UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# DEVELOPMENT OF DATA LOGGING SYSTEM FOR LIGHTNING EVENT BASED ON LECROY 4061 INSTRUMENTATION

NOOR BAZLAN BIN MOHD SAZANUDDIN

B071710756



BACHELOR OF ELECTRICAL ENGINEERING TECHNOLOGY (INDUSTRIAL POWER) WITH HONOURS

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## Faculty of Electrical and Electronic Engineering Technology

# DEVELOPMENT OF DATA LOGGING SYSTEM FOR LIGHTNING EVENT BASED ON LECROY 4061 INSTRUMENTATION



**Noor Bazlan Bin Mohd Sazanuddin**

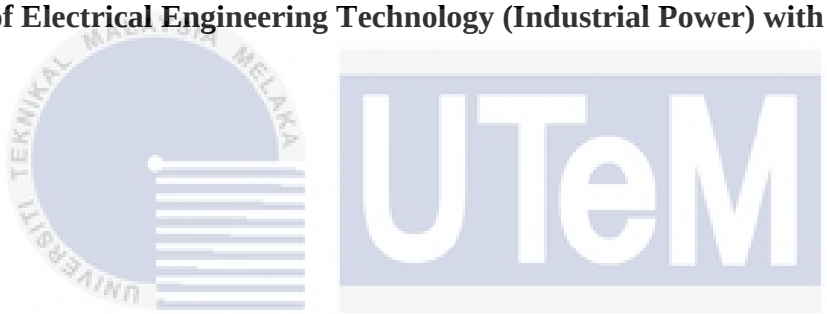
**Bachelor of Electrical Engineering Technology (Industrial Power) with Honours**

**2021**

**DEVELOPMENT OF DATA LOGGING SYSTEM FOR LIGHTNING EVENT BASED ON LECROY 4061 INSTRUMENTATION**

**NOOR BAZLAN BIN MOHD SAZANUDDIN**

**A thesis submitted**
**in fulfillment of the requirements for the degree of**
**Bachelor of Electrical Engineering Technology (Industrial Power) with Honours**



**Faculty of Electrical and Electronic Engineering Technology**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2021**

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: DEVELOPMENT OF DATA LOGGING SYSTEM FOR LIGHTNING EVENT BASED ON LECROY 4061 INSTRUMENTATION

Sesi Pengajian: 2020/2021

Saya **NOOR BAZLAN BIN MOHD SAZANUDDIN** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐ SULIT* Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

☐ TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,

.....

NOOR BAZLAN BIN MOHD SAZANUDDIN

Alamat Tetap:

PT 655, LOT 1490

KAMPUNG CABANG TIGA

PENDEK, 15100 KOTA BHARU

KELANTAN

Tarikh: 23 FEBRUARI 2021

Disahkan oleh penyelia:

.....

TS. DR. ZIKRI ABADI BIN BAHARUDIN

Cop Rasmi Penyelia:

TS. DR. ZIKRI ABADI BIN BAHARUDIN
PENSYARAH
FAKULTI KEJURUTERAAN ELEKTRIK & ELEKTRONIK
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Tarikh: 23 FEBRUARI 2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

**DECLARATION**

I hereby, declared this report entitled DEVELOPMENT OF DATA LOGGING SYSTEM FOR LIGHTNING EVENT BASED ON LECROY 4061 INSTRUMENTATION is the results of my own research except as cited in references.

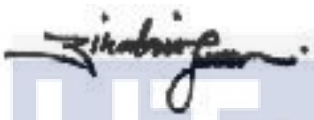
Signature: ……

Author : NOOR BAZLAN BIN MOHD SAZANUDDIN

Date: 23 FEBRUARI 2021

**APPROVAL**

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) With Honours.The member of the supervisory is as follow:



Signature: .....

