IMPLEMENTATION OF A CALIBRATION METHOD FOR LIGHTNING LOCATING SYSTEM (LLS)

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ABSTRACT

Data validating is important for a country-wide lightning mapping system. The existing lightning mapping and locating system owned by TNB Malaysia covered a wide area surrounding the Peninsular Malaysia. The system known as the Lightning Detection Network (LDN), consists of high performance sensors and is able to determine the coordinates of cloud to ground lightning strikes within ± 500 m accuracy. Obviously, it is desired that the mapping accuracy of the LDN data be improved for purposes which desire more accuracy such as insurance claims due to lightning strikes. Regarding that, a new method known as the localised lightning locating system (LLLS) is introduced in UTM Skudai to determine the coordinate of any cloud to ground lightning strike within a local region with a claimed accuracy of ± 20 m. This localised system is based on the measurement of induced voltages due to lightning strikes in the vicinity of a purposely overhead constructed twisted telephone lines. This study was carried out with the objectives of comparing the LLLS system in UTM with that of the LDN TNB system. Previously captured measurement data was analyzed and compared with the LDN TNB data readings. In addition, the improvements had been carried out on the LLLS to give better strike locations. The online system is ready to be used at any time for lightning data capturing (implemented using LabVIEW Software). The theoretical explanation of lightning induced voltages due to the travelling wave effect on a typical transmission line had also been proven using ATP EMTP Software.

ABSTRAK

Validasi data adalah sangat penting untuk system pemetaan kilat setempat. Sistem pengesanan dan pemetaan kilat yang diterajui oleh TNB Malaysia mempunyai liputan kawasan yang sangat luas merangkumi seluruh semenanjung Malaysia. Sistem ini dikenali sebagai Rangkaian Pengesanan Kilat yang terdiri daripada alat pengesan yang berkelajuan tinggi dan mampu menentukan koordinasi kilat antara awan ke bumi dalam julat ketepatan ± 500 m. Menggunakan data ini sebagai system validasi untuk sistem pemetaan setempat akan mengakibatkan bacaan yang kurang tepat. Berikutan itu, satu kaedah baru diperkenalkan di UTM Skudai yang dikenali sebagai Sistem Penempatan Kilat Setempat bertujuan untuk menentukan kordinat atau lokasi panahan kilat dengan baik dan tepat dalam kawasan tertentu dengan julat ketepatan ± 20 m. Sistem ini berdasarkan kepada penentuukuran voltan yang terhasil daripada panahan kilat dengan kehadiran kabel telekomunikasi yang sedia ada. Kajian ini dijalankan dengan tujuan untuk memperbaiki Sistem Penempatan Kilat Setempat di UTM ini bersama dengan pengujian validasi data. Data sebelum ini dianalisis dan dibandingkan dengan data daripada bacaan TNB Malaysia untuk menentukan penentuukuran dalam julat ketepatan bagi kedua-dua sistem pemetaan dan penempatan kilat. Dengan menggunakan perisian LabVIEW, satu kaedah pembaikan telah dilakukan dengan memberikan validasi yang lebih baik untuk pemetaan lokasi kilat sekaligus menjadikan sistem tersebut atas talian dan sentiasa bersedia pada bila-bila masa untuk pemetaan data kilat. Tambahan dari itu, teori tentang voltan yang terhasil di atas kabel talian penghantaran turut dibuktikan menggunakan perisian ATP EMTP.

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CHAPTER 1

INTRODUCTION

1.1 Overview

Lightning is one of the most unpredictable natural hazards. The lightning activity occurs billions of times, kills thousands of people and damages billions of assets per year worldwide. This natural hazard causes about ten percent of the people struck by lightning to be killed and leave the other ninety percent with various types of injuries. Compared with the high voltage electrical shocks which may cause severe internal tissue injuries, lightning seldom causes substantial burns.

Most lightning deaths involve people working outdoors and outdoor recreationists. People struck by lightning can suffer from nerve damage, memory and attention loss, chronic numbness, muscle spasms and stiffness, depression, hearing loss, and sleep disturbance. When a building, house or other structure are struck by the lightning, currents may flow through the metal conductors such as an electrical wiring, plumbing, radio/television reception system, telephone lines and etcetera to the ground.

Furthermore, lightning current surge can also travel through any metal wires or bars in concrete walls or flooring as well as windows and doors. It is important to avoid these conductors during an electrical storm, directly or indirectly, because of high possibility that a person can get injured, shocked or killed. In addition, it can also cause damage to the electrical appliances and other parts of electrical systems in the house or buildings.

In short, lightning strikes have caused either numerous fatalities or great damage for the human life. Therefore, it is important to know the accurate location of lightning strikes, so that a better lightning protection system can be designed and installed to protect lives and property against damage. The accurate information of lightning activity on a geographical system can also help a better research and data correlation for the overall public safety. Safety is also a concern to the aviation and the construction industry, public utilities and defense. The localised lightning locating system is known to be able to provide more accurate lightning data and therefore can be used as a calibrator to the nationwide lightning detection system.

The national lightning locating system provides the data of lightning information in real time cloud-to-ground discharge information and also assists in identifying lightning threats from the historical data. It is a hosted web-based information system which presents lightning activities on a geographical information system and visualizes lightning activities only from the computer system.

Thus, in this project, the implementation of a calibration system for lightning locating system is attempted using LLLS (Localised Lightning Locating System) in IVAT UTM Skudai. The National Lightning Detection Network (NLDN) in TNB Malaysia is to be calibrated using the comparison technique.

1.2 Problem Statement

The existing country wide lightning locating system, NLDN (National Lightning Detection Network) owned by TNB Malaysia comprises of high performance of sensors throughout the Peninsular Malaysia and a centrally located processor. The NLDN covers a large area for detecting and locating lightning in real time mapping with ± 500 m accuracy. The wide area covered by the NLDN causes it to have a relatively large uncertainty as far as a localised area is concerned.

The localised lightning locating system (LLLS) in UTM may solve this problem since it can give the coordinate of the cloud to ground strikes to within ± 20 meters accuracy provided the strikes occur within the localised area. This system will be used to calibrate the NLDN.

1.3 Objectives

The purpose of this project is first to improve the performance of LLLS (Localised Lightning Locating System) developed in IVAT UTM Skudai. The strategies of improvement include the followings:-

i. to make the system fully on-line 24 hours a day
ii. to make the accurate lightning strike coordinate calculations
iii. to improve on the user interface

Then, the measured data using the LLLS will be compared with those from the NLDN and attempt to calibrate the NLDN data system against the LLLS data.

1.4 Scope of Project

This project is focusing on the LLLS (Localised lightning locating system) already setup in IVAT UTM. From the available LLLS, data analyses have been done to see the performance of lightning activity. Some improvements for the measurement of lightning are also to be considered. The data used are limited on those during the duration of this project only.

1.5 Thesis Outline

This thesis is organized into five chapters. In Chapter 1, project introduction is elaborated. Then, in Chapter 2, the explanation about the lightning characteristics, effect, measurement of induced voltages and some discussion regarding the lightning locating system is briefly reviewed.

Chapter 3 describes the methodology used in this project. The flowchart and the software simulation as a tool in this project are also discussed in this chapter.

Chapter 4 presents the results and finally, conclusions and recommendations of the project documented in Chapter 5.

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