INVESTIGATION OF THE EFFECTIVENESS OF
A DISASTER ALERT SYSTEM

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“I hereby declare that I have read through this report entitle “**Investigation of the Effectiveness of a Disaster Alert System**” and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Mechatronics Engineering.

Signature :

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Date : 6 June 2018

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INVESTIGATION OF THE EFFECTIVENESS OF

A DISASTER ALERT SYSTEM

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A report submitted in partial fulfilment of the requirements for the degree of

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I declare that this report entitle "*Investigation of the Effectiveness of a Disaster Alert System*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	
Name	:	CHUA LI YING
Date	:	6 June 2018

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To my beloved mother and father

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ABSTRACT

Earthquake is the most dreadful phenomenon among the 5 types of most common natural disaster. The existing earthquake alert system is costly and there may be faulty detections. Therefore, a low cost Internet of Thing (IoT) based real time earthquake early alert system is proposed where the system could estimate the earthquake epicenter and P-wave arrival time in an area around 25 kilometers apart from 3 sensor nodes. A disaster messaging system is develop which aims to send alert information and a site recorded video to Telegram channel for validation purpose when one of the accelerometers in 3 sensor node detects acceleration exceeds threshold value of 0.05 m/s^2. The time for delivering the alert message with photo and video attachment of the proposed system is calculated to check its efficiency. The map which illustrate the estimated epicenter coordinate and estimated P-wave arrival time using ThingSpeak MATLAB Visualization feature will then be sent to the Telegram channel for better understanding purpose. 3 shaking tables will be built to verify the proposed system through earthquake simulation at 6 different preset epicenter locations at each sensor node. Through the experiments, the final alert warning will be sent to Telegram channel within 68.1 seconds and earns an average short period of 35 seconds respond time for immediate evacuation or other purposes before P-wave hits the destination.

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ABSTRAK

Gempa bumi adalah fenomena paling dahsyat di antara 5 jenis bencana alam yang paling biasa berlaku. Sistem amaran gempa bumi yang sedia ada adalah mahal dan berkemungkinan memberi data yang salah. Oleh itu, satu sistem amaran awal gempa bumi yang dibina dengan kos yang rendah dicadangkan di mana sistem tersebut boleh meramalkan lokasi gempa bumi dan menganggarkan masa impak P-gelombang di kawasan sekitar 25 kilometer jauh daripada 3 nod pengesan. Satu sistem pemesejan bencana dibangunkan untuk menghantar maklumat amaran dan tapak video yang dirakam ke Telegram untuk tujuan pengesahan apabila salah satu pecutan dalam 3 nod sensor mengesan pecutan melebihi 0.05 m/s^2. Masa untuk menyampaikan mesej amaran dengan lampiran foto dan video dikira untuk memeriksa kecekapan sistem yang dicadangkan. Peta yang menggambarkan lokasi gempa bumi dan masa ketibaan P-gelombang menggunakan ThingSpeak MATLAB Visualization akan dihantar ke Telegram untuk tujuan pemahaman yang lebih baik. 3 meja goncang akan dibina ke setiap nod pengesan untuk mengesahkan sistem yang dicadangkan melalui simulasi gempa bumi di 6 lokasi yang berbeza. Melalui eksperimen, amaran akhir akan dihantar ke Telegram dalam masa 68.1 saat dan memperoleh tempoh masa pendek purata 35 saat untuk bertindak atau tujuan lain sebelum gelombang P menemui destinasi.

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LIST OF ABBREVIATIONS

ADC	-	Analog-to-Digital Converter
USB	-	Universal Serial Bus
CPU	-	Central Processing Unit
P-wave	-	Primary Wave
S-wave	-	Secondary Wave
GPIO	-	General Purpose Input/Output
SMS	-	Short Messaging Service
HDMI	-	High Definition Multimedia Interface
IoT	-	Internet of Things
IFRC	-	International Federation of Red Cross and Red Crescent Societies
UNISDR	-	United Nations Office for Disaster Risk Reduction
EM-DAT	-	International Disaster Database
CRED	-	Centre for Research on the Epidemiology of Disasters
WSAN	-	Wireless Sensor and Actor Network
WSN	-	Wireless Sensor Network
CSI	-	Camera Serial Interface
LAN	-	Local Area Network
GSM	-	Global System for Mobile Communications
AVI	-	Audio Video Interleave Video
MP4	-	MPEG-4 (Motion Picture Expert Group 4) Video
MKV	-	Matroska Video
GIF	-	Graphics Interchange Format

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CHAPTER 1

INTRODUCTION

1.1 Overview

There are five subtopics to be presented in this chapter, which includes motivation, problem statement, objective and scope. Related statistical data will be shown to support the motivation of this project. Besides, limitation on current technology will also be discussed. Last but not least, the aim and research boundary of the project will also be discussed in this chapter.

1.2 Motivation

A natural disaster is known to hit any part of the world without any prior warning due to natural processes of the earth which includes cyclone, flood, earthquake and other geological processes [1]. In recent years, countless people died, injured or become homeless because of such disasters. Regardless of the cause of incident, disaster causes destruction in terms of economic and human lives in the history of mankind. Table 1.1 below shows the number of reported natural disaster and number of deaths, by type of phenomenon occurs worldwide between years 2011 until 2015.

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Table 1.1: Total number of reported natural disaster and number of deaths, by type of phenomenon occur worldwide between years 2011 until 2015 [2].

