MOBILE DATA LOGGER FOR TEMPERATURE, HUMIDITY, AND ATMOSPHERIC ELECTRIC FIELD OBSERVATION

MOHD QAMARUL ARIFIN BIN RUSLI

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To my dearest parents, Rusli Mohamed and Rokiah Che Draman, my dearest brothers and sister, my friends, whoever help and support me in the thesis

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ABSTRACT

The increasing of atmospheric electric field (AEF) in between the swarm and the earth ground have the correlation when lightning occurs with the forging of a cumulonimbus cloud. The lightning activities can be anticipated during the evolution of the atmospheric electric field. The observation for the AEF is usually taken away by using static immobile observation stations with high monetary value of equipment and installation especially for information acquisition. The main hurdle for the researchers is the collection of data saving system. The collections of experimental data are very crucial when it came in bulk or big size of the collected data. In this project a low cost mobile data logger device to record AEF magnitude, humidity, temperature and location coordinate is presented. The device system is designed based on Arduino UNO module and also Arduino 1.0.5 open source software for coding process. The development of low cost mobile data logger device technology for atmospheric field magnitude and recording are still few. It is one the great challenge to explore the new application of multiple implementation of sensors, GPS system and an SD Card for multiple type of detections, which is a cost-effective and low maintenance cost for data monitor and logging system. This diligence will contribute an extra method to meteorologists and researchers as they can monitor and aware any activity during the experimentation. The finding can be motivating the further research on utilizing a portable mobile data logger system as a guide for multi-use system.

ABSTRAK

Peningkatan medan elektrik beratmosfera (AEF) di antara awan dan tanah bumi mempunyai korelasi apabila kilat berlaku dengan awan komulonimbus. Aktiviti kilat boleh dijangkakan semasa evolusi medan elektrik atmosfera. Pemerhatian terhadap AEF biasanya diambil dengan menggunakan stesen yang tidak bergerak dengan nilai kos pembuatannya yang tinggi dari segi peralatan dan pemasangan terutama bagi perolehan maklumat atau data. Halangan utama untuk penyelidik adalah koleksi sistem penyimpanan data. Koleksi data eksperimen sangat penting ketika datang secara pukal atau saiz besar data yang dikumpul .Dalam projek ini kos rendah peranti penyimpanan data mudah alih untuk mencatat magnitud AEF , kelembapan ,suhu dan lokasi eksperimen dibentangkan. Sistem peranti ini direka bentuk berdasarkan modul Arduino UNO dan juga perisian Arduino 1.0.5 untuk proses pengkodan. Pembangunan peranti berkos rendah penyimpanan data mudah alih teknologi untuk magnitud bidang atmosfera dan rakaman masih sedikit. Ia adalah salah satu cabaran yang hebat untuk meneroka aplikasi baru pelaksanaan pelbagai sensor, sistem GPS dan memori kad untuk jenis berganda bagi pengesanan , yang merupakan kos efektif dan penyelenggaraan yang rendah untuk memantau data dan sistem penyelidikan. Usaha ini akan menyumbang kaedah tambahan kepada ahli kaji cuaca dan penyelidik kerana mereka boleh memantau dan mengetahui apa-apa aktiviti dalam uji kaji mereka. Dapatan ini boleh memberi motivasi penyelidikan lanjut mengenai menggunakan sistem simpanan data mudah alih sebagai panduan bagi pangkalan berbilang guna sistem.

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LIST OF ABBREVIATIONS

AWS	–	Automatic Weather System
GPS	–	Global Positioning System
UAV	–	Unmanned Aeriel Vehicle
GPRS	–	General Packet Radio Service
SD Card	–	Security Digital Card
GLD360	–	Global Lightning Detection Network
LF/VF	–	Low-frequency Vascular Fluctuations
TLS200	–	Total Lightning Sensor
CG	–	Cloud to Ground Flashes
PV	–	Photovoltaic
I/O	–	Input output
PIC	–	Programmable Integrated Circuit
PCB	–	Printed Circuit Board
WS	–	Wind Speed
WD	–	Wind Direction
RH	–	Relative Humidity
P	–	Pressure
AT	–	Air Temperature
SS	–	space segments
CS	–	Control segments
US	–	user segments
LED	–	Light Emitting Diode
LCD	–	Liquid Crystal Display
NTC	–	Negative Temperature Coefficient
NMEA	–	NationalMarine Electronics Association

MISO	–	Master in Slave Out
SCK	–	System Clock
SS	–	Slave Select
MOSI	–	Master out Slave in

LIST OF SYMBOLS

^{o}C	–	degree celcius
$kV\ m^{-1}$	–	kilovolt per meter
μs	–	microsecond
$\%$	–	percent
kb	–	kilobyte
V	–	Volt
$\$$	–	dollar
ms	–	milisecond

