modem. The GSM modem used

was claimed from the faculty which provide poor service. The device sometimes function properly and sometimes not.

In term of configuration, the coding is new to me, so I have to learn how to use it from the internet.

5.3 FUTURE WORK

Although the objectives was achieved, the enhancement are still necessary. The future system should include the following criteria

1. Implement automatically on off relay to limit power consumption.
2. Use the power generated from the environment (solar energy)
3. Better interface for Water Management System

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