IOT-BASED FLOOD MONITORING AND ALERTING SYSTEM USING ARDUINO UNO AND GSM

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Bachelor of Engineering

Electrical and Electronics Engineering

with Honours

2022

UNIVERSITI MALAYSIA SARAWAK

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IOT-BASED FLOOD MONITORING AND ALERTING SYSTEM USING ARDUINO UNO AND GSM

NUR AIDA ARIFFAH BINTI KAMIS

A dissertation submitted in partial fulfilment

of the requirement for the degree of

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To my beloved family and friends.

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ABSTRACT

This project describes on the design and implementation of IoT-based Flood Monitoring and Alerting System using Arduino UNO and GSM which can provide access to reliable information and speed up evacuation process during flood. The main purpose of this project is to investigate the utilization of sensor and IoT-based technology as a monitoring and alerting system. Nowadays, several countries still employs conventional means in detecting flood level by using human observer to conduct observation. Consequently, the information obtained is less accurate and may maximise the adverse effects of flood. Therefore, an IoT-based Flood Monitoring and Alerting System using Arduino UNO and GSM is proposed and designed. This monitoring and alerting system is constructed based on three different sensors namely HC-SR04 Ultrasonic Sensor, DHT11 Temperature and Humidity Sensor and Water Level Sensor. Arduino UNO acts as the microcontroller board and GSM SIM900A can be utilized for sending alert messages to user in the form of SMS. There are four different cases altogether which are extreme low quantity of water, normal level, warning level as well as danger level and users will receive different SMS according to the cases. Call and redial can also be made to user once the water is at danger level. Thus, user is able to monitor the current water level, humidity and temperature at any time after the system was run. Once the red LED and buzzer are activated, it indicates that flood will occur soon and evacuation process is necessary. Otherwise, the situation is still not alarming. The main advantage of the system is the affordable production cost and the system's capability in helping user to avoid uncalled danger related to flood.

ABSTRAK

Projek ini menerangkan tentang reka bentuk dan pelaksanaan Sistem Pemantauan dan Pemberitahuan Banjir berasaskan IoT menggunakan Arduino UNO dan GSM yang boleh menyediakan akses kepada maklumat yang boleh dipercayai dan mempercepatkan proses pemindahan semasa banjir. Tujuan utama projek ini adalah untuk menyiasat penggunaan sensor dan teknologi berasaskan IoT sebagai sistem pemantauan dan amaran. Pada masa ini, beberapa buah negara masih menggunakan kaedah konvensional dalam mengesan tahap banjir dengan menggunakan pemerhati manusia untuk menjalankan pemerhatian. Akibatnya, maklumat yang diperoleh adalah kurang tepat dan boleh memaksimumkan kesan buruk banjir. Oleh itu, Sistem Pemantauan dan Pemberitahuan Banjir berasaskan IoT menggunakan Arduino UNO dan GSM dicadangkan dan direka. Sistem pemantauan dan amaran ini direka berdasarkan tiga sensor yang berbeza iaitu Sensor Ultrasonik HC-SR04, Sensor Suhu dan Kelembapan DHT11 dan Sensor Aras Air. Arduino UNO bertindak sebagai papan mikropengawal dan GSM SIM900A boleh digunakan untuk menghantar mesej amaran kepada pengguna dalam bentuk SMS. Terdapat empat kes yang berbeza semuanya iaitu kuantiti air yang sangat rendah, paras normal, paras amaran dan paras bahaya dan pengguna akan menerima SMS yang berbeza mengikut kes tersebut. Panggilan dan dail semula juga boleh dibuat kepada pengguna apabila air berada pada tahap bahaya. Oleh itu, pengguna boleh memantau paras air semasa, kelembapan dan suhu pada bila-bila masa selepas sistem dijalankan. Sebaik sahaja LED merah dan buzzer diaktifkan, ini menunjukkan bahawa banjir akan berlaku tidak lama lagi dan proses pemindahan adalah sangat diperlukan. Namun begitu, sekiranya kedua-dua LED merah dan buzzer tidak bernyala atau mengeluarkan bunyi, keadaan dianggap masih tidak membimbangkan. Kelebihan utama sistem ini ialah kos pengeluarannya yang berpatutan dan kebolehan sistem dalam membantu pengguna mengelak bahaya berkaitan banjir yang tidak dijangka.

