Faculty of Computer Science and Information Technology

FLASH FLOOD OBSERVER

CHRISTOPHER SII HOW CHIONG

Bachelor of Computer Science with Honours

(Network Computing)

2022

FLASH FLOOD OBSERVER

CHRISTOPHER SII HOW CHIONG

This project is submitted in partial fulfilment of the

requirements for the degree of

Bachelor of Computer Science with Honours

(Network Computing)

Faculty of Computer Science and Information Technology

UNIVERSITI MALAYSIA SARAWAK

2022

FLASH FLOOD OBSERVER

CHRISTOPHER SII HOW CHIONG

Projek ini merupakan salah satu keperluan untuk

Ijazah Sarajana Muda Sains Komputer dan Teknologi Maklumat

(Pengkomputeran Rangkaian)

Fakulti Sains Komputer dan Teknologi Maklumat

UNIVERSITI MALAYSIA SARAWAK

2022

UNIVERSITI MALAYSIA SARAWAK

THESIS STATUS ENDORSEMENT FORM

TITLE **Flash Flood Observer**

ACADEMIC SESSION: 2019/2020

CHRISTOPHER SII HOW CHIONG
(CAPITAL LETTERS)

hereby agree that this Thesis* shall be kept at the Centre for Academic Information Services, Universiti Malaysia Sarawak, subject to the following terms and conditions:

1. The Thesis is solely owned by Universiti Malaysia Sarawak
2. The Centre for Academic Information Services is given full rights to produce copies for educational purposes only
3. The Centre for Academic Information Services is given full rights to do digitization in order to develop local content database
4. The Centre for Academic Information Services is given full rights to produce copies of this Thesis as part of its exchange item program between Higher Learning Institutions [or for the purpose of interlibrary loan between HLI]
5. ** Please tick (√)

☐	CONFIDENTIAL	(Contains classified information bounded by the OFFICIAL SECRETS ACT 1972)
☐	RESTRICTED	(Contains restricted information as dictated by the body or organization where the research was conducted)
✓	UNRESTRICTED	

Validated by

(AUTHOR'S SIGNATURE) (SUPERVISOR'S SIGNATURE)

Permanent Address

Lot 8293, Kampung Damai,
Taman Desa Senadin
98000, Miri, Sarawak.

Date: 23 January 2023 Date: ______________________

Note * Thesis refers to PhD, Master, and Bachelor Degree
** For Confidential or Restricted materials, please attach relevant documents from relevant organizations / authorities

DECLARATION

I, Christopher Sii How Chiong, with student ID 69385, declare that the work presented in this project entitled "Flash Flood Observer System" is my original work and has not been previously submitted for any other examination. I have not copied any material from any other students' work or any other source without proper citation and acknowledgement. I also affirm that no part of this project has been written for me by another person. All sources used in the research have been properly acknowledged and referenced.

(CHRISTOPHER SII HOW CHIONG) 23 JANUARY 2023

ACKNOWLEDGMENT

In this project, I would like to express my gratitude to the following individuals and organisations for their support and assistance during the course of this project.

First and foremost, I would like to extend my sincere appreciation to my supervisor, Dr. Lau Sei Ping, for his guidance and invaluable feedback throughout the project. Dr. Lau's honest advice, patience, knowledge, and support have been invaluable in helping me complete this project on time and with high productivity. I am also grateful to Ms. Ho Wan Yu for collaborating with me on this project and for providing valuable insights and ideas.

Additionally, I would like to express my gratitude to the Faculty of Computer Science and Information Technology and Universiti Malaysia Sarawak for providing me with the necessary resources, specifically the microcontroller and sensor, to aid in my project development. The support from the faculty was instrumental in the success of this project. I would also like to thank Dr. Wang Yin Chai, the Final Year Project coordinator, for his helpful tips and guidance throughout the project.

Lastly, I would like to acknowledge the support and encouragement of my family and friends. Their spiritual support and guidance helped me navigate the challenges of completing this project within the given time frame and I am deeply grateful for their unwavering support.

ABSTRACT

Flash floods are a serious natural disaster that can occur quickly and cause significant damage to the environment and living beings. This project aims to develop a pre-flood warning system in Kota Samarahan, Sarawak, an area that is frequently affected by flash floods. The system, called Flash Flood Observer, will utilise hardware devices to track water levels and issue alerts in a timely manner. The device is designed to be easily configurable by administrator using mobile application and will be placed in multiple flood-prone areas in Kota Samarahan. The project will be carried out in collaboration with another final year project, "Flash Flood Monitoring and Warning System" by Ms. Ho Wan Yu to include an application that will allow users to receive emergency alerts and stay informed about the flood disaster status. The purpose of this project is to minimise the impact of flash floods and provide a permanent solution to the issue.

