



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF IDENTIFICATION SYSTEM FOR CLOUD
AND GROUND FLASHES LIGHTING USING PATTERN
RECOGNITION**

This report is submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor's Degree in Electrical Engineering
Technology (Department of Electrical Engineering Technology) (Hons.)

by

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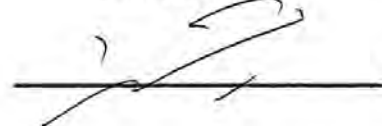
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DECLARATION

I hereby, declared this report entitled “Development of identification system for cloud and ground flashes lighting using pattern recognition” is the results of my own research except as cited in references.

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Date : 09 DECEMBER 2015

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Department of Electrical Engineering Technology) (BETI). The member of the supervisory is as follow:


.....
(AHMAD IDIL BIN ABDUL RAHMAN)

ABSTRACT

The two type of lighting is cloud-to-cloud lighting and cloud-to-ground lighting. For the cloud to cloud lighting only happen in the sky which meant the lighting only stroke at the sky. As for the cloud-to-ground, the lighting stoke directly to the ground and very dangerous for human and also can course many fault to electronic and electrical machine or other application that relate with it. The reading between this type are different, that cause make confusion data from different researcher and engineer that make the studies about it. So, a new program that will be develop for extract the data receive to determine the type of lightning by knowing the parameter of lightning. The program will be use is MATLAB and it will display the graft to shown us the parameter that we need to determine the type of lightning.

ABSTRAK

Terdapat dua jenis petir iaitu petir jenis awan-ke-awan dan awan-ke-tanah. Untuk petir jenis awan-ke-awan, ia hanya berlaku di sekitar awan atau langit sahaja dimana petir tersebut hanya dipanah dikawasan awan. Untuk awan-ke-tanah pula, petir di panah terus ketanah dan ia sangat membahaya kepada manusia serta akan menyebabkan banyak peralatan berasaskan elektronik dan elektrik atau kaitan dengannya akan rosak. Selain itu juga, bacaan data antara dua jenis petir ini amat berbeza dan ia masih memberikan kekeliruan maklumat kepada penyelidik dan juga jurutera yang mengkaji kejadian petir tersebut. Dengan ini, satu prisian pengaturan akan dibina untuk menentukan jenis petir melalui parameter petir. Pengaturan ini memerlukan prisian seperti MATLAB dan ia boleh memaparkan bentuk graf dan menunjukkan kepada kita parameter yang di perlukan untuk menentukan jenis petir tersebut.

DEDICATIONS

To my beloved parents, S.Rusman and Puspawati.
Appreciation for their supports and understanding.

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LIST OF SYMBOLS AND ABBREVIATIONS

TNB	=	Tenaga Nasional Berhad
MMS	=	Malaysian Meterological Service
GUI	=	Graphical User Interface
us	=	Micro second
LLS	=	Lightning Locating system
MDF	=	Magnetic direction finding
LDS	=	Lightning Detection System
TOA	=	Time of arrival

CHAPTER 1

INTRODUCTION

1.0 Introduction

This beginning chapter will explain about project background, problem statement, scope and objective regarding to this project.

1.1 Background

The electrical engineers and researchers always doing studies about the lightning phenomenon. Although the exact description of the physical processes for specific instances is not predictable, its behavior is fairly predictable in general terms. The interpretation, and sometimes speculation, is often complicated which owing to the complexity and variability of lightning generation mechanisms. Besides, there is no official evidence that lightning could be prevented, most are doing some method one recognize the possibility of a lightning strike and take appropriate measures to make each strike harmless. The implementation of appropriate actions for the characteristics of the lightning anticipated for finding better ways for lightning protection.

There is many of the characteristics of lightning flashes, for instance the characteristics of storms (individual or systems), occurrence statistics, pulse structure, number of strokes per flash and the polarity of the charge lowered to the ground, apparently depend on the season, geographical region, latitude and storm type.

The characterization of electric fields from electromagnetic field measurements is still considered an important tool for electrical engineers and researchers because the knowledge obtained can give improvement the investigator

to comprehend the potential effect of deleterious coupling of lightning fields with various objects especially to sensitive electronic devices (Zikri Abadi B, 2014).

By using the characterization of field data, it can extract information such as the time dependence of the voltage or current, which can be used for modeling and as an input for the computation of lightning electromagnetic fields. To do an approximate mathematical construct designed to reproduce certain aspects of the physical processes involved in the lightning discharge, it must use any lightning model that necessarily. The basic assumptions of the model should be consistent with both the expected outputs of the model and the availability of quantities required as an input to it.

