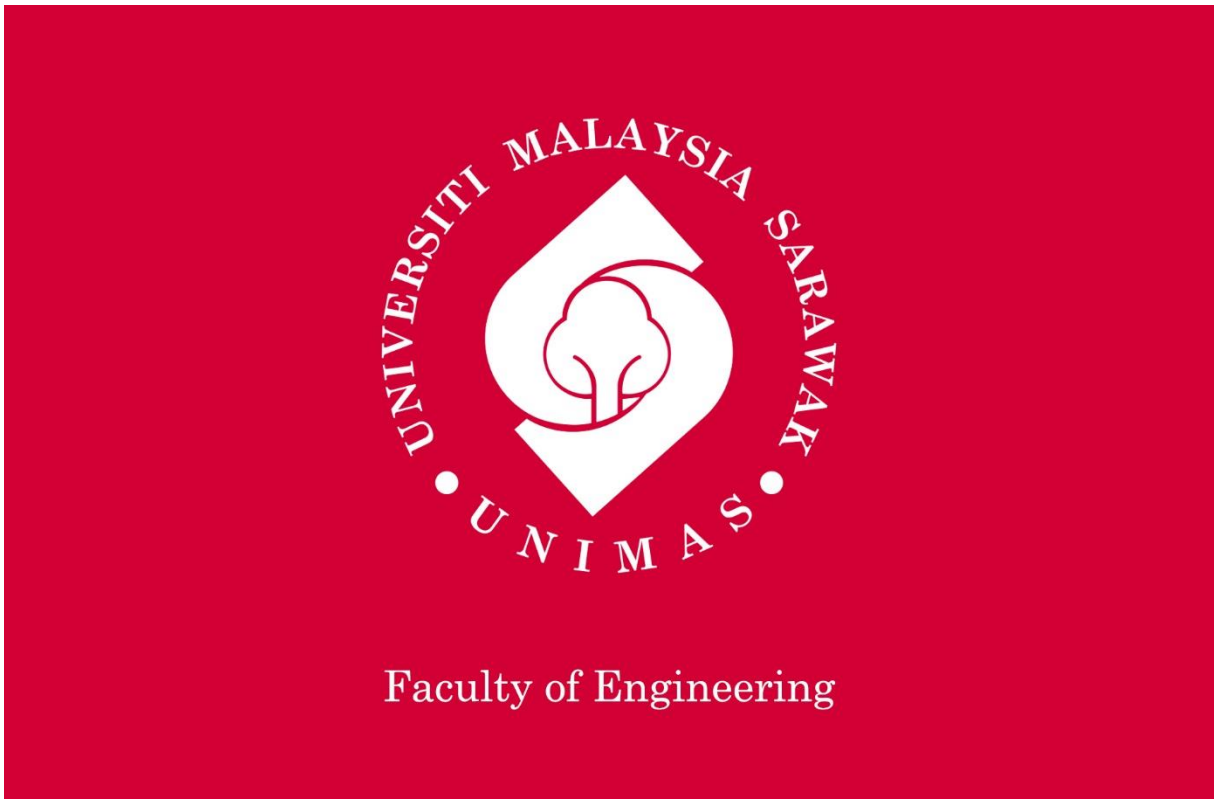

DEVELOPMENT OF SENSOR MEASURING MODULE AS THE PAYLOAD ON UNMANNED AERIAL VEHICLES (UAV) IN ENVIRONMENTAL MONITORING

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Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

2017

UNIVERSITI MALAYSIA SARAWAK

Grade: A-

Please tick (√)

Final Year Project Report ☑

Masters ☐

PhD ☐

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DEVELOPMENT OF SENSOR MEASURING MODULE AS THE PAYLOAD ON UNMANNED AERIAL VEHICLES (UAV) IN ENVIRONMENTAL MONITORING

MUHAMMAD NAZIRUL BIN HAMDAN

A dissertation submitted in partial fulfilment

of the requirement for the degree of

Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

Faculty of Engineering

Universiti Malaysia Sarawak

2017

To my dearest mother, beloved family, lecturers and friends

ACKNOWLEDGEMENT

First of all, I wish my greatest gratitude and praise to Allah SWT for knowledges, experiences and skills that I gained during preparing the thesis and all my effort on completing the report. Without His righteousness, its will be impossible for me to go through all the obstacles and allegations in completing the thesis.