ABTRAK

Banjir kilat adalah bencana alam yang serius yang boleh berlaku dengan cepat dan menyebabkan kerosakan yang signifikan kepada alam sekitar dan makhluk hidup. Projek ini bertujuan untuk mengembangkan sistem amaran banjir kilat di Kota Samarahan, Sarawak, sebuah kawasan yang kerap terjejas oleh banjir kilat. Sistem ini, yang dikenali sebagai Flash Flood Observer, akan menggunakan peranti keras untuk menjejaki aras air dan mengeluarkan amaran dalam masa yang sesuai. Peranti ini akan direka untuk boleh dikonfigurasi dengan mudah oleh pentadbir menggunakan aplikasi mudah alih dan akan diletakkan di pelbagai kawasan yang berisiko banjir di Kota Samarahan. Projek ini akan dilakukan dalam kerjasama dengan projek tahun akhir lain, "Sistem Pemantauan dan Amaran Banjir Kilat" oleh Cik Ho Wan Yu untuk menyertakan aplikasi yang akan membolehkan pengguna menerima amaran kecemasan dan tetap dikemaskini mengenai status bencana banjir. Tujuan projek ini adalah untuk mengurangkan kesan banjir kilat dan menyediakan penyelesaian kekal kepada masalah tersebut.

Table of Contents

DECLARATION i

ACKNOWLEDGMENT ii

ABSTRACT iii

ABTRAK iv

List of Figures vii

List of Tables x

List of Code Snippets xi

CHAPTER 1: INTRODUCTION 1

1.1 Introduction 1

1.2 Problem Statement 2

1.3 Scope 2

1.4 Objectives 3

1.5 Methodology 3

1.5.1 Phase 1: Requirement planning 3

1.5.2 Phase 2: User design 4

1.5.3 Phase 3: Construction 4

1.5.4 Phase 4: Cut over 4

1.6 Significance of Project 4

1.7 Project Schedule 5

1.8 Expected Outcome 5

1.9 Project Outline 6

1.9.1 Chapter 1: Introduction 6

1.9.2 Chapter 2: Background & Literature Review 6

1.9.3 Chapter 3: Requirement Analysis and Design 6

1.9.4 Chapter 4: Implementation and Testing 6

1.9.5 Chapter 5: Conclusion and Future Work 6

CHAPTER 2: LITERATURE REVIEW 7

2.1 Introduction 7

2.2 Review on similar existing systems 7

2.2.1 i-HYDRO, Online Hydrological Telemetry System 7

2.2.2 A Water Level Detection: IoT Platform Based on Wireless Sensor Network 9

2.2.3 SMS Gateway in the Flood Notification System using Raspberry Pi 10

2.2.4 Flood Monitoring System using WSN and IoT based on Cloud 13

2.3 Comparison between reviewed systems 20
2.4 Direction of Proposed System 21
2.5 Summary 22
CHAPTER 3: METHODOLOGY 23
3.1 Rapid Application Development (RAD) 23
3.1.1 Requirement planning 24
3.1.2 User design 24
3.1.3 Construction 24
3.1.4 Cut-over 25
3.2 Requirement Analysis 26
3.2.1 Identify the user 26
3.2.2 Identify requirement 27
3.3 System Design 28
3.3.1 Identify module function 28
3.3.2 Flow chart 31
3.3.3 Context diagram (Application on Smartphone) 32
3.3.4 Data flow diagram level 0 33
3.3.5 Data flow diagram level 1 35
3.3.6 Entity relationship diagram 36
3.3.7 Sketch of interface 39
3.4 Summary 45
CHAPTER 4: IMPLEMENTATION 46
4.1 Installation and Configuration 46
4.1.1 Android Studio 46
4.1.2 Visual Studio Code 46
4.1.3 Flutter 47
4.1.4 Arduino IDE 47
4.1.5 Python 48
4.1.6 Heroku 48
4.1.7 ClearDB MySQL 48
4.1.8 GitHub 49
4.2 Introduction of Role Access System Implementation 49
4.3 Hardware Implementation 50
4.3.1 List of devices 50
4.3.2 Installation of TOF10120 water level sensor in TTGO T-Call ESP32 with SIM800L 50

4.3.3 Installation of FC37 rain sensor in TTGO T-Call ESP32 with SIM800L........................... 51
4.3.4 Installation of DHT11 sensor in TTGO T-Call ESP32 with SIM800L 52
4.3.5 Complete installation of Flash Flood Observer prototype 53
4.4 Mobile Application Implementation 57
4.4.1 Function of each module in Flash Flood Observer 57
4.5 Database Implementation 74
4.5.1 Admin table 74
4.5.2 Adminnotification table 74
4.5.3 FCM_tokens table 75
4.5.4 Sensor_device table 75
4.5.5 Station table 76
4.5.6 Sensor_reading table 76
4.6 Summary 77
CHAPTER 5: TESTING 78
5.1 Functional Testing 78
5.1.1 Unit Testing 78
5.1.2 Test Items 86
5.1.3 System Testing 87
5.2 Non-Functional Testing 88
5.3 Summary 88
CHAPTER 6: CONCLUSION AND FUTURE WORKS 89
6.1 Project Achievement 89
6.2 Project Limitation 89
6.3 Future Works 90
6.4 Contribution 90
6.5 Conclusion 90
References 91

