

**SINGLE STATION LOCALISED LIGHTNING LOCATING SYSTEM**

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**UNIVERSITI TEKNOLOGI MALAYSIA**

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A project report submitted in partial fulfilment of the  
requirements for the award of the degree of  
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Specially dedicated to my beloved family and friends, for their encouragement  
and support

## **ACKNOWLEDGEMENT**

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## **ABSTRACT**

Lightning can be beautiful in view yet dangerous when it struck things and human beings. Many techniques had been produced in order to detect the location of lightning strikes. Some techniques require high cost of installation yet the system is not accurately locating the possible point. In this paper, the technique proposed is by using Magnetic Direction Finder (MDF) by the help of time-to-thunder method. The hardware part consists of microphone to detect sound of thunder and closed-loop antenna to detect electromagnetic wave signal which can be considered as flash. These two inputs will be then being simulated by using MATLAB software in order to get the longitude of the possible location of lightning strike which can be seen on the google earth. The system is much cheaper yet accurate compared to the other existing lightning detection system produced.

## ABSTRAK

Kilat mungkin member gambaran yang indah tetapi kilat amat berbahaya jika ia memarah bangunan dan manusia di bumi. Pelbagai teknik digunakan untuk mengesan lokasi panahan kilat. Sesetengah teknik memerlukan kos yang tinggi untuk memasang alat pengesan dan ada juga teknik yang tidak mampu mengesan dengan tepat lokasi kemungkinan berlakunya panahan kilat. Kajian dan penulisan ini mengusulkan teknik mengesan kilat dengan menggunakan kaedah Pengesan Arah Magnetik (MDF) dengan bantuan kaedah masa ke guruh (Time to Thunder). Alatan yang digunakan melibatkan mikrofon untuk mengesan bunyi guruh dan antena gelung silang 'cross loop' untuk mengesan signal elektromagnetik yang boleh dianggap sebagai hasil dari cahaya kilat. Kedua-dua input ini akan dianalisis menggunakan perisian MATLAB untuk mendapat longitud dan latitude lokasi berkemungkinan berlakunya panahan kilat. Sistem yang dihasilkan melalui kajian ini adalah lebih berpatutan dari segi kos namun masih mengekalkan ketepatan berbanding penggunaan kaedah atau teknik mengesan kilat yang pernah dihasilkan sebelum ini.

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**LIST OF ABBREVIATION**

CG	-	Cloud-to-Ground
CID	-	Intracloud lightning discharge
d	-	Distance
DE	-	Detection Efficiency
EMTR	-	Electromagnetic time reversal
GPS	-	Global Positioning System
HD	-	Hertzian Dipole
Hz	-	Hertz
IVAT	-	Institut Voltan Arus Tinggi
LA	-	Location Accuracy
MDF	-	Magnetic Direction Finder
ms	-	Meter per second
SRDE	-	Sensor Relative Detection Efficiency
TOA	-	Time Of Arrival
VHF	-	Very High Frequency
VLF	-	Very Low Frequency
WWLL	-	Worldwide Lightning Location

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background of Study**

Lightning is the transfer of charge between two charged object basically involving cloud and other object. It can occur between cloud to cloud, cloud to air, and cloud to ground. The common one is cloud to ground which theoretically involving a very large and fast impulse current flow to ground. Lightning strikes might be beautiful in view because it shines in the sky. Yet, lightning strikes can kill living things, destroy equipments, and can also be the cause of power failure. This is why it is important to have some precautions towards the event of lightning strikes.

There are numbers of lightning detection techniques that can be used in order to detect and locate possible lightning strikes. Presently there are three techniques commonly used ; Magnetic Direction Finder (MDF), time of arrival (TOA) and interferometry. MDF technique is used to determine the location, and direction of the lightning signal. In this system, electromagnetic field radiated by lightning will be sensed by two or more direction finding stations which consists of antennas and



flat plat antenna with certain frequency level. It then transmits the signal to central station to analyse the data in order to get the position and direction.

Time of arrival technique is depending on monitoring the accurate time of an event occur at different points. Locating lightning by TOA method requires high precise synchronisation sensors, basically from GPS and minimum of three other sensors. Lightning radiated propagates in all directions with the speed of light and hence differences in arrival time at sensors located will be observed. While interferometry technique is based on changes between band signals received at each of two closely spaced receivers are compared electromagnetically to determine the direction of the source.

## 1.2 Problem Statement

Existing Lightning Locating System (LLS) is basically using the combination of two methods ; Magnetic Directional Finder (MDF) and Time of Arrival (TOA). This combination had been used in many countries in order to locate the position of possible lightning strikes which can be dangerous to human beings if it is happen. However, the combination system is a bit expensive to install due to the high cost of buying the sensor used in TOA technique. The sensors need to be precise and accurate to capture the signal thus the expensive and quality sensors need to be used. Not to mention the quantities of the sensor, normally more than three sensors are to be used.

Other method is using time-to-thunder which is widely known as the least accurate because the point of lightning strike is given in radius. It can be anywhere within the radius, thus it provide extra work to get the location. But, in terms of cost, it is definitely cheaper and suitable to be used in single station system.

In this paper, a new combination had been proposed. Instead of using stand alone time-to thunder method, MDF method also be implemented in the system. The system is much cheaper because it required only one sensor which the antenna yet the accuracy can be increased by reducing the points of lightning strikes.

### 1.3 **Scope of Project**

The title of this project is “Single Station Localised Lightning Locating System”. It is a research on how to locate potential lightning strike by using Magnetic Direction Finder and Time to Thunder. The hardware part consists of microphone to detect sound of thunder and cross-loop antenna to detect electromagnetic wave signal which can be considered as flash.

The main task is to simulate electromagnetic signal from cross-loop antenna and acoustic signal by using MATLAB software in order to get the angular point of the possible location of lightning strike which can be seen on the map.

### 1.4 **Purposes and aim**

There are four main objectives and aims that need to be achieved by the end of the project.

- a) To analyze the wave signal from both antennas and microphone
- b) To calculate the distance of lightning strike by using time-to-thunder method
- c) To calculate theta of lightning position by using magnetic direction finder method
- d) To locate the angular direction on the map

## **1.5 Thesis outline**

This thesis is divided into five (5) chapters. The first chapter is the introduction of the project. It gives the overview of the topic, problem statements, scope of the project, and the objectives. The second chapter is the literature review part. In this chapter, the briefs of lightning detection method are given in the first part of the chapter. All basic method that had been used worldwide had been introduced in this chapter. Previous research works from other researchers also had been included.

The technical part begins in the third chapter of methodology. In this chapter, the hardware part of the project also had been included to give the view on how the simulation will take place.

The results of the project will be presented in the fourth chapter. Data obtained from the hardware part are simulated and the signal is used to calculate the distance and direction of the lightning strikes. Some calculations also included and the final result obtained is shown on the map.

The final chapter is the conclusions part. The project is concluded with some recommendation for the future works. Besides, the limitation of the project is discussed.

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