Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF FLASH FLOOD EARLY TRIGGERING SYSTEM BASED ON RAINFALL INTENSITY AND LEVEL INCREASING RATE USING NODEMCU ESP32

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Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

2022

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

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development of Flash Flood Early Triggering System Based on Rainfall Intensity and Level Increasing Rate Using NodeMCU ESP32

Sesi Pengajian : 2022/2023

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APPROVAL

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

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Supervisor Name : TS. AHMAD NIZAM BIN MOHD JAHARI @ MOHD JOHARI

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Date : ....

DEDICATION

This thesis is dedicated to those who have helped me from the beginning to the finish of the project's development

To my beloved mother and father,
My supervisors,
My lecturers,
and
All my friends.
Thank you for all of the guidance, support, and encouragement up to this point.

ABSTRACT

Flooding in urban can happen suddenly, leaving residents with little time to prepare. Notifying the people who are most at danger helps to mitigate the disaster's effects. Residents can get flood alerts in some places, but most of them are for organizations and only cover a short distance. When flooding occurs, it takes time to reach closest neighbours, and most of them are unable to rescue their belongings. Floods cause chaos on people's homes, schools, and bridges. As a result, early warning and triggering systems can help citizens and governments avoid flood damage. The objective of developing this system is to analyze water level increasing rate of river or drainage system at urban area for flash flood early detection and notification system. Besides, to develop a system that able to estimate and measure rainfall intensity for early detection of flash flood. In addition, to develop a flash flood early detection and notification system based on evaluation of objective stated before. This proposed system use a flow rate sensor and an ultrasonic sensor to monitor rainfall intensity and the increasing rate at which the water level in a river or drainage rises. The siren and the Blynk apps will be used to alert residents in the surrounding region. An authority entity, such as BOMBA or APM, will be notified by Telegram Bot and will take appropriate action. Therefore, it is predicted that the system will aid in the process of relocating individuals in order to prevent substantial property damage and loss of life.

ABSTRAK

Hujan lebat yang berterusan selama beberapa jam serta sistem saliran yang tidak baik menyebabkan paras air sungai atau longkang meningkat dengan pantas di kawasan bandar dan menjadi penyumbang utama kepada faktor kejadian banjir kilat yang merosakkan penempatan penduduk serta fasiliti awam. Kesan banjir kilat di kawasan bandar dapat dikurangkan dengan memberikan informasi awal kepada penduduk yang terdedah kepada risiko banjir kilat seperti yang tinggal di kawasan yang mudah dinaiki air. Di Malaysia, sistem amaran banjir hanya terdapat di kawasan tertentu sahaja seperti di lembangan sungai. Oleh sebab itu, sistem pengesanan awal banjir kilat dan sistem notifikasi boleh membantu rakyat dan kerajaan dalam menangani masalah banjir kilat di kawasan bandar. Antara objektif sistem ini dibangunkan adalah untuk menganalisis kadar peningkatan paras air sungai atau sistem saliran di kawasan bandar bagi pengesanan awal dan notifikasi berkenaan banjir kilat. Selain itu, sistem ini menganggar dan mengukur kadar kelebatan hujan untuk pengesanan awal banjir kilat serta sebagai sistem pengesanan awal dan notifikasi banjir kilat berdasarkan penilaian terhadap kadar kelebatan hujan dan sistem saliran di kawasan bandar. Sistem ini menggunakan sensor kadar aliran air dan sensor ultrasonik bagi memantau kelebatan hujan dan kadar peningkatan air sungai atau longkang. Siren dan aplikasi Blynk digunakan untuk menyampaikan amaran kepada penduduk di kawasan sekitar. Pihak berkuasa seperti BOMBA atau APM, akan menerima notifikasi melalui Telegram Bot dan akan mengambil tindakan yang sewajarnya sekiranya menerima pemberitahuan awal berkenaan banjir kilat. Oleh itu, sistem amaran awal banjir kilat ini dapat membantu mengelakkan kerosakan harta benda yang besar dan kehilangan nyawa akibat banjir kilat di kawasan bandar.