Type / Criteria	Floods	Storms	Earthquakes	Droughts	Extreme Temperatures
Number of reported disaster	744	495	134	123	117
Number of deaths	26,529	17,495	33,076	10,035	13,048

Based on Table 1.1 shown above, there are 5 types of most common disaster, and earthquake results the highest total number of deaths although it was third highest reported.

Every year, at the global level, there are about 2 earthquakes above or equal to Richter scale of 7 and nearly 150 earthquakes of magnitude above Richter scale of 6 are reported occurred in inhabited regions, stated by the researchers at the Paris Institute of Earth Physics (IPGP) [3].

Recently, a major earthquake with Richter scale of 7.1 struck southern Mexico on 19 September 2017, 123km from Mexico City, in Puebla state which killed at least 230 people as shown in the Figure 1.1 below.

Figure 1.1: Earthquake disasters in Mexico [4].

The earthquake took place on the 32nd anniversary of a devastating earthquake that killed thousands in Mexico City in 1985, and came less than 2 weeks after another

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massive earthquake with a Richter scale of 8.1 killed at least 96 people and left 2.5 million in the need of aid in the state of Oaxaca. According to the government, more than 40 buildings in the country‟s capital, Mexico City near the quake‟s epicenter, have completely collapsed, with thousands more left damaged and unstable [4].

In year 2016, earthquake has again reminded the global population its existence by achieving top 2nd and 3rd rank on the 5 deadliest natural disasters happened in 2016 at Ecuador and Italy. On April, a powerful earthquake with a Richter scale of 7.8 hit the northwestern coast of Ecuador, South American nation, leaving nearly 300 dead and thousands injured. After a few months, another powerful earthquake disaster rattled central Italy on August. With a Richter scale of 6.2, more than 200 people are killed and more than 1000 people have been displaced by the quake [5].

In terms of seismic activity, Malaysia is classified as a country with low to medium seismic activity level. However, the seismic risk, in terms of damage potential should not be ignored since there have been numerous tremors on Malaysian soil due to the earthquakes disaster happened in nearby country over the past decade. Recently, an earthquake with a Richter scale of 6.4 hit southern Sumatra, Indonesia on 13 August 2017 and causes tremors felt in parts of Johor, Melaka and Singapore. Luckily, no injuries or deaths were reported [6]. In 5 June 2015, an earthquake with a Richter scale of 6.0 strikes Ranau, Sabah. It is the strongest earthquake ever recorded in Malaysia which kills 18 climbers due to the tremors felt during their climbing on Mount Kinabalu [7].

In conclusion, an efficient disaster management system is needed; especially on earthquake detection due to the harms it brings to the world. Occurrence of earthquake in Malaysia is less than other countries. However, Malaysia should have an up-to-date disaster management system to avoid earthquake such as the tragic incident 2015 at Sabah.

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1.3 Problem Statement

With the aids of available technologies and preparation, alert messages are now able to be spread out when an earthquake is sensed nearby. The earthquake alert system implemented in Japan can even inform the citizen the area that will be hit by earthquake impact. However, due to its extremely high cost at around 1 billion dollars for implementation of a dense network with 1000 seismographs throughout the entire country to rapidly detect earthquakes, this system has not yet been popularized to other country, especially Malaysia. Besides, Taiwan has developed an earthquake early warning system which costs around 1.01 million dollars based on Japan‟s system. Over 700 strong-quake and 100 real-time monitoring stations have been set up nationwide. Thus, a low cost earthquake warning model with ability to estimate earthquake epicenter and arrival time should be designed to meet the needs of those countries which have low possibility of strong earthquake happening.

Next, validation is one of the main concerns of a disaster warning system. High false alarm rate of the system is triggered by faulty detection that may occur as a result of noise from accidents, lightning or device failure which in turns activates false alert. This will not only undermine public confidence towards the impact alerts, but also a waste of money due to unnecessary evacuation. One of the example is the false alert happened in 5th January 2018 in Japan which causes panic to millions of citizens and disrupted Tokyo‟s transport network. Therefore, an alert message should be sent to local authorities with an attachment of media file like video as a proof of an earthquake hit to avoid unnecessary wastes.

An effective disaster alert system depends on how quickly the situation is notified to the right people. Even a few additional seconds of warning can make a huge difference in saving hundreds or even thousands of human lives. The Japanese system gives citizens an average of 30 to 50 seconds warning while the Taiwan

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system allows at most a 10 seconds warning since the seismic activity take place closer to the island. On the other hand, Malaysia earthquake alert system takes 8 minutes to deliver the alert due to the latency of receiving alert information from neighboring countries. Thus, the efficiency of the system must be considered so that people could take appropriate action and respond to that situation effectively.

In conclusion, this research will focus on developing a real time earthquake monitoring and alert system by estimating the epicenter and time arrival of earthquake with the aid of low cost Internet of Things (IoT) sensing model.

1.4 Objective

The objectives of this research are stated as below:

1. To design a disaster alert system that estimates the epicenter and arrival time of earthquake by using accelerometer.
2. To develop a disaster messaging system for sending alert information and video recorded on earthquake scene by using Pi camera module through smartphone‟s application and web based network.
3. To calculate the efficiency for delivering the alert message with photo and video attachment.

1.5 Scope

1. The system is specialized for earthquake detection by taking into account only the P-waves.
2. The system sends warning message only when accelerometer reading exceeds threshold value of 0.05 m/s^2.

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