DEVELOPMENT OF SLOW ELECTRIC FIELD SENSOR IN LEGOLAND MALAYSIA RESORT

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DEDICATION

Dedicated to ALLAH Almighty,

My beloved wife Suria Hani Shamsuri,

My loving family members for your infinite and unfading love, sacrifice, patience, encouragement and best wishes.

My colleagues and best friends

Mohd Riduan Ahmad,

Shamsul Ammar Shamsul Baharin,

Selventhran Ratnagandhi,

Zairi Muhamad,

Firza Fahmi,

Murni Masrom,

Dian Hafini Yusoff,

And to everyone.

ABSTRACT

Considering the industry's needs in general and LEGOLAND Malaysia Resort's specific requirements, LEGOLAND Malaysia Resort only required a short-range lightning detection system with a distance and radius of 7-8 km or less. This lightning information was needed to inform and warn visitors to move from open or wet areas to safe sheltered areas such as buildings or shade. Based on these requirements and considering the characteristics of the slow electric field, indeed it was deemed sufficient and suitable as a prediction method for LEGOLAND Malaysia Resort. This research pioneered a novel approach by delving into the analysis of the slow electric field, aiming to develop a waveform analysis to estimate the distance and radius of lightning occurrences at LEGOLAND Malaysia Resort. The newly implemented and installed Lightning Detection System (LDS) at LEGOLAND Malaysia Resort leveraged a straightforward and cost-effective setup, incorporating a capacitive antenna, slow and fast electric field sensors and dedicated data analysis software. In order to achieve accurate data, proper grounding and isolation from electrical noise were essential, as signal interference from power lines, towers or machinery could potentially trigger false signals. The effectiveness and accuracy of the LDS underwent a rigorous comparison with data from a weather service provider subscribed monthly by LEGOLAND Malaysia Resort, namely the Data Transmission Network (DTN), where lightning information from the DTN was sent to LEGOLAND Malaysia Resort via email. A comprehensive data set of approximately 50,000 lightning strikes was collected between July 2020 and July 2022. The analysis was made with a focus on December 2020 as the peak of the rainy and lightning season in Malaysia, showed that the LDS demonstrated superior lightning detection capabilities compared to DTN, identifying 69% of strike compared to DTN 31%. Negative Cloud-to-Ground (-NCG) lightning dominated the data, accounting for over 75% of all strikes at Legoland Malaysia Resort, Intracloud (IC) lightning represented 13%, while Narrow Bipolar Event (NBE) and Positive Cloud-to-Ground (+PCG) lightning comprised 5% and 2%, respectively. -NCG lightning was the most common type of cloud-to-ground lightning, accounting for about 70% of all lightning worldwide. Apart from that, 45% of lightning occurred Within the Reversal Distance (WRD), while the remaining 55% happened Beyond the Reversal Distance (BRD). This research contributed detailed documentation on the analysis of slow electric field data, encompassing waveform patterns and key characteristics. The comparative evaluation between the novel system and the current subscription service at LEGOLAND Malaysia Resort shed light on the efficiency and capabilities of the newly introduced methodology and served as a valuable resource for future research and refinement of lightning detection systems.

PEMBANGUNAN PENDERIA MEDAN ELEKTRIK TERUBAH PERLAHAN DI LEGOLAND MALAYSIA RESORT

ABSTRAK

Dengan mengambil kira keperluan industri secara am dan keperluan Taman Tema LEGOLAND Malaysia secara khususnya, Taman Tema LEGOLAND Malaysia hanya memerlukan sistem pengesanan kilat jarak dekat dengan jarak dan jejari 7-8 km atau kurang. Maklumat kilat ini diperlukan untuk memaklumkan dan memberi amaran kepada pengunjung agar berpindah dari kawasan lapang dan basah ke kawasan terlindung yang selamat seperti bangunan atau berbumbung. Berdasarkan keperluan ini dan mengambil kira ciri-ciri medan elektrik perlahan, ia dianggap sangat sesuai sebagai kaedah mengesan kilat untuk Taman Tema LEGOLAND Malaysia. Penyelidikan ini mempelopori pendekatan dengan mendalami analisis medan elektrik perlahan, bertujuan untuk membangunkan analisis bentuk gelombang untuk menganggarkan jarak dan jejari kilat di Taman Tema LEGOLAND Malaysia. Sistem Pengesanan Kilat (LDS) yang baru dilaksanakan dan telah dipasang di Taman Tema LEGOLAND Malaysia memanfaatkan persediaan yang mudah dan kos efektif, menggabungkan antena kapasitif, penderia medan elektrik perlahan dan pantas serta perisian analisis data khusus. Untuk mendapatkan data yang tepat, pembumian dan pengasingan yang betul daripada hingar elektrik adalah penting, ini kerana gangguan isyarat daripada talian kuasa, menara atau jentera berpotensi mencetuskan isyarat palsu. Keberkesanan dan ketepatan LDS telah melalui perbandingan yang ketat dengan data daripada penyedia perkhidmatan cuaca yang dilanggan setiap bulan oleh Taman Tema LEGOLAND Malaysia, iaitu Rangkaian Penghantaran Data (DTN), di mana maklumat kilat daripada DTN dihantar ke Taman Tema LEGOLAND Malaysia melalui e-mel. Set data komprehensif kira-kira 50,000 kejadian kilat telah dikumpul antara Julai 2020 sehingga Julai 2022. Analisis dibuat dengan tumpuan pada Disember 2020 sebagai kemuncak musim hujan dan kilat di Malaysia, LDS menunjukkan keupayaan pengesanan kilat yang unggul berbanding DTN, dengan mengesan 69% kejadian kilat berbanding DTN 31%. Kilat Negatif Awan-ke-Tanah (-NCG) mendominasi data, menyumbang lebih 75% daripada semua kejadian kilat di Taman Tema LEGOLAND Malaysia, kilat Antara-Awan (IC) mewakili 13%, manakala kilat Bipolar Sempit (NBE) dan kilat Positif Awan-ke-Tanah (+PCG) terdiri daripada 5% dan 2%, masing-masing. Kilat -NCG ialah jenis kilat awan-ke-tanah yang paling kerap berlaku, menyumbang kira-kira 70% daripada semua kilat di seluruh dunia. Selain itu, 45% kilat berlaku dalam Jarak Pembalikan (WRD), manakala 55% lagi berlaku di Luar Jarak Pembalikan (BRD). Penyelidikan ini menyumbangkan dokumentasi terperinci tentang analisis data medan elektrik perlahan, merangkumi corak bentuk gelombang dan ciri-ciri utama. Penilaian perbandingan antara sistem novel dan perkhidmatan langganan semasa di Taman Tema LEGOLAND Malaysia memberi penerangan tentang kecekapan dan keupayaan metodologi yang baru diperkenalkan dan berfungsi sebagai sumber berharga untuk penyelidikan masa depan dan penghalusan sistem pengesanan kilat.

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