Supervisor: TS. DR. ZIKRI ABADI BIN BAHARUDIN

# ABSTRAK

Penyelidikan ini bertujuan untuk mengkaji mengenai Sistem Pengesanan Kilat (LDS). Di Malaysia, LDS dikendalikan oleh Sains Meteorologi Malaysia (MMS) dan Tenaga Nasional Berhad (TNB). LDS biasanya berdasarkan Time of Arrival terutamanya mencari titik kilat kilat dan menunjukkan nilai kilat semasa (A), kilat voltan (V), jarak (KM), dan arah. Walau bagaimanapun, profil sebenar setiap peristiwa kilat tidak didedahkan oleh pemaju LDS kerana nilai sulitnya. Masalah yang bermasalah seperti yang dinyatakan di atas mendorong penulis untuk mencadangkan untuk mengubahsuai LDS sedemikian rupa sehingga sistem memungkinkan pengguna untuk melihat profil sebenar profil kilat dari setiap peristiwa. Dalam projek ini, penulis berusaha untuk meneroka sistem pengesanan kilat berdasarkan ukuran sebenar yang dikenali sebagai hit-stroke tepat yang telah dilakukan oleh banyak penyiasat terkenal dengan mempertimbangkan dua komponen utama iaitu persilangan sifar dan waktu meningkat. Kedua-dua parameter ini adalah zero cross dan waktu naik telah digunakan untuk pemodelan program analisis automatik dengan menggunakan MATLAB R2019b dengan menerapkan Teknik Pengekstrakan Ciri. Data yang dimuatkan dalam MATLAB R2019b biasanya dalam data mentah yang dinormalisasi. Tetapi, semua data mentah ini telah diproses dengan menggunakan teknik pengiraan yang dikenali sebagai kaedah pengekstrakan ciri. Kaedah pengekstrakan ciri adalah mengira nilai pengesanan masa kenaikan automatik dan pengesanan persilangan sifar automatik. Dalam proses terakhir projek ini, penulis menunjukkan semua data yang diproses secara automatik dalam Antaramuka Pengguna Grafik (GUI). nilai yang ditunjukkan dalam GUI mengikuti ciri kilat berdasarkan parameter.

## ABSTRACT

This research is purposely to study about the Lightning Detection System (LDS). In Malaysia, LDS are managed by Malaysia Meteorology Science (MMS) and Tenaga Nasional Berhad (TNB). LDS typically is based on Time of Arrival mainly locate the lightning strike point and indicating the value of current lightning (A), voltage lightning (V), distance (KM), and direction. However, real profile of each lightning event was not being exposed by the developer of the LDS because of its confidential value. The problematic issue as stated above motivate author to propose to renovate the LDS in such a way that the system allow the user to see the real profile of lightning profile from each event. In this project, the author tries to explore the lightning detection system based on the real measurements which is known as accurate-stroke-count that has been conduct by many well-known investigators by considering two main components which are zero crossing and rising time. These two parameters which are zero crossing and rising time has been used for modelling of automatic analysis program by using MATLAB R2019b via implementing the Feature Extraction Technique. The data that uploaded in the MATLAB R2019b usually in normalized raw data. But, all of these raw data has been processed by using the calculating technique known as the feature extraction method. The feature extraction method is calculating the value of automatic rising time detection and automatic zero crossing detection. In the final process of this project, the author showed all of the processed data automatically in Graphical User Interface (GUI). the value shown in GUI following the characteristic of lightning based on the parameters.

## DEDICATION

It is my real grateful and mildness regard that I dedicated this work to my beloved parent, my family, my respectful supervisor and co supervisor, my precious lecturers and my fellow friends. Many thanks for the support and facilitate given to me on finishing this thesis.

## ACKNOWLEDGEMENTS

First most, because of Allah S.W.T. Allah Almighty for provides me a blessed for finalizing this report. I might prefer to impart my folks and family for giving me full support, understanding and patience.

I would prefer to express my feeling and appreciation to any or all people who gave me the chance to finish this report. I categorical my deep sense of feeling to my supervisor, Dr Zikri Abadi bin Baharudin for his steering and inspiration relating to the project of " DEVELOPMENT OF DATA LOGGING SYSTEM FOR LIGHTNING EVENT BASED ON LECROY 4061 INSTRUMENTATION " for completing project smoothly.

