REAL-TIME MODELLING AND IMPLEMENTATION OF A FLOOD OBSERVATORY SYSTEM (FOS) ON IOT PLATFORM

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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Signature	:	....
Supervisor Name	:	Dr. Siva Kumar Subramaniam
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DEDICATION

Special dedication to my beloved family, supervisor, lecturers, and fellow friends

ABSTRACT

Flash and seasonal flooding events have always been a concern in many countries around the world, particularly in the tropical region with heavy rain falls. Thus, there is always a demanding urge to set an effective flood observatory system in line with the increasingly changing environment and growing population located in these flood-prone regions. The key focus area of implementation is to prompt the detection to alert relevant authorities and public in the flood-prone region as events are recorded in the system through the IoT platform. The proposed model is designed and developed from a real-time measurement collected from measuring points. The real-time data on rainfall variation in the tropical regions are also collected for further analysis to strengthen the outcome of the proposed model, particularly in the early warning system. The collected data is then further used in the analysis and evaluation of flood prediction system for future flood mitigation plans by relevant authorities and research community.

ABSTRAK

Banjir kilat dan banjir bermusim sentiasa menjadi kebimbangan bagi kebanyakan negara, terutamanya di kawasan tropika yang sering ditimpa hujan yang lebat. Oleh itu, akan ada keperluan yang tinggi untuk melengkapi sistem pemerhatian banjir sehubungan dengan peningkatan perubahan persekitaran dan peningkatan populasi di kawasan yang cenderung untuk banjir berlaku. Implementasi sistem ini adalah untuk memudahkan pengesanan supaya pihak berkuasa yang berkaitan dan orang awam di kawasan yang cenderung untuk banjir lebih berwaspada sebagai kejadian yang direkodkan di dalam sistem melalui platform IoT LoRa. Model yang diusulkan adalah direka dan dibina berdasarkan pengukuran masa sebenar yang diperolehi daripada titik pengukuran. Data masa sebenar untuk taburan hujan di kawasan tropika juga diperolehi untuk selanjutnya dianalisa untuk memberi sokongan kepada hasil model yang diusul, khususnya di dalam sistem amaran awal. Data yang diperolehi kemudiannya digunakan untuk analisa dan penilaian sistem peramalan banjir untuk rancangan awal oleh pihak berkuasa yang berkaitan dan komuniti penyelidik.

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LIST OF SYMBOLS AND ABBREVIATIONS

ABP	:	Activation by Personalization
ADR	:	Adaptive data rate
AP	:	Access point
BW	:	Bandwidth
CR	:	Code rate
CRC	:	Cyclic redundancy check
DEM	:	Digital Elevation Model
DR	:	Data rate
FOS	:	Flood Observatory System
GIS	:	Geographical information system
GPRS	:	General Packet Radio Service
GPS	:	Global Positioning Systems
GSM	:	Global System for Mobile
IIS	:	Integrated information system
IoT	:	Internet of Things
JPS	:	Department of Irrigation and Drainage
LiDAR	:	Light Detection and Ranging
LoRa	:	Long Range
LOS	:	Line of sight

LPWAN	:	Low power wireless network
MCMC	:	Malaysian Communications and Multimedia Commission
MQTT	:	Message Queuing Telemetry Transport
PCB	:	Printed circuit board
RSSI	:	Received Signal Strength Indicators
SF	:	Spreading factor
SMS	:	Short Message Service
WLMS	:	Water Level Monitoring System

CHAPTER 1

INTRODUCTION

This chapter will discuss the brief of this project, problem statement, objectives, scope, methodology, and thesis plan for this project.

1.1 Introduction

According to Department of Irrigation and Drainage (JPS) Malaysia, a flood can be defined as a rising, overflowing, and swelling of water to the uncovered land. This commonly happens when there is heavy or seasonal rainfall, storm, ice melt, and tidal action. It also happens when there is unwanted disposal into the water sources and can cause a loss of lives and properties.

There are three critical things that must be considered during a flood event which are time, cost and plan [3]. Logically, time and plan are always related to each other. Time is set up for the residents to estimate the possibilities for flooding to occur at the location through monitoring the water rise. If the water level reaches a moderate level, the authorities will take action using the available source. This process is time-consuming so it is very crucial for the authorities to be more aware at this level. The rescuing time is also crucial because every second is important for the rescue team in order to rescue the residents.

This project consists of two devices, which are a LoRa sensor node (Figure 1.1) and a LoRa gateway (Figure 1.2). For the sensor node, it is powered up using a power bank and made up using Arduino, LoRa module, temperature sensor, humidity sensor, water level sensor, and tipping bucket. This sensor node is designed so that it can be deployed at the water source (Figure 1.3) to detect water level, temperature, humidity, and rainfall measurement. The data from the sensor node will be sent through the gateway to the cloud or database so that the authorities can monitor the data.