List of Figures

Figure 1.1 Rapid application development mode 3

Figure 1.2 Proposed project Gantt chart 5

Figure 2.1 Category of warning levels at water level telemetry station (Adapted from Department of Irrigation and Drainage Sarawak, 2022b) 8

Figure 2.2 Flood prone areas in Samarinda City, Indonesia (Adapted from Prafanto & Budiman, 2018) ... 9

Figure 2.3 Schematic electronics design (Adapted from Prafanto and Budiman, 2018) 9

Figure 2.4 Dashboard of HC-SR04 sensor in thingerio 10

Figure 2.5 Results of prototype SMS gateway-based flood notification system. (Adapted from Satria et al., 2020) 11

Figure 2.6 Results of SMS received by users. (Adapted from Satria et al., 2020) 11

Figure 2.7 Proposed system of Flood Monitoring (Adapted from Pallavi & Chandrakala, 2017) 13

Figure 2.8 Workflow of n-mote operation (Adapted from Pallavi & Chandrakala, 2017) 14

Figure 2.9 Workflow of n-gateway operation (Adapted from Pallavi & Chandrakala, 2017) 14

Figure 2.10 Workflow of cloud operation (Adapted from Pallavi & Chandrakala, 2017) 15

Figure 2.11 Serial monitor for N-Gateway (Adapted from Pallavi & Chandrakala, 2017) 16

Figure 2.12 Environmental data on cloud (Adapted from Pallavi & Chandrakala, 2017) 17

Figure 2.13 Step for creating events (Adapted from Pallavi & Chandrakala, 2017) 18

Figure 2.14 Showing created events on Ubidots (Adapted from Pallavi & Chandrakala, 2017) 19

Figure 2.15 SMS reached to numbers which are given while creating events (Adapted from Pallavi & Chandrakala, 2017) 19

Figure 3.1 Rapid Application Development 23

Figure 3.2 Block diagram for Flash Flood Observer 29

Figure 3.3 Flow chart for proposed Flash Flood Observer system 31

Figure 3.4 Context diagram for Flash Flood Observer application 32

Figure 3.5 Data flow diagram level 0 for Flash Flood Observer and Flash Flood Monitoring and Warning Systems 34

Figure 3.6 Data flow diagram level 1 for process 2.0, Login 35

Figure 3.7 Data flow diagram level 1 for process 5.0, Send alert notification 35

Figure 3.8 ERD for Flash Flood Observer 36
Figure 3.9 Main page design 39
Figure 3.10 Admin login page 39
Figure 3.11 Admin registration page 40
Figure 3.12 Admin account page 40
Figure 3.13 Monitoring station page 41
Figure 3.14 Monitoring Station (add device) page 41
Figure 3.15 Add device (QR Code/ Barcode) page 42
Figure 3.16 Add device page 42
Figure 3.17 Station's dashboard page 43
Figure 3.18 set threshold page 43
Figure 3.19 Notification page design 44
Figure 3.20 Push notification design 44
Figure 3.21 SMS notification 45
Figure 4.1 Website of Android Studio 46
Figure 4.2 Website of Visual Studio Code 47
Figure 4.3 Flutter doctor to check flutter installation environment 47
Figure 4.4 Heroku dashboard 48
Figure 4.5 ClearDB MySQL tables 48
Figure 4.6 GitHub dashboard 49
Figure 4.7 TOF10120 water level sensor connected to the TTGO T-Call ESP32 51
Figure 4.8 (Arduino) FC37 rain sensor hooked up to the TTGO T-Call ESP32 52
Figure 4.9 DHT11 sensor interfaced with the TTGO T-Call ESP32 53
Figure 4.10 The completed Flash Flood Observer prototype 54
Figure 4.11 Flash Flood Observer prototype schematic diagram 55
Figure 4.12 Complete assembly of flash flood observer 56

Figure 4.13 Admin Register module 58
Figure 4.14 Admin Login and Logout modules 61
Figure 4.15 Add device module 66
Figure 4.16 Station dashboard module 69
Figure 4.17 Edit station module 71
Figure 4.18 Notification module 73
Figure 5.1 Functional testing and synchronise water level with project collaborator's Flash Flood Warning and Monitoring System. 87

List of Tables

Table 2.1 Testing time for receiving SMS based on flood height (Adapted from Satria et al., 2020) 12
Table 2.2 Comparison between reviewed systems 21
Table 3.1 Hardware requirement and function 27
Table 3.2 Software requirement and function 28
Table 3.3 Administrator table 37
Table 3.4 Admin Notification table 37
Table 3.5 FCM token table 37
Table 3.6 Sensor device table 37
Table 3.7 Sensor reading table 38
Table 3.8 Station table 38
Table 3.10 User interface design for mobile application 39
Table 5.1 Test Case for Registration page 79
Table 5.2 Test Case for Login and Logout page 80
Table 5.3 Test Case for Add Device page 81

Table 5.4 Test Case for Station and Dashboard pages 83
Table 5.5 Test Case for Edit Station page 84
Table 5.6 Notification page 85
Table 5.7 Types of non-functional testing 88
Table 6.1 Achievements of project objectives in Flash Flood Observer 89