The two type of lighting, cloud-to-cloud lighting and cloud-to-ground lighting. Basically the cloud to cloud lighting only happen in the sky which meant the lighting only stroke at the sky. As for the cloud-to-ground, the lighting stoke directly to the ground and very dangerous for human and also can course many fault to electronic and electrical machine or other application that relate with it. The reading between this type are different, which the reading for cloud-to-cloud lighting had lower reading than cloud-to-ground. For cloud-to-ground will have higher reading than cloud-to-cloud. The cloud-to-ground had two types, positive and negative type. For negative cloud-to-ground lighting consist of multiple "return strokes", which are additional pulses of current that illuminate the channel again and again, for positive cloud-to-ground lighting usually consist of only one return stroke, which is typically very bright and intense relative to other lightning activity in a storm and typically very loud, and many times sounds like a series of deep, low-frequency sonic booms. The program that will be develop, can identify which type of lighting base from the reading and range.

1.2 Problem Statement

In Malaysian, only negative cloud-to-ground lightning flashes and is about 90% for downward negative lightning flashes account. For more than 30 years, the data about thunderstorm event especially about lighting ground flash and cloud discharge had been collected by Malaysian Meterological Service (MMS). The

lightning ground flash density N_g is defined as the number of cloud-to-ground flashes in $\text{km}^{-2} \text{ yr}^{-1}$, is actually an important meteorological data that is used in calculating the risk of lightning strikes to a structure, avionic system, flight activities and any sensitive devices. Moreover, Tenaga Nasional Berhad (TNB) also play role for monitoring this activity since year 1995. For type of lightning measurement for Lightning Locating system (LLS) always been use by the MMS or TNB such as magnetic direction finding (MDF), time of arrival (TOA) and interferometry. The arrangement can be either individual or combination of all types.

So, the availability of lightning data recorded by MMS or TNB. Unfortunately, the data collected either by MMS or TNB presented site error in their mapping system. They suggested that this error may due to unresolved site errors inherent in the existing Lightning Detection System (LDS). This is because that the data recorded by TNB were found to be not identical to each other. Moreover they found a positive ground flashes were registered in TNB system while in their measurement, that type of flashes never appeared in their system. The positive ground flashes is actually considered as a unique flashes that only occurred in temperate region (latitude above 30 degree). This issue really raised a big doubt on the reliability of LDS for MMS or TNB .

1.3 Objectives

Objective of this project are: -

- 1.3.1 To develop a characterization technique of Lightning Detection System (LDS)
- 1.3.2 To analyse the performance of characterization technique for the identification of cloud and ground flashes.

1.4 Scope of Project

For the scope for this project, we need to identify the type of lightning that often happen in Malaysia by using the data that been receive form TNB or MMS. By using these data, we need to use MATLAB software for this project to construct the graft. After that, base from the graft, we need to identify the parameter that we need such as;

- 1.4.1 Zero-crossing time (us)
- 1.4.2 10-90 percent rise time (us)
- 1.4.3 Slow front duration (us)
- 1.4.4 50% of peak
- 1.4.5 Fast transition. 10-90 percent rise time (us)

1.5 Report Outline

In this report there are three chapters altogether. Chapter 1 gives some introduction, objective and scope of this project. Literature review of this project is included in chapter 2. This chapter reviews the related work that been done by other people as well as the existing project. Chapter 3 reveals the methodology of completing this project. For Chapter 4 is about result data receive and discussion based on result. Chapter 5 will be conclusion for the project.

CHAPTER 2

THEORETICAL BACKGROUND

2.0 Introduction

This subtopic review is about some previous works that has been developed so far related to identification of lightning, in terms of concept, specification, implementation and other useful information that related to execute this project.

2.1 Lightning Detection System (LDS)

A lightning detection system (LDS) is a device that detects lightning produced by thunderstorms. There are three primary types of lightning detection system such as ground-based systems using multiple antennas, mobile systems using a direction and a sense antenna in the same location and space-based systems. Ground-based and mobile detectors calculate the direction and severity of lightning from the current location using radio direction-finding techniques together with an analysis of the characteristic frequencies emitted by lightning. While mobile systems estimate distance using signal frequency and attenuation, Space-based lightning detectors, on artificial satellites, can locate range, bearing and intensities by direct observation, the ground-based systems use triangulation from multiple locations to determine distance.

