UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF SOLAR POWER ASSISTED FLOOD ALERT SYSTEM WITH GSM

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics (Telecommunications) Engineering Technology with Honours.

by

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His report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) (Hons). The member of the supervisory is as follow:

……

(En. Mohd Faizal bin Zulkifli)

DEDICATION

I dedicate this project report to my parents and friends. A special thanks to my father Mr. Patrick Charles A/L Anthony Dass and my mother Mrs. Irene Patrick who both taught me to keep trying and be the best that I can be in anything that I do while continuously providing me with the necessities to complete this project.

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TABLE OF CONTENT

TITLE **PAGE**

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

A	- Ampere
mA	- Milli Ampere
mAh	- Milli Ampere per Hour
I	- Current
V	- Voltage
V_{in}	- Voltage Input
V_{out}	- Voltage Output
V_{mpp}	- Voltage Maximum Power Point
P	- Power
W	- Watts
PV	- Photovoltaic
AC	- Alternating Current
DC	- Direct Current
I/O	- Input & Output
MHz	- Mega Hertz
L	- Inductor
C	- Capacitor
°C	- Degree Celsius
kB	- Kilobytes
mm	- Millimeter
g	- Gram
s	- Seconds
mΩ	- Milliohm
Tx	- Transmitter
Rx	- Receiver

LIST OF ABBREVATIONS

API	-	Application Programme Interface
BSS	-	Base-station Subsystem
CPU	-	Central Processing Unit
GPRS	-	General Packet Radio Service
GSM	-	Global System for Mobile Communications
SMS	-	Short message service
HTTP	-	Hypertext Transfer Protocol
IP	-	Internet Protocol Suite
MCU	-	Microcontroller Unit
MMS	-	Multimedia Messaging System
MS	-	Mobile Station
NPN	-	Negative-Positive-Negative Transistor
NSS	-	Network and Switching System
OSS	-	Operation and Support Subsystem
PIC	-	Peripheral Interface Controller
PIR	-	Passive Infrared
PWM	-	Pulse-Width Modulation
RF	-	Radio Frequency
SMS	-	Short Messaging System
SMS-G	-	Short Messaging System- Gateway
TCP/UDP	-	Transmission Data Protocol or User Datagram Protocol
TDMA	-	Time Division Multiple Access
TOF	-	Time of Flight
USB	-	Universal Serial Bus

ABSTRAK

Projek ini merupakan sebuah pembangunan alat yang memberi notifikasi melalui *SMS* apabila alat tersebut mengesan paras air di kawasan taakungan air menaik melebihi paras yang selamat. Alat ini dibantu oleh tenaga solar untuk mengecas bateri sistem alat ini. Alat ini dapat membantu orang ramai yang menetap di kawasan yang sering dilanda banjir. Projek ini diusahakan kerana Malaysia menerima hujan yang banyak dalam setahun dan ini meyebabkan banyak kawasan di Malaysia dilanda banjir sekurang-kurangnya sekali dalam masa setahun. Oleh it, alat yang dibangunkan ini dapat membantu orang ramai di Malaysia pada musim tengkujuh terutamanya dengan muda kerana alat ini senang diperolehi pada kos yang rendah berbanding dengan alat mengesan banjir yang sedia ada tetapi hanya boleh didapati pada kos yang agak tinggi. Alat ini telah diusahakan dengan membuat pengaturcaraan cara litar berfungsi dengan komponen pengesan paras air yang kemudian disambung kepada litar mengecas bateri melalui tenaga solar. Alat mengesan paras air yang menghantar notifikasi SMS dengan bantuan cas oleh tenaga solar ini boleh menghantar notifikasi SMS dalam masa 20 saat selepas mengesan paras air dan kuasa baterinya mampu dijimatkan sebanyak 40% dengan bantuan tenaga solar untuk mengecas bateri.