List of Code Snippets

Code Snippet 4.1 Arduino code Initialising the TOF10120 sensor and function to read the distance. 50
Code Snippet 4.2 Arduino code for Setting up the FC37 rain sensor pin and reading its digital value...... 51
Code Snippet 4.3 Arduino code for Initialising the DHT11 sensor and reading the sensor values 52
Code Snippet 4.4 Arduino code for making HTTP POST request to the server with sensor data. 53
Code Snippet 4.6 Flutter code for admin registration in the mobile application 57
Code Snippet 4.7 PHP code for handling the admin registration on the server side 57
Code Snippet 4.8 Admin Login Implementation in Flutter 59
Code Snippet 4.9 Admin Login Verification with PHP and MySQL 60
Code Snippet 4.10 Admin Logout Implementation in Flutter 60
Code Snippet 4.11 Flutter Code for Adding IoT Device 62
Code Snippet 4.12 PHP Backend Script for Adding IoT Device 63
Code Snippet 4.13 ElevatedButton widget for connecting ESP32 to Wi-Fi 63
Code Snippet 4.14 showWifiList function displays available Wi-Fi networks and initiates the connection process 64
Code Snippet 4.15 Dual Network Connectivity in IoT Devices: Using Wi-Fi and GPRS as Primary and Fallback Connections respectively 65
Code Snippet 4.16 Fetching Station Data: The _getStations function retrieves the latest sensor readings for each station associated with the provided adminId. 66

Code Snippet 4.17 Retrieving and Parsing Sensor Data from Server to Dashboard page 67
Code Snippet 4.18 Server-side Data Fetching and Response Formatting.. 68
Code Snippet 4.19 Flutter code that handle the submission of the form containing the threshold values for alert, warning, and danger levels and other station's information. 70
Code Snippet 4.20 Python script for sending FCM push notifications to the device tokens 72
Code Snippet 4.21 Python script for processing water level data and sending notifications...................... 72
Code Snippet 4.22 SQL Query for `admin` Table Creation 74
Code Snippet 4.23 SQL Query for `adminnotification` Table Creation 74
Code Snippet 4.24 SQL Query for `fcm_tokens` Table Creation.. 75
Code Snippet 4.25 SQL Query for `sensor_device` Table Creation.. 75
Code Snippet 4.26 SQL Query for `station` Table Creation.. 76
Code Snippet 4.27 SQL Query for `sensor_reading` Table Creation 76

CHAPTER 1: INTRODUCTION

1.1 Introduction

A flash flood happens when low-lying areas like washes, rivers, dry lakes, and depressions get flooded quickly. It can be caused by heavy rain from a severe thunderstorm, hurricane, or tropical storm, or by meltwater from ice or snow flowing over ice sheets or snowfields. Flash floods can also happen after the collapse of a natural ice or debris dam or a man-made structure like a dam, as happened before the Johnstown Flood of 1889. Flash floods are different from regular floods because the time between rain and the start of flooding is less than six hours (National Weather Service, 2019).

In Malaysia, flooding occurs practically every year during the monsoon season and is regarded as a common natural calamity. Since the local tropical wet season in Malaysia lasts from November to February every year, heavy and frequent rainfall is a constant threat, and flood is an inevitable consequence of these cyclical monsoons (Sarawak Government, 2022). There was a loss of life and property worth millions of Ringgit, and millions more were lost in agricultural and livestock losses as a result of the floods (Chan, 2015). According to the Department of Irrigation and Drainage Sarawak (2022), the total number of 1295 historical flood events recorded in Sarawak from the year 1946 until today while the number is growing every year. In the Star news, Datuk Nor Hisham Mohd Ghazali, the director-general of the Irrigation and Drainage Department (DID), mentioned that floods had been getting more frequent in recent years, especially in cities where rapid urbanisation was taking place (Murad, 2021). Due to the inevitability of increased rainfall, Hisham decided that the situation could get much worse if no permanent solution was put in place to alleviate the issue. It is therefore crucial to develop a pre-flood warning system.

Unfortunately, there is a lack of concern for the substance of an early warning system in Kota Samarahan, despite the widespread availability of the necessary technology. A traditional warning system that shows residents of rising water levels is feasible, however it has significant flaws that should be addressed. Traditional warning systems are deficient in their ability to track water levels and issue timely alerts. Consequently, the purpose of this project is to develop a pre-flood warning system in order to inform users of the water level and flood disaster status, as well as to develop an application for the proposed Flash Flood Observer system.

1.2 Problem Statement

Flooding is a well-known natural disaster that causes significant damage to the environment and living beings (Chan, 2015). This project addresses the problem of floods and identifies an alternative way to deal with flash floods promptly. The recent flood occurred in Kota Samarahan in February 2021, resulting in casualties and damage. The event has been triggered by heavy rain that has been affecting Kuching and Lundu as well. A total of 755 people from 211 families affected by the floods in three districts have been evacuated to relief centers (Malaymail, 2021).