I am deeply indebted to all my lecturers and my fellow friends who have contributed to the preparation of this project report and support me and give me some moral to me to complete the report on time.

I will be always indebted to them. Without their support, I would not have been able to finish my research project.

# TABLE OF CONTENTS


| | | PAGE |
|---|---|---|
| **TABLE OF CONTENTS** | | **xii** |
| **LIST OF TABLES** | | **xv** |
| **LIST OF FIGURES** | | **xvi** |
| **LIST OF SYMBOLS** | | **xviii** |
| **LIST OF ABBREVIATIONS** | | **xix** |
| **CHAPTER 1** | **INTRODUCTION** | **20** |
| 1.0 | Introduction | 20 |
| 1.1 | Problem Statement | 21 |
| 1.2 | Objective of Project | 22 |
| 1.3 | Scope of Project | 22 |
| **CHAPTER 2** | **LITERATURE REVIEW** | **23** |
| 2.0 | Introduction | 23 |
| 2.1 | Lightning Phenomenon | 23 |
| 2.2 | Forming Process of Lightning | 25 |
| 2.3 | Type of Lightning | 26 |
| | 2.3.1 Cloud to Cloud Lightning | 26 |

2.3.2 Ground to Cloud Lightning 27

2.3.3 Cloud to Ground Lightning 28

2.3.3.1 Downward Moving Process 30

2.3.3.2 Upward Moving Process 31

2.4 Real Time System 32

2.5 Data Logging System 34

**CHAPTER 3 METHODOLOGY 35**

3.0 Introduction 35

3.1 Project Overview 36

3.2 Flow Chart of Project 37

3.3 Development Software 38

3.3.1 Design Procedure to Develop MATALB Code and GUI system 39

**CHAPTER 4 RESULTS & DISCUSSION 51**

4.0 Introduction 51

4.1 Software Development 51

4.2 Analysis of Zero Crossing 52

4.3 Analysis of Rising Time 55

4.4 Analysis of Normalize Raw Data 57

4.5 Overall Graphical User Interface (GUI) System 58

4.6 Summary 59

**CHAPTER 5 CONCLUSION & RECOMMENDATION 60**

5.0 Conclusion 60

5.1 Recommendation 61

**REFERENCES 62**

**APPENDIX 64**

# LIST OF TABLES


| TABLE | TITLE | PAGE |
|---|---|---|
| Table 2.1: | The difference between the hard real time system and soft real time system | 33 |
| Table 3.1: | The function of each selected component | 43 |
| Table 4.8: | Gantt Chart Final Year Project 1 | 64 |
| Table 4.9: | Gantt Chart Final Year Project 2 | 65 |

# LIST OF FIGURES


| FIGURE | TITLE | PAGE |
|---|---|---|
| Figure 2.1: | Electrical Charge Distribution in Thunderstorm | 24 |
| Figure 2.2: | Type of Cloud to Ground Lightning | 27 |
| Figure 2.3: | The Various of Ground Strikes | 29 |
| Figure 2.4: | Downward Moving Process | 30 |
| Figure 2.5: | Upward Moving Process | 31 |
| Figure 2.6: | Block Diagram of Real Time System | 32 |
| Figure 2.7: | Example of Triggered Based Data Logging That Will Have Some Gap Between the Data | 34 |
| Figure 3.1: | Block Diagram of Flow Data Collecting | 36 |
| Figure 3.2: | Flow Chart of Project | 37 |
| Figure 3.3: | Block Diagram of Software Development | 38 |
| Figure 3.4: | The Icon of MATLAB R2019b Software | 39 |
| Figure 3.5: | The Default Display After MATLAB are Opened | 39 |
| Figure 3.6: | Create a New Folder | 40 |
| Figure 3.7: | Open and Create a New Script | 40 |
| Figure 3.8: | Command Window | 41 |
| Figure 3.9: | Select the Blank GUI default | 41 |