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LISTS OF SYMBOLS

cm	-	centimetre
%	-	Percent
kB	-	kilo-Byte
MB	-	Mega-Byte
V	-	Volt
MHz	-	Mega-Hertz
mA	-	milli-Ampere
µA	-	micro-Ampere
kbps	-	kilobits per second
kHz	-	kilo-Hertz
m	-	meter
mm	-	milli-meter
°	-	Degree
µS	-	micro-Siemens
°C	-	Degree Celsius
dBA	-	Decibels A
mg	-	milli-grams
W	-	Watts
g	-	grams
Ω	-	Ohms
kΩ	-	kilo-Ohms
°F	-	Degree Fahrenheit

LISTS OF ABBREVIATIONS

IoT	-	Internet of Things
GSM	-	Global System for Mobile communication
IDE	-	Integrated Development Environment
Hex	-	Hexadecimal
USB	-	Universal Serial Bus
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
PIC	-	Peripheral Interface Controller
Wi-Fi	-	Wireless Fidelity
HD	-	High Definition
API	-	Application Programming Interface
ESP	-	Electronic Stability Program
4G	-	Fourth Generation
MATLAB	-	Matrix Laboratory
NodeMCU	-	Node Microcontroller Unit
ID	-	Identity
WSN	-	Wireless Sensor Network
IVR	-	Interactive Voice Response
SRAM	-	Static Random-Access Memory
PCB	-	Printed Circuit Board
TFT	-	Thin Film Transistor
IC	-	Integrated Circuit
NOOBS	-	New Out of Box Software
SMS	-	Short Message Service
SDK	-	Software Development Kit
APK	-	Android Package
MVC	-	Model View Controller
MySQL	-	My Structured Query Language
ICSP	-	In-Circuit Serial Programming

PWM	-	Pulse-Width Modulation
AC	-	Alternating Current
DC	-	Direct Current
HASL	-	High-Speed AUV-Based Silent Localization
MCU	-	Microcontroller Unit
GPRS	-	General Packet Radio Service
MT	-	Mobile Terminated
MO	-	Mobile Originated
CB	-	Cell Broadcast
PDU	-	Protocol Data Unit
UART	-	Universal Asynchronous Receiver-Transmitter
VCC	-	Voltage Common Collector
TRIG	-	Trigger
GND	-	Ground
TTL	-	Transistor-Transistor Logic
NTC	-	Negative Temperature Coefficient
V_F	-	Forward Voltage
ISIS	-	Intelligent Schematic Input System
ARES	-	Advance Routing and Editing Software

CHAPTER 1

INTRODUCTION

1.1 Background

In several parts of the world, flood is often acknowledged as the most frequent and destructive natural disaster caused by excessive rainfall. It is anticipated to become more often due to climate change. Floods inflict substantial harm to people, severe damage to properties and also have serious effects on socio-economic activities [1] . During a flood, the flow of water will become immense and there will an accumulation of dirt and debris once the floods retreat. Both of these occurrences will lead to terrible destruction [2] . As an example, following some of the worst flooding in decades, more than 120 people have died and at least hundreds are missing throughout Western Europe as rivers burst their banks as a result of continuous rainfall, having a disastrous impact on the region [3] . In addition, on 17th September 2021, Malaysia also suffers from heavy downpours resulting in one of the worst floods ever faced by the country. After 10 days, about 18,000 people are affected and tremendous number of properties are damaged [4] .

Generally, flood can be classified into five types which includes, flash floods, river floods, ponding floods, coastal floods and urban floods. Flash floods and river floods are the most typical floods that have ever existed. Flash floods occur when there is a sudden heavy rainfall. Nevertheless, this type of flood only lasted for approximately six hours. On the other hand, river floods are caused by continuous flow of rainfall downstream, resulting in an overlap on the levees. Afterwards, the overlapping levees will eventually lead to flood [5] . Among these two floods, the most dangerous flood is the flash flood due to its devastative power and phenomenal speed [6] .

Figure 1.1 represents the number of natural disasters occurred worldwide according to the types in 2019. Based on the figure shown, the type of natural disaster that has the highest number of occurrences is flood. Therefore, in order to reduce the adverse effects caused by floods, the water level at particular areas should be constantly monitored. One of the methods to monitor the floods is by using an IoT-based system.