ACKNOWLEDGEMENTS

I would like to begin by acknowledging my PSM1 supervisor, Ts. Shahrizal Bin Saat, and my PSM2 supervisor, Ts. Ahmad Nizam Bin Mohd Jahari @ Mohd Johari, for their invaluable advice, wise words, and patience throughout this project.

My parents and Universiti Teknikal Malaysia Melaka (UTeM) also owe me gratitude for their financial assistance in helping me finish the project. Not to mention my housemates and friend who were willing to share their ideas and thoughts on the project.

My sincere gratitude goes to my parents, partner, and family members for their love and prayers during my studies. My mother deserves special recognition for her motivation and understanding.

Finally, I would like to thank all of the lecturers at the Faculty of Electrical and Electronic Engineering Technology, my colleagues and classmates, and others who aren't included here for their cooperation and assistance.

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LIST OF SYMBOLS

V	-	Volts
A	-	Ampere
L	-	Litre
	-	
	-	
	-	
	-	
	-	

LIST OF ABBREVIATIONS

$DBKL$	-	Kuala Lumpur City Hall
DID	-	Drainage and Irrigation Department
GSM	-	Global System for Mobile Communication
	-	
	-	
	-	
	-	
	-	

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CHAPTER 1

INTRODUCTION

1.1 Background

The worst natural disaster Malaysia has ever seen was a flash flood. Heavy rains that continued for several hours as well as poor drainage systems caused the water level of rivers or drains to rise rapidly in urban areas and became a major contributor to flash floods that damaged residents and public facilities. Flash floods are the most common and disruptive hydrometeorological event in Malaysia. They happen most often in urban area like Kuala Lumpur and Kajang. But flash floods can also occur in unexpected areas like the one that recently happened in 2021 in Shah Alam. These flash floods can occur at any time of the year, not just during the monsoon season, and they can cause a lot of damage and loss. So, to deal with flash floods, especially in urban area, it's important to take a number of steps and make some estimates.

Flash floods occur when heavy rain falls quickly and can cause major traffic jams. Thus, it's necessary to notify the most at-risk people to limit the effects of disasters. In some circumstances in Selangor and Kuala Lumpur, the water level rises quickly, leaving inhabitants little time to prepare for escape. Some places have flood alert systems for citizens, although most are intended for organisations, and the system can only cover a certain distance. When flooding occurs, it takes time to reach close residents, and most cannot preserve their belongings as water rises swiftly. The worst case is when floods destroy buildings, houses, schools, and bridges. Flooding is unavoidable and cannot be controlled, but early detection and warning systems can help citizens and governments avert losses.

As we know, flash flood occurs when water overflows within a few minutes or hours of excessive rainfall with high intensity and bad drainage system especially in urban area. This project is proposed to measure rainfall intensity and water level increasing rate of river or drain using flow rate sensor and ultrasonic sensor. People at the surrounding area will be notified using siren and Blynk application. An authority body like BOMBA and APM will be trigger through Telegram Bot in order to take a proper action. So, it expected that system will help the process to relocate people to avoid significant property damage and lost of life.

1.2 Problem Statement

Floods in urban areas can occur suddenly and unexpectedly, leaving residents with little time to prepare. The impact of disasters can be reduced by providing early information to the most at-risk populations. Nowadays, residents can receive flood warnings in some places, but most are for organizations and only cover close distances. When floods occur, most of them are unable to rescue items due to ineffective flood early warning systems and do not cover long distances. Furthermore, poorly maintained structures with clogged drains and inadequate drainage, as well as poor canal design and construction, have all contributed to the occurrence of flash floods on a regular basis. Flash floods can also cause catastrophic loss and devastation. The floodwaters also damaged homes and public facilities such as schools and bridges that connect people. Therefore, flash flood early detection and notification systems can assist citizens and governments in preventing and minimize the effects of flash floods.