Figure 3.10: Editor Layout in GUI 42

Figure 3.11: GUI Control Panel 42

Figure 3.12: Layout GUI after editing 44

Figure 3.13: The GUI load data push button setting 44

Figure 3.14: The GUI reset button setting 45

Figure 3.15: The GUI axes setting 45

Figure 3.16: The GUI uitable setting 46

Figure 3.17: Coding for opening GUI 47

Figure 3.18: Coding for designing of load button 47

Figure 3.19: Coding for load data 48

Figure 3.20: Coding for Zero Crossing Calculation 48

Figure 3.21: Coding for Rising Time Calculation 49

Figure 3.22: Coding for Designing of the Reset Button 50

Figure 4.1: Diagram to calculate the duration of the zero crossing 52

Figure 4.2: Diagram duration of the zero crossing 53

Figure 4.3: Flowchart of zero crossing codes 54

Figure 4.4: Diagram duration of the rising time 55

Figure 4.5: Flowchart of rising time codes 56

Figure 4.6: The normalized amplitude value set to greater than 0.5 57

Figure 4.7: GUI display of Data Logger System 58

# LIST OF SYMBOLS

| | | |
|---|---|---|
| **A** | - | Ampere |
| **V** | - | Volt |
| **KM** | - | Kilometer |

# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| **MMS** | - | Malaysia Meteorology Science |
| **TNB** | - | Tenaga Nasional Berhad |
| **GUI** | - | Graphical User Interface |

# CHAPTER 1

# INTRODUCTION

## 1.0 Introduction

Lightning is one of the most unforeseen forces of nature. Any lightning strike is an electric discharge triggered by imbalances in or inside the clouds between storm clouds and the ground. Polarization then creates a cloud electrical field. When the electrical field produced is high enough, it ionizes and drives the air. The atmosphere charges can be passed with conductive air to the ground, and lightning strikes therefore occur (Nag A. & V.A.Rakov (2012)). The lightning discharges are also considered to emit intense electromagnetic energy from less than 1 Hz to 300 MHz in the radio frequency range. Such lightning will also emit approximately 5 to 10 kHz in the frequency spectrum, as the lightning will take place beyond 50 km (William E. (2005)).

Commercially, Lightning Detection System (LDS) is based on Time of Arrivals concepts which consist of multiple measurement stations, electric field sensor, magnetic field sensor and GPS time server or master clocking. The electric field and magnetic field sensors have to be tune in such a way that it should be fulfil the condition of frequency spectrum of lightning. This proposal project is aimed to develop data logger for recording lightning data event based on real measurement using the application high speed transient recorder on LeCroy 4160. In order to gather lightning data, Kampus Induk UTeM, Durian Tunggal will be chosen as the measurement station. The idea of this project is to transfer the recording data of lightning from High Speed Transient Recorder to the computer for pattern recognition and logging the data to the proper auto registration folder.

## 1.1 Problem Statement

Malaysia is one of the countries that have highest lightning strikes in the world approximately around 180 to 260 strikes has been recorded. The lightning strikes happen in the Malaysia because the location of the country that lies on the equator. In Malaysia, there are two agencies that manage the lightning strikes detection system which are Tenaga Nasional Berhad and Malaysia Meteorology Science. Basically, these two agencies will record and monitor the parameters of lightning data from the lightning strikes in term of the voltage lightning, current lightning and distance or location of the lightning without knowing exact the real profile of each lightning event. Most of the parameters of the lightning data recorded are too confidential which it is really difficult to explore the real event or situation in the lightning detection system. In this project, the author tries analyze the lightning detection system based on the real parameter which is known as the accurate stroke count that has been conductor by well known investigators by considering zero crossing and rising time. Nonetheless, there is no have much detailed information in terms of how the data have recorded on the real parameters. The author was developed a lightning detection system that can read every data automatically and view it in the Graphical User Interface (GUI). Besides, this project only focusing at the first return stroke pulse.