In these circumstances, receiving emergency alerts of drainage water level status in various conditions is critical. However, most of the deployed flood warning instruments are rather traditional that limit the warning propagation until it is too late. The Flash Flood Observer system detects flood events so that the local community can be alerted in advance and take appropriate measures to minimise the impact.

1.3 Scope

The Flash Flood Observer system focuses on:

Hardware device development

1. Develop a hardware device, an embedded program that allows the onsite configurating, testing, and posting of the water level information to be relayed to a centralised repository for further processing, which will be carried out in collaboration with Ms. Ho Wan Yu's final year project, "Flash Flood Monitoring and Warning System".
2. Deploy hardware devices with custom configurations in multiple flood-prone areas in Kota Samarahan based on drainage heights.
3. A solar panel powers the hardware devices so it can run on batteries during a flood or at night.

Mobile Application development

1. A mobile application to read data from the hardware devices to monitor flood condition.
2. A mobile application to configure hardware device set-up and customise the threshold values for the sensors based on user specific needs and preferences without hard coding.
3. Alert the user when values exceed a dangerous threshold.

1.4 Objectives

The objectives that will be achieved through this project are:

- To assemble water level observer with off-the-shelf microcontroller and depth sensor.
- To design and develop an embedded program local device configuration and water level measurement.
- To relay, and store water level readings in an online system.

1.5 Methodology

A methodology is a set of procedures for addressing problems within a particular domain, that include a wide range of rules or principles. The Rapid Application Development (RAD) approach was chosen as the software design methodology for the Flash Flood Observer system. This rapid pace is driven by RAD's ability to minimise planning stage efforts, maximise prototype development, and speed up project release times. The RAD phases involve the subsequent:

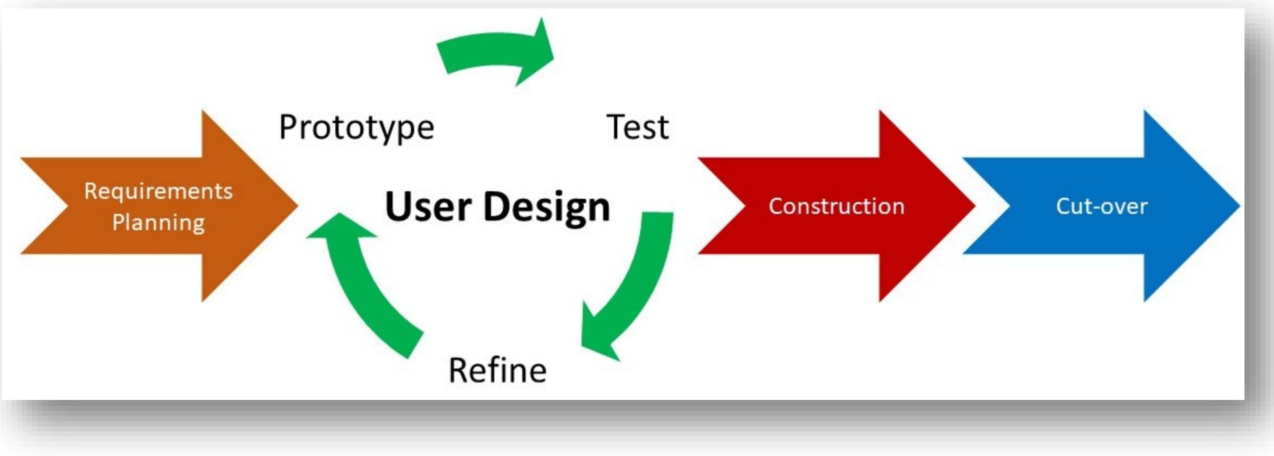


Figure 1.1 Rapid application development mode

1.5.1 Phase 1: Requirement planning

Rapid Application Development begins by defining a loose set of requirements and emphasising on a general awareness of current problems that occur in society's surrounding environment, resulting in the creation of the Flash Flood Observer system. Second, the proposed system can incorporate a speedy design based on an analysis of the surrounding problem. The user also communicates their vision for the Flash Flood Observer system and the necessary requirements. Requirements are prone to change frequently, but RAD can adapt to these modifications.

1.5.2 Phase 2: User design

Here is where the actual development of the Flash Flood Observer system occurs. Developers will go through prototype cycles, which are repeating phases that can help developers refine, test, and demonstrate the prototype of the system. This phase is repeated iteratively until the project objectives are met and the prototype demonstration meets the requirements.

1.5.3 Phase 3: Construction

With a prototype ready, the system will be present to the end-users. As a subsequent step, developer can immediately receive feedback on the interface and functionality. During this phase, system specifications may be evaluated. Upon receiving feedback, developers return to the prototype phase to continue reconstructing or modifying the prototype. If all feedback is positive and the user is pleased with the prototype, developers can proceed to the last phase.

1.5.4 Phase 4: Cut over

The final stage of RAD involves deploying the Flash Flood Observer system into a live production environment.