ABSTRACT

This is a Development of Solar Power Assisted Flood Alarm System which has been designed to detect a raise in the level of water in an area of concern such as a river nearby a residential and send SMS Alert should there be a raise in the level of water. This system has been designed to be portable with minimum maintenance as it will assisted by the recharging through Solar Power. This helps people who live in flood prone areas in Malaysia since Malaysia receives a lot of rain in a year and flood is one of the frequent disasters faced by most Malaysians. Besides this device will also be available to residence easily since it is aimed to be low cost. This development was done by coding the programme and configuring the switch circuit with the Arduino UNO before being connected to another circuit configuration to recharge the batteries with solar power. The device sends an alert in less than 20 seconds from the time water level has been detected and it saves 40% battery with the aid of solar power.

CHAPTER 1
INTRODUCTION

1.0 Introduction

In Malaysia, the most devastating natural disaster experienced is flood [1]. It occurs during the north-eastern monsoon season which takes place generally from November to March each year. This monsoon season generally brings heavy rainfalls to the east coast of the Malaysian Peninsular and some areas of Sabah and Sarawak causing floods in low lying areas. However, other areas in Malaysia could also receive as much rain since Malaysia is an equatorial country with average rainfall of up to 2500mm per year. Even Penang, a state lying on the west coast of the Peninsular of Malaysia, received a heavy rainfall within November 2017 which caused heavy floods in various parts of the island. Besides, flood disaster could also occur due to improper irrigation method in a housing area [2]. Floods could be a tricky phenomenon to be predicted since it also depends on the tides of the sea, as well as the drainage of a certain area. Often, residents of a flood-prone area only realise the flood when it is too late to evacuate, and this results in damage of properties, injuries and in worst case scenarios, deaths. Therefore, technology such as a device to detect possible flood occurrence and alert nearby residents could be used to aid the situation and possibly buy time to reduce the negative effects of a flood. This device should be portable, easy to use and last long since it would be placed in monsoon drains, river banks, etc. which are places in which no power supply from the grid is available. Hence, the device should function based on solar power as the supply. This flood detecting device should be able to send alerts via Short Messaging System (SMS), using Global System for Mobile Communications (GSM) to the residents around the flood-prone area.

1.1 Problem Statement

Floods are difficult to predict and often not detected early enough to evacuate. Often, residents are aware of flooding only when it's too late, and as a result property are damaged, lives are at risk and there is a rush to evacuate because many people need to be evacuated at the same time.

A flood detecting system needs power to operate for a long term without supervision. This is because most of the measurement or the monitoring sites in the case of this project will be in remote places [3]. Even if the monitoring area is to be done at the monsoon drains and water catchment areas of a housing area and such, obtaining continuous power supply from the grid is a challenge. Therefore, a flood detecting system needs a power solution for long term functionality without frequent supervision.

Residents in flood prone areas need to be alerted early of an incoming flood so that they can brace for it by moving properties and evacuating themselves to prevent being caught off guard by the flood. Residents using a flood alert device need a reliable method to receive alerts. Method of alert is important so that the device's purpose is achieved. Using sound and lights alone may not be enough to alert residents of an incoming flood as these mediums can be overlooked due to several factors. Residents living a certain distance from the area of monitor yet within the radius of facing the flood need to receive alerts direct and quickly as well.

Existing solutions for flood warning and forecasting are expensive and, in a community, it requires many people's approval to obtain such technologies which a challenge is to obtain a flood warning device. Besides, most flood alert devices on the market lack portability.

1.1 Objectives

Based on the problem statement discussed above, the objectives of this project are to:

i. To study a device that can detect incoming flood early using sensors to detect the level of water in the area of concern.
ii. To design a portable and affordable solar power assisted flood alert system device that picks up water level from the sensors and sends alert via Global System for Mobile Communications (GSM) to the residents or user through Short Messaging System (SMS).
iii. To analyse the designed solar power assisted flood alert system device with GSM.