2.2 Lightning Mechanism

Lightning or also called lightning discharge, in it's entirely whether it strikes to ground or not, is usually termed a "lightning flash" or just a "flash". A lightning

discharge that involves an object on ground or in the atmosphere is sometimes referred to as a “lightning strike”. A commonly used non-technical term for a lightning discharge is “lightning bolt”. The term for “stroke” or “component stroke” apply only to components of cloud-to-ground discharges. Each stroke involves a downward leader and an upward return stroke and may involve a relatively low level that continuing current that immediately follows the return stroke. As noted by W. R. Gamerota Marshall (2015), transient processes occurring in a lightning channel while it carries are initiated by “stepped” leaders while subsequent strokes following previously formed channel channels are initiated by “dart” or dart-stepped” leaders .

There is four different type of lightning discharge between cloud and earth from the observed polarity of the charge effectively lowered to the ground and the direction of propagation of the initial leader had been identified. The four type of lightning is;

2.2.1 Downward negative lightning

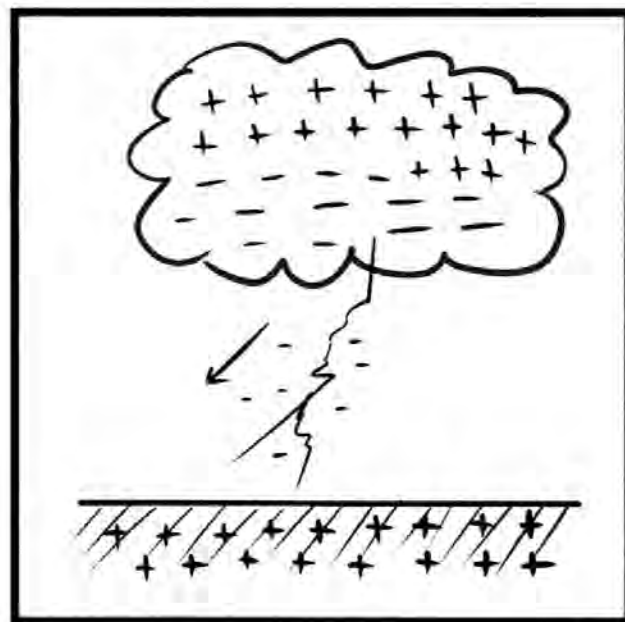


Figure 2.1: Downward negative lightning

2.2.2 Upward negative lightning

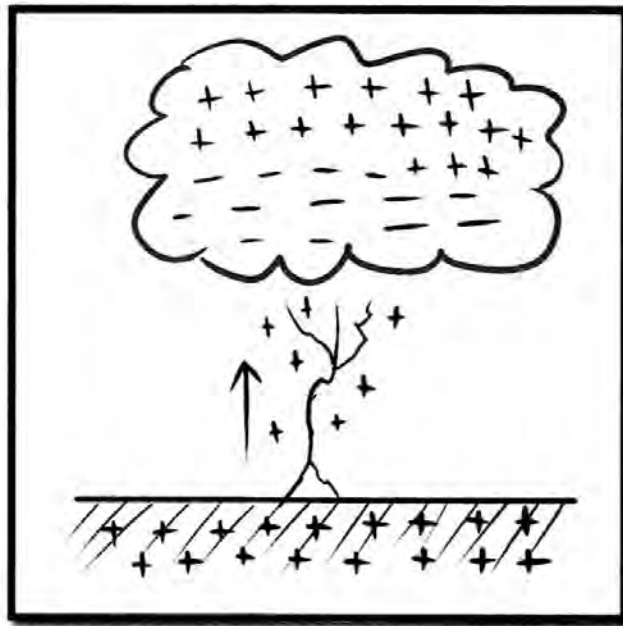


Figure 2.2: Upward negative lightning

2.2.3 Downward positive lightning

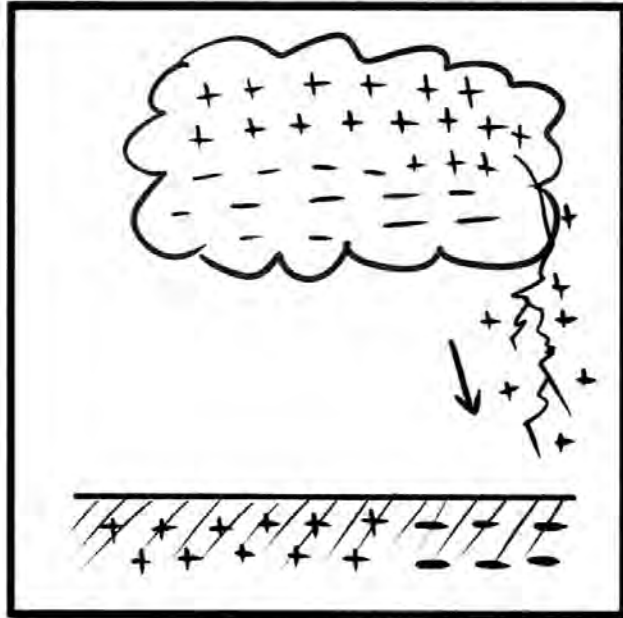


Figure 2.3: Downward positive lightning

2.2.4 Upward positive lightning

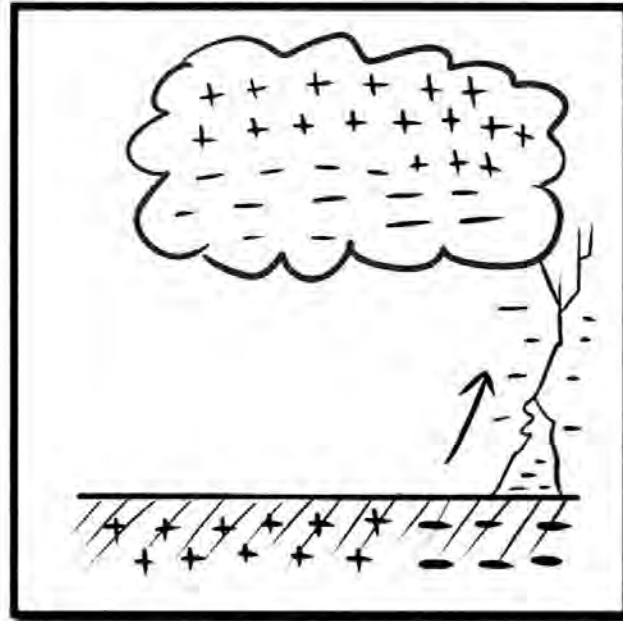


Figure 2.4: Upward positive lightning

Discharge of all four types can be viewed as effectively transporting cloud charge to the ground and therefore are usually termed cloud-to-ground discharges. It is believed that downward negative lightning flashes account is about 90 percent or more of global cloud-to-ground lightning, and that 10 percent or less of cloud-to-ground discharges are downward positive lightning flashes. Upward lightning discharges, upward negative lightning and upward positive lightning are thought to occur only from tall object (higher than 100m or so) or from object of moderate height located on mountain tops.