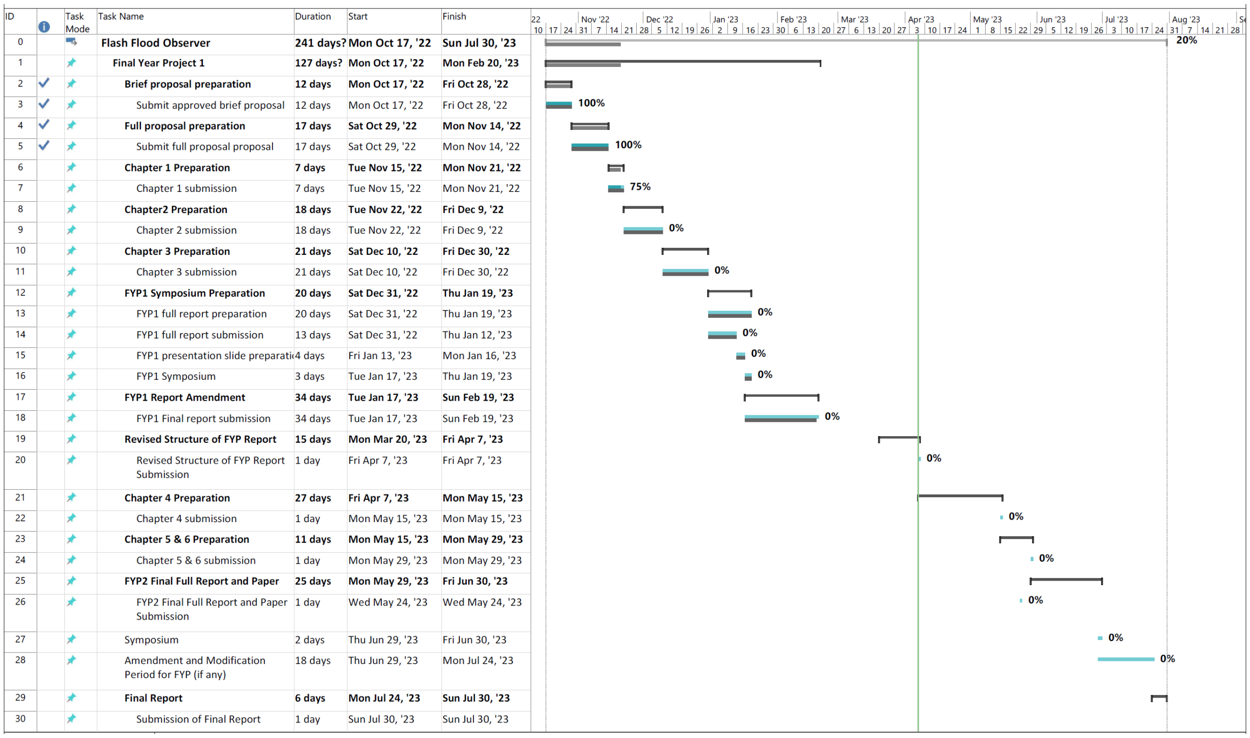
1.6 Significance of Project

As a result of the damage that floods can cause to people and their environments, Flash Flood Observer system development can help communities and residents prepare and warn them of coming flood danger. The systems can help prevent excessive flooding-related damage and loss, and possibly save lives. Some of the benefits of using a Flash Flood Observer system are:

- high reliability because data is sent in real time;
- early detection of flood risks;
- customised solutions that are easy to connect to other systems and development at any level, such as connectivity, user application, and device.

1.7 Project Schedule

A project schedule serves as a guideline and reminder for the Flash Flood Observer system development. Microsoft Project is used to create the Gantt chart that displays the project schedule. This helps to ensure that the project is completed on time. Figure 1.2 below shows the tasks and important dates to complete FYP 1 and FYP 2.