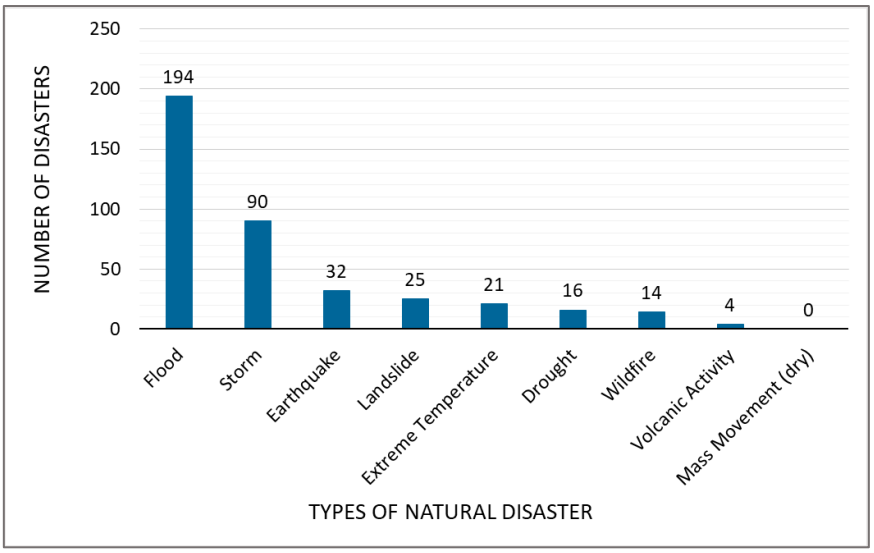

Figure 1.1: Number of natural disasters occurred worldwide in 2019 [7]

IoT which stands for Internet of Things can be defined as an extension of the Internet and other network connections that is used to connect different types of sensors and devices. IoT also requires an exceptional capability in computing and analytical thinking [8] . Contrarily, an IoT-based flood monitoring system is known as a technology that can detect and alert the public regarding the current water level. Thus, when the water reaches a dangerous level, an alert will be given prior to the flood to facilitate the evacuation process [9] . Moreover, unlike other types of systems, an IoT-based system is able to provide warning in real time regarding the flood. Hence, more damages can be prevented and therefore, brings a lot of benefits towards the public and society. As Petra Nemcova, the co-founder of Happy Hearts Fund, proclaims, “We cannot stop natural disasters but we can arm ourselves with knowledge, so many lives would not have to be lost if there was enough disaster preparedness”[10] . With the advent of technology along with sufficient knowledge and dedication, nothing is impossible to address including the efforts in dealing with catastrophic floods.

It is crucial to make sure that the proposed system is simplified, easy to run, cost effective, provide understandable and fundamental monitoring interface as well as sufficient data on the level of flood and able to feasibly inform society in the case of dangerous situations [11] . Consequently, not only that the system proposed may contribute to the public safety and health but useful in facilitating government affairs especially in the process of evacuating flood victims.

1.2 Problem Statement

At present, disaster relief in the event of flooding in developing countries still employs many conventional means. Those countries depend on human observers to monitor the water level and thus, hampers the accuracy and timely transmission of data. Through the conventional route, the flood early warning system still could not reach the entire community. Thus, information received regarding the impending disaster is overdue. This is worrying as the speed of information delivery is significant in times of emergency [12] . When disaster-related information is not successfully delivered, it will result in loss of properties and lives.

To solve the problem stated above, a system must provide advanced access to reliable information with the aid of IoT-based technology. Arduino UNO and GSM in particular allow users to receive messages, alerting about the current water level at nearby areas. Early warning information enables people to take action when disaster strikes. Hence, an IoT-based flood monitoring and alerting system using Arduino UNO and GSM is proposed.

1.3 Objectives

The purposes of this project are:

i. To investigate the utilization of sensor and IoT-based technology as a monitoring and alerting system.

ii. To design and fabricate a prototype of IoT-based flood monitoring and alerting system using Arduino UNO and GSM.

iii. To test the performance of IoT-based flood monitoring and alerting system using Arduino UNO and GSM in terms of monitoring and alerting in a smaller scale.

1.4 Scope

The scopes for this project are the software development and the hardware development. This project will be carried out with the following steps:

i. Design of the system

- The design of the project will be simulated using Proteus 8 Professional and Arduino IDE will be utilized to generate and compile the code in order to check the presence of errors. Subsequently, the code will be uploaded to Arduino UNO. After the codes are written and compiled, Arduino IDE will generate a hex file. A hex file is referred to as the hexadecimal files that are recognized by Arduino and transferred to the board via USB cable [13] . The code will then be executed as Arduino UNO possessed a microcontroller which will receives the hex file.

ii. Implementation of the hardware

- The IoT-based flood monitoring and alerting system using Arduino UNO and GSM will be designed and implemented using water level sensor, HC-SR04 Ultrasonic Sensor, DHT11 Temperature and Humidity Sensor, Arduino UNO, GSM SIM900A module, piezoelectric buzzer, LEDs, jumper wires, breadboard, resistors and mini solar panel with 9V rechargeable battery.

iii. Evaluation and testing of the developed system

- The developed system will be evaluated and tested to ensure that the system is able to properly monitor and inform users about the current water level. Four alert messages will be sent to users via SMS. The fourth alert message received by users signified that the water has reaches its maximum level, indicating that flood will occur in a matter of minutes. In addition, another purpose of testing the system is to check whether the piezoelectric buzzer produces a sound once the water hits the highest level. There are three levels altogether which are the normal, warning and danger level. The LEDs will be examined and made sure to light up at their respective water level.