1.3 Project Objective

The main aim of this project is to propose a systematic and effective methodology to detect early signs of flash floods based on rainfall intensity and level increasing rate. Specifically, the objectives are as follows:

a) To develop a system that will be able to analyze water level increasing rate of river or drainage system at urban area for flash flood early detection and notification system.

b) To develop a system that will be able to estimate and measure rainfall intensity for early detection of flash flood.

c) To develop a flash flood early detection and notification system based on evaluation of objective (a) and (b).

1.4 Scope of Project

The urban region in Selangor and Kuala Lumpur that was recently impacted by flooding is the primary focus of this project. Both a river and a drain are suitable testing locations for the proposed system. The data on the water level was gathered and then updated on a regular basis in order to keep track of any changes in the water level or the rate at which it was rising. The project makes use of NodeMCU ESP32, which already has wireless networking built right into the board itself. The most recent information regarding the flood situation is uploaded to the Blynk application, and a Telegram Bot is utilised in order to notify the relevant authorities, such as BOMBA and APM.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Flash floods are a typical occurrence in Malaysia's capital city. Every year, the city is hit by a series of flash floods. The city is located in the center of a valley, in the river basins of two large rivers (the Klang River and the Gombak River). As a result, floods are an unavoidable occurrence in the urban area [1]. Flash floods are usually produced by seasonal monsoon rain, which causes insufficient drainage systems to channel the water flow effectively. The overflow of rivers is also a key cause of flash floods in the city. The city's two independent departments deal with flash floods: Kuala Lumpur City Hall (DBKL) handles drainage and street-related flash floods, while the Drainage and Irrigation Department (DID) handles river-related flash floods.

Small yet regular climatic and hazardous occurrences make urban areas vulnerable. A flash flood that strikes an urban area unexpectedly can cause a slew of problems for the city and its residents. Multiple aspects of the productive sector could be disrupted or shut down, putting a disproportionately high number of assets at risk. A flash flood can also wreak significant destruction and damage to individuals and assets that are more vulnerable.

In study on some literature review, other researchers implement different methods for flash flood early triggering system. Most of the article is study on developing a real-time water level monitoring system using different sensor and controller, and different application for notification system. The purpose of this literature review is to search for new approaches to monitor water level and improve flash flood warning system based on rain intensity which is more reliable.

2.2 Past Related Research

2.2.1 Flash Flood in Malaysia

Fluvial flash floods and drainage system-induced flash floods are two types of flash floods that occur in Kuala Lumpur throughout the year[1]. Separate stakeholders are responsible for handling and monitoring each form of flash flood. DID handles river flash floods, while DBKL handles drainage and street-related flash floods. Rainfall is a crucial factor in both forms of flash floods. Clogged drains, narrowing water channeling ways, littering behavior of humans, and urbanization all contribute to flash flood hazard occurrences.

