International Conference on Electrical Engineering and Computer Science (ICECOS) 2019

Detecting Sensor Coordination in a Calibrated Lightning Locating System

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***Abstract*—A number of applications use the information from lightning locating systems. Public individuals rarely have their own lightning detection networks; thus they rely on national Lightning Locating Systems (LLSs) or weather forecasters. Therefore, local LLS is useful for public to warn them as soon as the sensors detect the lightning strike. An accurate location estimation of Cloud to Ground (CG) flashes is required to be obtained by applying available detecting methods. Common lightning locating system (LLS) uses various detection techniques such as Time Difference of Arrival (TDOA), Magnetic Direction Finding (MDF) and interferometry. However, these techniques have their own positive points and disadvantages. Low accuracy, high cost, time synchronization problems are several of these weaknesses. Therefore, calibrating the lightning detecting sensors has direct impact on the accuracy of a LLS. In this study, a calibrated LLS including the cross loop antennas, parallel plate antennas and GPS cards with data loggers have been installed at each of the three stations to capture the waveforms and to save the time stamps of incoming signals for further analyses. The captured waveforms of a real lightning discharge were investigated to measure the accuracy of a calibrated system.**

Keywords—Lightning Locating System Calibration, TDOA Technique, MDF Technique, Parallel Plate Antenna, Cross Loop Antenna

I. INTRODUCTION

Lightning is a charge transfer between two charged objects, which occur either between two different clouds, in one cloud, cloud to air, or cloud to ground. The cloud to ground (CG) lightning strike involves huge and very fast impulse current flow to the ground, which in turn produces a corresponding electromagnetic field. The cloud to ground lightning has negative impacts to humans and properties [1, 2]. Therefore, lightning strike is a great concern to mankind and industry because of its detrimental impact on human safety, hazard and equipment failures due to alternating current (AC) main power conducting electrical transients. Several people are killed by this phenomenon each year around the world. These fatalities and damages are high in countries with higher rate of thunderstorm days such as Malaysia [3]. Lightning locating system (LLS) is employed to detect lightning occurrences in single station or multi-station systems. A single station locating system is more convenient for small buildings and centres which have outdoor activities such as golf courts and sport centres. The single station system can detect propagated very low frequency (VLF) electromagnetic waves of lightning flashes to estimate the distance from lightning strike [4]. The multi-station system is more accurate to cover larger area but it requires expensive equipment and facilities. There are different lightning detection methods such as TDOA, MDF and interferometry [5, 6]. The coverage range of each lightning locating system is from a hundred meters to hundred kilometers, depending on the LLS type and number of stations.

TDOA and MDF as two main localization techniques are currently used in lightning detection networks. Both methods have some advantages and disadvantages over each other. Nowadays, the multi-station detecting systems are mostly based on combination of the MDF and TDOA methods. The combination of the TDOA and MDF methods is a powerful way to gain higher performance of lightning detecting system. The combined system has an advantage that it can utilize both localisations by hyperbolas intersections of

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