ID		Task Mode	Task Name	Duration	Start	Finish
0			**Flash Flood Observer**	**241 days?**	**Mon Oct 17, '22**	**Sun Jul 30, '23**
1			**Final Year Project 1**	**127 days?**	**Mon Oct 17, '22**	**Mon Feb 20, '23**
2	✓		**Brief proposal preparation**	**12 days**	**Mon Oct 17, '22**	**Fri Oct 28, '22**
3	✓		Submit approved brief proposal	12 days	Mon Oct 17, '22	Fri Oct 28, '22
4	✓		**Full proposal preparation**	**17 days**	**Sat Oct 29, '22**	**Mon Nov 14, '22**
5	✓		Submit full proposal proposal	17 days	Sat Oct 29, '22	Mon Nov 14, '22
6			**Chapter 1 Preparation**	**7 days**	**Tue Nov 15, '22**	**Mon Nov 21, '22**
7			Chapter 1 submission	7 days	Tue Nov 15, '22	Mon Nov 21, '22
8			**Chapter2 Preparation**	**18 days**	**Tue Nov 22, '22**	**Fri Dec 9, '22**
9			Chapter 2 submission	18 days	Tue Nov 22, '22	Fri Dec 9, '22
10			**Chapter 3 Preparation**	**21 days**	**Sat Dec 10, '22**	**Fri Dec 30, '22**
11			Chapter 3 submission	21 days	Sat Dec 10, '22	Fri Dec 30, '22
12			**FYP1 Symposium Preparation**	**20 days**	**Sat Dec 31, '22**	**Thu Jan 19, '23**
13			FYP1 full report preparation	20 days	Sat Dec 31, '22	Thu Jan 19, '23
14			FYP1 full report submission	13 days	Sat Dec 31, '22	Thu Jan 12, '23
15			FYP1 presentation slide preparati	4 days	Fri Jan 13, '23	Mon Jan 16, '23
16			FYP1 Symposium	3 days	Tue Jan 17, '23	Thu Jan 19, '23
17			**FYP1 Report Amendment**	**34 days**	**Tue Jan 17, '23**	**Sun Feb 19, '23**
18			FYP1 Final report submission	34 days	Tue Jan 17, '23	Sun Feb 19, '23
19			**Revised Structure of FYP Report**	**15 days**	**Mon Mar 20, '23**	**Fri Apr 7, '23**
20			Revised Structure of FYP Report Submission	1 day	Fri Apr 7, '23	Fri Apr 7, '23
21			**Chapter 4 Preparation**	**27 days**	**Fri Apr 7, '23**	**Mon May 15, '23**
22			Chapter 4 submission	1 day	Mon May 15, '23	Mon May 15, '23
23			**Chapter 5 & 6 Preparation**	**11 days**	**Mon May 15, '23**	**Mon May 29, '23**
24			Chapter 5 & 6 submission	1 day	Mon May 29, '23	Mon May 29, '23
25			**FYP2 Final Full Report and Paper**	**25 days**	**Mon May 29, '23**	**Fri Jun 30, '23**
26			FYP2 Final Full Report and Paper Submission	1 day	Wed May 24, '23	Wed May 24, '23
27			Symposium	2 days	Thu Jun 29, '23	Fri Jun 30, '23
28			Amendment and Modification Period for FYP (if any)	18 days	Thu Jun 29, '23	Mon Jul 24, '23
29			**Final Report**	**6 days**	**Mon Jul 24, '23**	**Sun Jul 30, '23**
30			Submission of Final Report	1 day	Sun Jul 30, '23	Sun Jul 30, '23

Figure 1.2 Proposed project Gantt chart

1.8 Expected Outcome

This project outcome is aimed at the development of a flash flood observer system using a depth sensor with a microcontroller and communicating with a mobile application that displays sensor data. The user can easily access information about the water level by using the mobile application. When the drainage water surface rises, the water level rises closer to the system and simultaneously causes a flood warning alert to be sent to the user. The distance between the rising water surfaces and the system is measured using a depth sensor. This system is designed to be deployed in multiple flood-prone areas and send all sensor data to the command center. This warning gives users an early evacuation from flood-prone areas, which will help reduce the many losses due to flooding. Early notification of flood monitoring can be seen through the push notification of the mobile application.

1.9 Project Outline

Flash Flood Observer System will be described in this project report, which will be broken down into five sections.

1.9.1 Chapter 1: Introduction

Chapter 1 describes the project overview in detail, including an introduction to the overall project, problem statement, project aim, scope, objectives, methodology, project significance, project schedule, and expected outcome.

1.9.2 Chapter 2: Background & Literature Review

In Chapter 2, similar existing systems to this project will be reviewed, and each system will be thoroughly analysed to determine its strengths and weaknesses. A comparison of the systems will be discussed based on the functions and features. This chapter will include a review of the technology tools used to develop the proposed system, as well as citations and references from sources such as websites, journals, and articles. All appropriate sources are included in this chapter to demonstrate acceptable technology tools for developing the proposed system.

1.9.3 Chapter 3: Requirement Analysis and Design

In this chapter, the chosen methodology is thoroughly explained. Rapid Application Development (RAD) is the selected methodology for the proposed system. It will serve as a model to build the proposed system. From the beginning of the project to its conclusion, each phase will be described in detail.

1.9.4 Chapter 4: Implementation and Testing

In Chapter 4, the proposed system's implementation and testing procedures will be carried out. The hardware device development and mobile application will be described in a technical way. In addition, this chapter provides an in-depth discussion of the testing techniques and procedures utilised for the proposed system.

1.9.5 Chapter 5: Conclusion and Future Work

The fifth chapter will conclude the entire project and set the stage for future works. In this chapter, lessons learned from the development of the proposed system are also listed with examples. In a nutshell, this chapter will examine the future work for this proposed system and will consider new ideas to enhance the system.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide a comprehensive discussion and detailed description of similar systems that have similar functions and features to the proposed system. A comprehensive analysis will be carried out to inspect the strengths, weaknesses, and features of each reviewed system. The literature review focuses on iHYDRO (Online Hydrological Telemetry System), A Water Level Detection: IoT Platform based on Wireless Sensor Network, SMS Gateway in the Flood Notification System using Raspberry Pi, and Flood Monitoring System using WSN and IoT based on Cloud. These systems are all designed to monitor the water level. To ensure that the proposed system takes advantage of the strengths and avoids the weaknesses of the current system, it will be compared to the existing system based on the analysis.