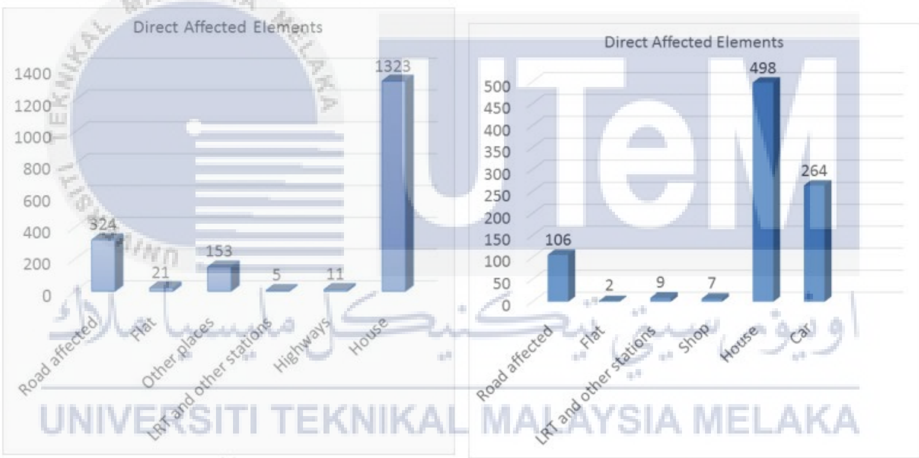

Figure 2.1(a) Fluvial Flash Flood (b) Drainage Related Flash Flood

Both types of flash floods, as in the city, have a direct impact on some common features such as roads, buildings, vehicles, train stations, and so on. Due to the limited amount of detail data, this could be a lower bound computation. Figures 2.1 (a) and 2.1 (b) depict the elements of the city that were immediately damaged by flash floods. Roads and highways, buildings, and automobiles are the most often and severely impacted elements by both forms of flash floods. In terms of fluvial flash flood, it is difficult to estimate the number of automobiles that were affected.

2.2.2 Flash Flood Data

The flash flood data were obtained from the Selangor Department of Irrigation and Drainage (DID) and the Malaysian Meteorological Department's websites (MMD). The DID gave data on water levels and rainfall, while the MMD provided weather information as well as minimum and maximum temperature readings[2]. The dates were gathered during the course of this research. Data from numerous areas in Selangor were also collected, including the area, district, main basin, and sub-river basin. A total of 9,665 datasets were collected from 32 different locations between June 2020 and March 2021.

Table 2.1 A sample of dataset in Selangor

Area	Weather	*Rainfall	*Water level	Min Temp.	Max Temp.	Flash Flood
Kg. Asahan	Sunny	80.00	7.80	26.00	33.00	Yes
Sri Aman	Sunny	5.00	4.85	25.00	33.00	No
Parit Mahang	Sunny	2.00	2.56	25.00	33.00	No
Kg. Delek	Sunny	0.00	-0.59	26.00	33.00	No
Pekan Meru	Sunny	0.00	2.92	26.00	33.00	No
Taman Sri Muda	Thunder	0.00	2.33	26.00	33.00	No
Tugu Keris	Sunny	0.00	2.88	26.00	33.00	No
TTDI Jaya	Thunder	0.00	3.43	26.00	33.00	No
Batu 3	Thunder	0.00	2.48	26.00	33.00	No
Taman Mayang	Thunder	7.00	14.51	26.00	33.00	No
Puchong Drop	Thunder	0.00	5.16	26.00	33.00	No
Jalan 222	Thunder	75.00	17.03	26.00	33.00	Yes
Seri Kembangan	Thunder	0.00	35.34	26.00	33.00	No
Taman Tun Teja	Rainy	1.00	33.16	25.00	33.00	No
Sungai Batu	Sunny	17.00	49.28	25.00	33.00	No
Country Homes	Rainy	36.00	16.02	25.00	33.00	No
Serendah	Thunder	10.00	34.77	25.00	33.00	No
Jambatan SKC	Sunny	25.00	17.24	25.00	33.00	No
Tanjung Malim	Sunny	80.00	36.67	25.00	33.00	Yes
Kg. Sungai Selisek	Sunny	0.00	24.47	25.00	33.00	No
Kg. Sungai Buaya	Thunder	33.00	14.36	25.00	33.00	No
TNB Pangsun	Thunder	0.00	132.60	25.00	33.00	No
Batu 12	Sunny	0.00	40.93	25.00	33.00	No
Kg. Pasir	Sunny	0.00	47.99	25.00	33.00	No
Pekan Kajang	Thunder	0.00	22.33	25.00	33.00	No
Sungai Rinching	Thunder	0.00	20.42	25.00	33.00	No
Batu 20	Thunder	0.00	88.27	25.00	33.00	No
JPS Sungai Manggis	Rainy	0.00	0.87	25.00	33.00	No
Kg. Kundang	Thunder	0.00	1.50	25.00	33.00	No
Dengkil	Thunder	0.00	3.43	25.00	33.00	No
Kg. Labu Lanjut	Rainy	0.00	3.01	25.00	33.00	No
Kg. Salak Tinggi	Thunder	0.00	6.92	25.00	33.00	No