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CHAPTER 1

INTRODUCTION TO THE PROJECT

1.1 Introduction

Lightning activities have correlation with the forming of thundercloud where the thundercloud will increase the atmospheric electric field (AEF) in between the cloud and the earth. Observation regarding the development of AEF will lead a prediction of lightning activities close to the particular location. The observation becomes utmost important for countries with high isokraunic level. Usually the observation is carried out by using static immobile observation stations with high cost of equipment and installation such as computer, data acquisition, tower, and antenna. However, the fast moving forwards of technologies provide a possibility to develop an effective mobile AEF data logger with lower cost. Interestingly, mobile data logger for AEF measurement was not carried out intensively yet, especially when it was related to lightning activities. Meanwhile there are lots of works have been carried out regarding applications of sensors and data logger system in many fields of science or engineering research for instance in meteorological, geosciences, geophysics, aeronautic, and aerospace. In order to obtain a good data for performing analysis, critical aspect that should be considered in applying data logger system is the process of data recording. In the past, experimental data are being monitored and logged by using computer desktop. There are many constrain if the researchers want to use computer desktop or laptop because the power comsumption is very big and cannot be carried around because of the limited on supply power. Developers are trying to design a data logging system as small as possible, so that the system can fit the term of ‘mobility’.

1.2 Problem Statements

Nowadays technology scene are seems overheated to some. Many designers are designing and developing a system that can contribute to human being. One of the field of research is in the atmospheric field measurement system. Many researchers are developing and improvise the atmospheric field detection system. The system can be static or dynamic. There are lot of designs related to dynamic system such as automatic weather system, Vaisala ceilometer, and rotating electric field mill. Meanwhile, the static usage to measure the atmospheric field are quite few. The main hurdle for the researcher is the data collection. The collections of experimental data are very crucial for researchers when it came in a bulk or big size of collected data. There are a lot of data logger have been designed, such as development of a low-cost system for temperature monitoring[1], an inexpensive open-source ultrasonic sensing system for monitoring liquid levels[2] and many others[3-6], but these design are only focusing on the usage of one or two sensors only at one time.

1.3 Research Objectives

The objectives to be achieved for the project are:

1. To design and develop a low cost mobile data logger system.
2. To observe and record temperature, humidity and atmospheric electric field magnitude as well as the location.
3. To analyse the performance of the developed device.

1.4 Scope of Study

The designed system developed by using Arduino Uno board environment and also Arduino 1.0.5 open project software. Also, additional supporting circuits are designed. Then, a laboratory test by using function generator carried out to observe the device's capability. Meanwhile to verify the performance of the input modules,

field test is performed. The test covered the performance of GPS, humidity and temperature sensor. The device is enclosed in a prototype box. Only particular sensors will be positioned and shielded properly outside.

1.5 Significant of Study and Original Contribution

The development of low cost mobile data logger device technology for atmospheric field magnitude and recording are still few. It is one the great challenge to explore the new application of multiple implementation of sensors, GPS system and SD Card for multiple type of detections, which is a cost-effective and low maintenance cost for data monitor and logging system. This application will give an additional method to meteorologists and researchers as they can monitor and aware any activity during experiment. The finding can be motivating the further research on utilizing a portable mobile data logger system as a guide for multi-use system. The concept for the project is referring to the temperature, humidity, and also electric field detection of its surrounding.

1.6 Outline of Thesis

For a system to become mobile or portable, the device selection also need to be small in size, easier to carry anywhere. Idea of the project also is referred to a lot of references to get concrete understanding on what the author is doing. By doing some homework and review, it will give the author more comprehensive on the atmospheric detection field. The referred sources are from conference paper, book chapter, journal and thesis.

First of all, a rough sketch of the ideas should be planned. The ideas is transferred in term of circuit drawing. All the input and output are being combined to become as one system. Main circuit of the design is using Arduino Uno Board, consist of an Atmega32 processor. The I/O port of the PIC should be enough for the designed system. The design can be sketched using computer software such as

Proteus ISIS or Orcad Eagle. The author will use Orcad Eagle because it is user-friendly and the component package is mostly complete when designing a PCB.

The next phase is to run a pre-laboratory test. It purpose is to verify the performance of the designed system before it can run it actual test. The test include all the usage of required sensors such as on surrounding temperature, humidity and last with data logging system. When it is confirmed to be used in actual test, which is for atmospheric electric field detection, the system can be used without any problem and hurdle. This phase will be in chapter 4, result and discussion.

The important of the developed system then is concluded in the last phase of the design. The finding can be motivating the further research to develop and improve the utilizing of the system such as add more sensors to get more efficient result.

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