2.2 Review on similar existing systems

In this section, there will be a detailed study of the three reviewed systems, which will be used as the implementation purpose in flash flood observer system. Four of the existing flood detection solutions are iHYDRO (Online Hydrological Telemetry System), A Water Level Detection: IoT Platform based on Wireless Sensor Network, SMS Gateway in the Flood Notification System using Raspberry Pi, and Flood Monitoring System using WSN and IoT based on Cloud. This review will be analysed based on the functions and features that have been used to track water levels and provide access to instantaneous data.

2.2.1 i-HYDRO, Online Hydrological Telemetry System

i-HYDRO is an Online Hydrological Telemetry System developed to provide platform for real-time flood and drought monitoring. According to the Department of Irrigation and Drainage Sarawak (2022b), the department has been upgrading its hydrological stations to telemetry stations since1985. The first stations were set up in the Batang Sadong River Basin at the Krusen, Gedong, Serian, and Meringgu stations. With telemetry stations, data and information can be obtained instantly online through satellite, General Packet Radio Service (GPRS), or other means of communication, even for stations in hard-to-reach, remote areas. The capability to provide online information about rainfall and water level in real time makes it possible to monitor in detail of floods at critical flood prone areas and drought situation in the river basin. This would enable for the early and effective coordination of crucial disaster relief operations and management in the affected areas.

Under Centralized Information Telemetry Networks (CITN), i-HYDRO is also a public domain for the Hydrological Telemetry System (HTS). Rainfall and water level data are shown in real time, so flooding in Sarawak can be tracked and assessed as early as possible to limit damage to property and loss of life. The website *http://www.ihydro.did.sarawak.gov.my* can be used to access i-HYDRO. The user would be able to find out if it is raining lightly, moderately, heavily, or very heavily in their area. They would also know how the river is doing right now, like if the water level has reached an alert, warning, or danger level as shown in the Figure 2.1 (Department of Irrigation and Drainage Sarawak, 2022b).

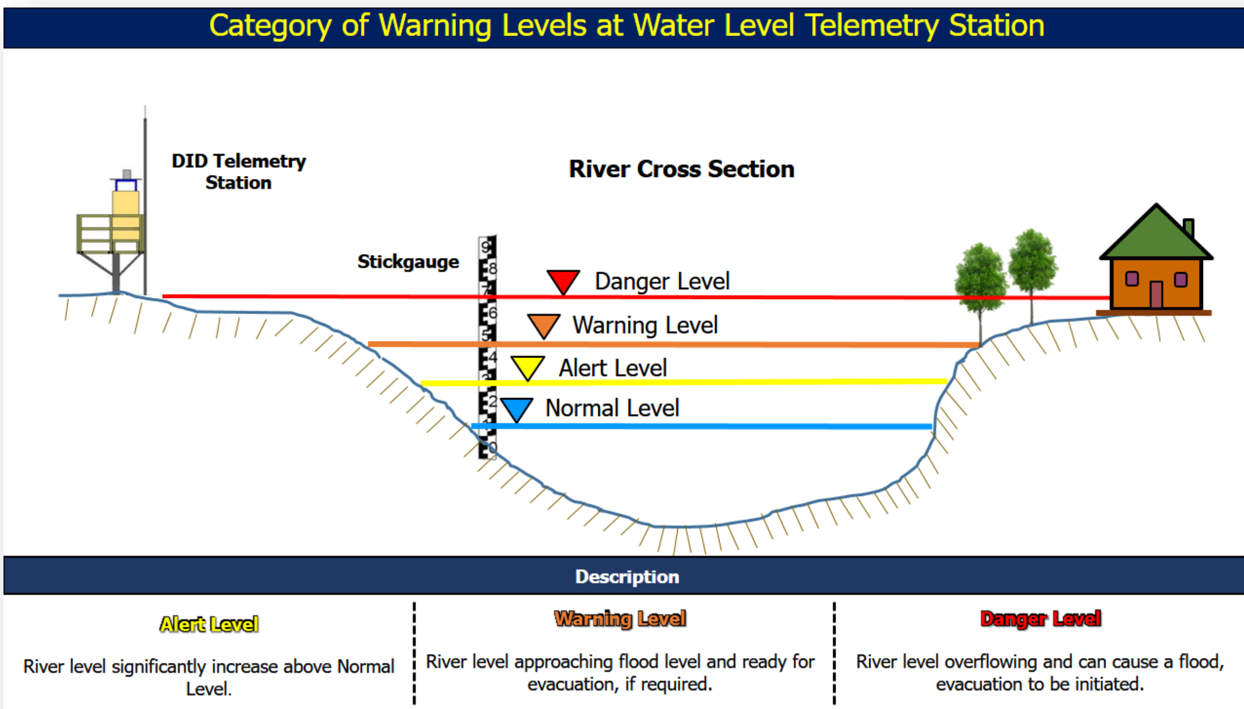


Figure 2.1 Category of warning levels at water level telemetry station (Adapted from Department of Irrigation and Drainage Sarawak, 2022b)