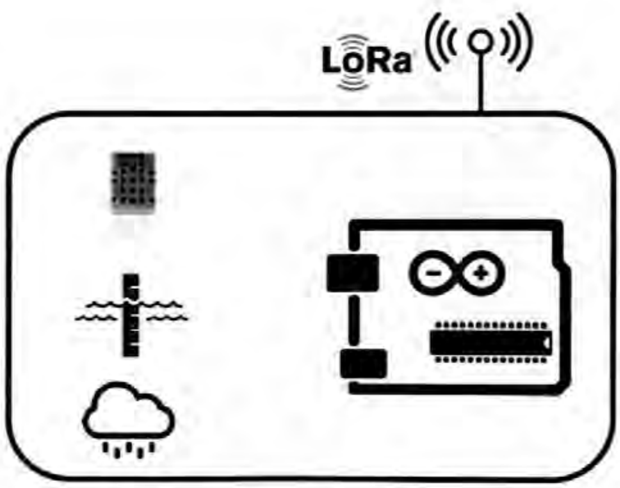

Figure 1.1: The sensor node

The gateway used is Dragino LoRa LG01P (Figure 1.2) and it will be placed at the data center (Figure 1.3). The usage of the LoRa gateway is crucial in this project because the transmitted data has to be received by the same language of the transceiver. The data is then translated and sent to the cloud using an Ethernet cable or WiFi connection.

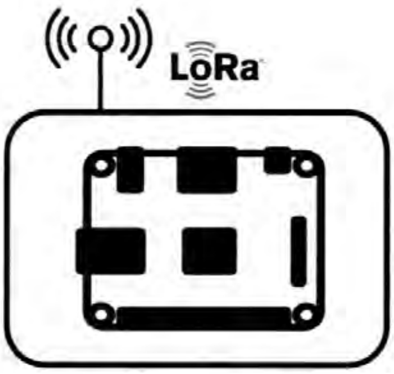

Figure 1.2: LoRa gateway

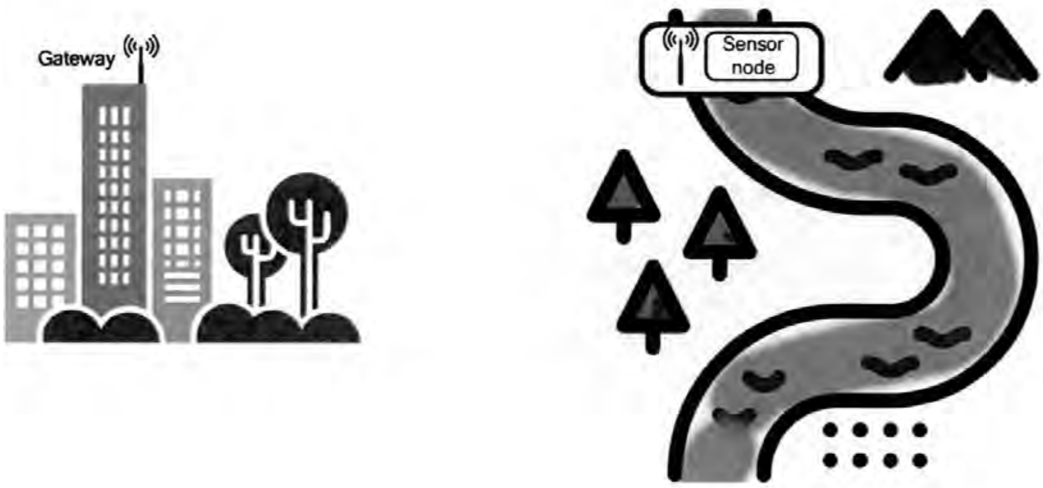

Figure 1.3: Sensor node and gateway placement

1.2 Problem Statement

The current web system or platform does not have the ability to save and view the previous history of the data such as water level and rainfall measurement [1]. There are several clouds that offer the data storing but the data will last only for several months. The proposed project should overcome this problem by using the internet platform that can provide the ability to view the data since the beginning of the measurement up to the present.

The internet platform used in the current flood monitoring system has a time delay to update the data of the water level. It is stated that on the website of JPS, the delay of the data displayed on the website might be up to more than 4 hours late. Therefore, the proposed project must eliminate this problem by using the internet platform that has no delay and can show the data in real-time.

The limited distance between the water source with the centralized station is one of the major challenges in developing flood observatory system [2]. Long-range wireless communication is required if the distance between the sensor node and the centralized monitoring station is too far from each other. The expected range between the gateway and the sensor node is 1 km

1.3 Objectives

i. To analyze the relationship between the previous data of water level and rainfall measurement of different telemetry station in Melaka to find out the suitable parameter LoRa that will be applied accordingly

ii. To design and develop an internet-based flood planning system that can monitor data in real time using LoRa

1.4 Scope of Project

The type of flood covered is the seasonal flood but another type of flood will be mentioned throughout the thesis because there are several observatory systems that were implemented for a flash flood. The development of this project divided into two scopes of work, which is hardware development and internet platform development. The development of hardware, which is a LoRa node, and LoRa gateway requires the components and modules that allow them to communicate. The LoRa frequency band of the modules used in this project is in between 915 MHz to 923 MHz because frequency band of 869 MHz to 870 MHz is not allowed in Malaysia as mentioned in regulation stated by Malaysian Communications and Multimedia Commission (MCMC). Arduino will be used as a controller for the sensor node and Arduino Yun as the controller for a gateway. There are 4 inputs that will be used; a water level sensor, temperature sensor, humidity sensor, and a rainfall sensor. The non-contact water level sensor will be used instead of the contact type of water level (submerge).

The internet platform used in this project is an open source IoT platform, which is Node Red. Node Red is a simple tool used to connect and communicate the sensor