## 1.2 Objective of Project

There are three consequential goals made for this project which are:

1. Implementing the lightning parameters that based on zero crossing and rising time of the negative cloud to ground flashes for the development of recognition programming.
2. Use the feature extraction method to identify the data of the negative cloud to ground flashes.
3. To implement auto registration procedure for displaying multiple data of lightning strikes.

## 1.3 Scope of Project

There are several scopes that are listed within its intended boundary to establish the research being conducted which are:

1. This project focuses on two stations where all of these stations are able to gather the data required.
2. The layout of data logger was developed that consist on several aspects.
3. Data was collected when the trigger level voltage on the oscilloscope exceeds 0.3V.
4. The data was processed in the MATLAB software by considering on several parameter which are zero crossing and rising time by using method of extraction features.
5. Viewing the data analysis in Graphical User Interface (GUI).

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Introduction

Some of the related literature and research associated with this project will be clarified and checked by the content of this chapter All the information was collected from a number of outlets, including the journal, papers, books, and websites. Each of the references were first researched and carried along to ensure that this research is completed on time. All the information was composed conscientiously, in addition. It is also important to increase the awareness and get some ideas before any project begins. Details and data describe in detail the project as a guide for analyzing the project and the article in depth and as shown below.

## 2.1 Lightning Phenomenon

Historically, according to the Benjamin Franklin (1706 – 1790) era that he trying to explore the study of lightning, he said that clouds are electrically charge. Within his exploration, where he standing on an electrical stand, holding an iron pole to pick up an electrical release between the other hand and a ground, concluded that on the off chance that the clouds were electrically charged, at that point sparks would hop between the iron pole and a grounded wire (Mohyedin, 2017).

The lightning can be defined as the voltage between the clouds and the earth is so high that streak electrons are accelerated into a cinematic energy sufficient to knock out the electrons from the air's atoms (Douglas C. Giancoli (2005)). Lightning is an amazing and scary feature, is really nothing more than an electric discharge at an enormous voltage. Billions of people are killed by natural disasters and billions of resources are harmed annually. The sheer control of a lightning strike, combined with light and concentrated flash, makes it the natural phenomenon that is most blinkering.

In general, lightning occurs when locals create positive and negative loads inside the cloud. There is usually a large amount of positive charge in the top cloud locations, an expansive negative load in the middle and a slightly positive load in the lower districts. These charges include drops of water, ice particles or both.

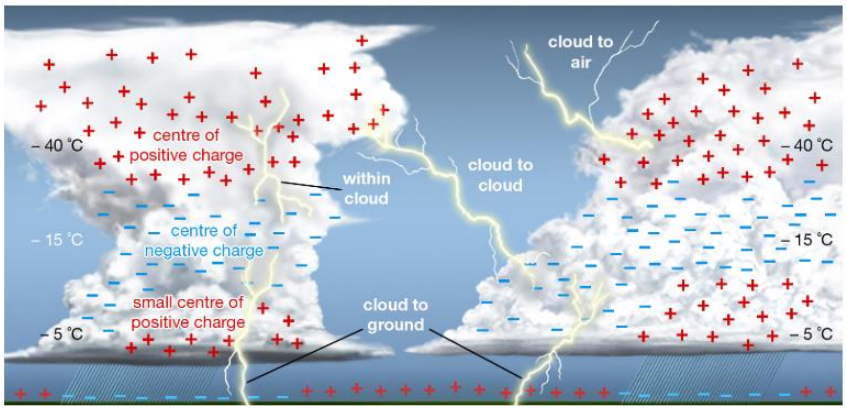



Figure 2.1: Electrical charge distribution in thunderstorm (Adapted from https://www.britannica.com/)

This creates a charging partition, which has an electrical field that is at its lowest negative and at its maximum positive. Ever after the collision, the electric field subsequently builds high, offering the planet's surface of charge. When these loads are high enough, the strength of the cloud flows down to the layer that ends like the lightning. Lightning may have projected itself as a transient, high current which usually measures its length in kilometres.