1.2 Project Scope

The project scope for this device is based on the stated objectives above. Ultrasonic sensors and Water level sensors will be used to precisely monitor the water level. Solar power will be used to recharge the batteries which power this flood alerting device to ensure the device can continuously operate without needing much supervision. Global System for Mobile Communications (GSM) is used to send out alerts to the users' mobile phones via Short Messaging System (SMS). A microcontroller, Arduino Uno is used as the core of the device which collects information from the sensors and processes it before sending out information to GSM to execute alerting process. Simple components are used to build this project device to keep costs low.

1.3 Expected Results

The sensors should be able to detect water level based on three levels. When the water as reached a certain level, triggering the water level sensor or the ultrasonic sensor, an alert is sent by Global System for Mobile Communications (GSM) via Short Messaging System (SMS). The user will receive the alert on the water level on the mobile phone. There will be three different fixed levels for an alert to be sent out. Upon

trigger of the lowest level, an alert is sent saying “Water is on a Safe Level”. The second alert is sent when the second level is triggered and an alert saying, “Water Level is rising to a medium level, caution!” is sent out to the user. When the water level hits the third level which is the highest point before a flood can occur, an alert is sent saying “Water Level is Dangerously High, Prepare to Evacuate now!”. In terms of power, the device should be able to operate with batteries which are constantly recharged by the solar power. Without proper irradiance of the sun, the device should be able to operate for a full day at least.

1.4 Organization

The focus of this project is on developing a solar powered flood alert system device with GSM which is reliable as well as low cost. In this report, there are five different chapters. The first chapter has a brief introduction to the problems, objectives and the scope related to this project. In the second chapter, a literature review is done based on existing technologies and past works that are related to this project. Light discussions are also done based on the reviewed papers. Moving on to chapter three, a description of the components and methods planned to build the device and complete this project is discussed in detail via tabulation, flowcharts, etc. Next, chapter four will present the results and the analysis of the built device upon which discussion is done. Last but not least is chapter five, in which conclusions are drawn and future recommendations are made.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

The previous work done by various researchers which are related to the development of a solar assisted flood alert system with GSM will be reviewed in this chapter. The validity of findings in the previous research works will be analysed. This literature review presents the opportunity to analyse the pros and cons of using certain systems, devices as well as techniques. Besides, reviewing past researches also allows for adoption of certain ideas that could enhancement the development of this project. Methods applied as well as the findings from previous research can be used as a comparison or as a benchmark for the completion of this project. This section has been broken down to a few parts which are past-related works, device components and solar energy. In past-related works, as stated, previous works by researchers that are similar to this project development will be reviewed and discussed. For device components, the electronic components that make up this device generally, would be reviewed and discussed to obtain a clearer understanding of how these components work and it would give an insight of what types of components should be used and why. The third part will be the discussion of solar energy upon review of past works that used solar energy either as a secondary mode of supply or primary mode of supply for those works. This would give a better understanding on the operation of solar energy and the limitations of it.

2.1 Past Related Works

2.1.1 Low-Cost Alternative for the Measurement of Water Levels in Surface Water Streams

This project had two main objectives with the first being to design a water level measurement system based on ultrasound. The second objective was to propose another method develop instruments, for institutions which conduct surface waterbody monitoring, based on their needs. This is because while there are vast range of technologies out there in the commercial world, budgeting becomes a hurdle to obtain those technologies and resorting to low-cost means is the most realistic option. This project has been divided into four sections, namely, signal acquisition, processing, recording as well as data transmission. Ultimately a CPU (Central Processing Unit) is needed to function as the brain of this system which calls for the use of a microcontroller. The microcontroller will cover the processing for this project. A storage element is needed for the recording of data while a communication device is used for the transmission of the recorded data. An extra element which is a digital time-clock was used to record the time stamps of recorded data, but the power source was split from the main power source to downsize the risk of deconfiguration of time. Finally, the power source is needed to enable the circuit to function for which a battery could be used.