There are three possible modes of charge transfer to ground in lightning discharges. It is convenient to illustrate these for the case of negative subsequent strokes. In negative subsequent strokes these three modes are represented by dart-leader-return-stroke sequences, continuing current and M-component. Basically, positive cloud-to-ground lightning is considerably more complex and less studied compared to the negative lightning (Chin-Leong Wooi, 2015).

2.3 Dart-Leader-Return-Stroke Sequences

The descending leader creates a conductive path between the cloud charge source and ground and deposits negative charge along this path. This following return stroke traverses that path, moving from ground toward the cloud charge source, and neutralizes the negative leader charge. Thus, both leader and return-stroke processes serve to transport effectively negative charge from cloud to ground.

2.4 Continuing Current

The lightning continuing current can be viewed as a quasi-stationary arc between the cloud charge source and ground. The typical arc current is tens to hundreds of amperes, and the duration is up to some hundreds of milliseconds.

2.5 M-Component

Lightning M-component can be viewed as perturbations (or surge) in the continuing current and in the associated channel luminosity. It appears that the M-component involves the superposition of two waves propagating in opposite directions. The spatial front length for M-component waves is of the order of a kilometer while for dart-leader and return-stroke waves the spatial front lengths are of the order of 10 and 100m, respectively. The M-component mode of charge transfer to ground requires the existence of a grounded channel carrying a continuing current that acts as a wave guiding structure. In contrast, the leader-return-stroke mode of charge transfer to ground occurs only in the absence of such a conducting path to the ground. In this latter mode, the wave-guiding structure is not available and is created by the leader.

The channel conductivity is of the order of 10^4Sm^{-1} , except for the channel section between the dart-leader tip and ground shown by a broken line. The primary distinction between the leader-return-stroke and M-component modes is the availability of a conducting path to ground. It is possible that, as the conductivity of