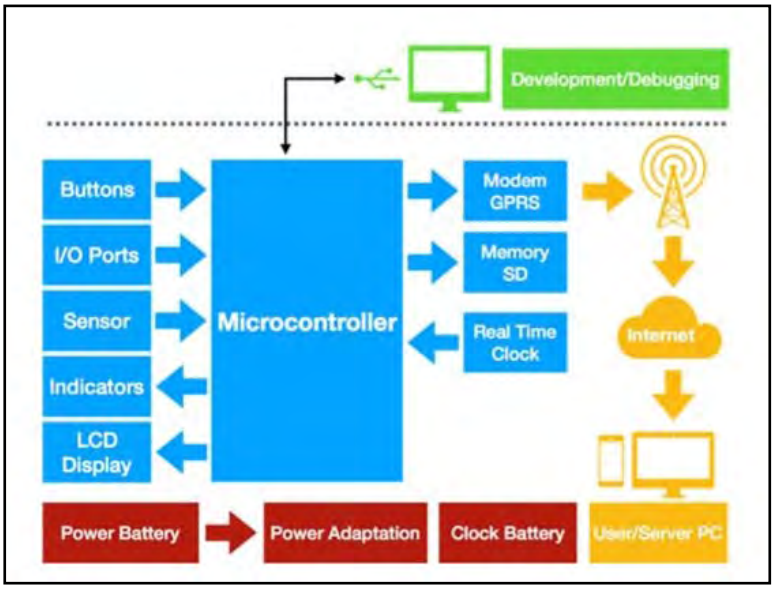

Figure 2.1: Block diagram of the major system elements (Illustration from "Low-Cost Alternative for the Measurement of WaterLevels in Surface Water Streams"[3]*)*

The system was designed to ensure data of river water level could be acquired every five mins which will be saved to a micro-SD card which will be sent to by wireless means such as GPRS. Ultrasonic sensors, though not the cheapest was used due to the low-cost solution which ticks the right boxes for the operation. PIC18F4620 was the microcontroller found to be the best suited for the requirements of the water level meter system. Rechargeable batteries were used because there wouldn't be continuous power supply at the site where this project is intended to be installed. Prior to assembly, a simulation was attempted in which, after the level signal obtained from the sensor was quantified the software implemented a first order filter to remove high frequency noise.

In a nutshell, this project was aimed to monitor the water level and data was sent to the system via GPRS. The main purpose was to study the water level. Upon successful implementation, it was understood that in slow flowing streams was where the best measurement could be obtained and there were problems found with the return wave of the ultrasound in fast flowing streams due to high turbulence. This shows that while ultrasound sensor is the best low-

cost option, it still has a certain weakness when it comes to fast flowing streams which could be aided with the additional sensors such as water sensor for better verification and prevention of false alarm when it comes to a flood alert system. However, sending an alert via GPRS may not be the most reliable option since this project is aimed for low cost. This is because while mobile data may be common in the modern society today, many places especially remote areas still have low coverage for mobile data and the coverage may affect the speed in which this alert is sent to the user. Besides, while many may have easy access to mobile data, it still isn't the cheapest option as well when compared the cost involving SMS.

2.1.2 Portable Water Level Monitoring System via SMS

Information could be sent and received easily via text messaging. Hence, this could be applied as a measure for safety by sending and receiving alert texts via text messaging [4]. The objective of this project was to caution people of the level of the water in the river. Three levels of warning were set with the lowest level being the "minor level", medium level being "moderate level" and lastly the highest as the "major level". This project was designed such that the people will receive an SMS (Short Messaging System) upon trigger of each one of these sensors by water. A custom message will be sent to the people based on the level of sensor which is triggered. A system that can provide a well-established way to aid the communities and emergency services by giving adequate time to prepare for the flood that is about to happen.[5].

This portable water level monitoring system via SMS is powered by rechargeable batteries and every component of the device will be active from the moment power is supplied to the circuit. An SMS module was used to send alert messages to the handphones of the people whose number has been keyed in the GSM (Global System for Mobile Communications). There was a siren which will be activated should the water level reach the highest level. This is an additional effort in case when the signal is weak, and the people do not get the text alert on time. The siren will be an additional alert should the people