I would like to express my sincere gratitude to Mr. Abang Mohamad Aizuddin bin Abg Mohd Mohtar, my supervisor and Mr. Muhammad Kasyfil Azim bin Mhd Ramzam, from Mechanical and Manufacturing Engineering Department of University Malaysia Sarawak as I feel very thankful for their full support, guidance and constructive criticism to me in order to be a better person and create a remarkable thesis.

My special gratitude to my beloved family, for their support and encouragement especially my mother, Jamaliah Binti Hassan, who never have a doubt in my choices, studies and learnings.

I sincerely thank my lecturers, fellow friends and everyone who supported and helped me from preparing of the thesis until the finishing. Their sharing and presence are very meaningful during my studies in UNIMAS especially in times of misery and distress.

ABSTRACT

A safe and healthy environment is important for human and other living creatures to continue their life without having any troubles or diseases. However, with current technology, several productions and services give a negative impact on surrounding in term of pollutions and damages. Thus, an environmental monitoring is needed to reduce the excessive effects on the environment. Several ways can be used in monitoring the environment depending on the necessary measurement. However, each of the options has their own limitation.

In this thesis, a sensor measuring module was invented for measuring the ambient temperature, humidity and gas (LPG, CO and CH4) concentration. The module is equipped with a microcontroller, a wireless transmitter and several type of sensors to obtain the data measurement from surrounding. The module was designed with a casing as a payload on the drone and fly over the area that inaccessible for human being. The data transmitted from the module to a computer by the wireless transmitter and a graphical user interface was developed for data presentation and analysis.

ABSTRAK

Persekitaran yang selamat dan sihat adalah penting untuk manusia dan hidupan lain untuk meneruskan kehidupan mereka tanpa menghadapi sebarang masalah mahupun penyakit. Walau bagaimanapun, dengan teknologi semasa, beberapa produksi dan perkhidmatan yang tersedia memberi kesan negatif ke atas persekitaran dalam bentuk pencemaran dan kerosakan. Oleh itu, pemantauan alam sekitar amat diperlukan untuk mengurangkan kesan-kesan yang berlebihan terhadap alam sekitar. Beberapa cara boleh digunakan dalam pemantauan alam sekitar bergantung kepada sukatan yang diperlukan. Walau bagaimanapun, setiap pilihan mempunyai had mereka sendiri.

Dalam tesis ini, modul sensor pengukur dicipta untuk mengukur suhu, kelembapan dan kepekatan gas (LPG, CO dan CH4) persekitaran. Modul ini dilengkapi dengan pengawal mikro, pemancar tanpa wayar dan beberapa jenis sensor untuk mendapatkan bacaan data dari sekitarnya. Modul ini direka dengan bekas yang berfungsi sebagai muatan untuk quadcopter dan terbang ke atas kawasan yang tidak boleh dilalui olehmanusia. Data yang diperoleh akan dihantar dari modul ke komputer dengan pemancar tanpa wayar dan antara muka pengguna grafik dibangunkan untuk paparan data dan untuk membuat analisa.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

bps	–	bit per second
Cp	–	constant pressure
Cv	–	constant volume
dBm	–	decibel-milliwatts
°C	–	degree Celsius
°F	–	degree Fahrenheit
e	–	exponent
GHz	–	gigahertz
g	–	gram
P_H	–	Heater consumption
R_H	–	Heater Resistance
T_L	–	Heater Time
V_H	–	Heater Voltage
K	–	kelvin
kbps	–	kilobit per second
KB	–	kilobyte
kg/m^3	–	kilogram per metre cube (density)
km	–	kilometre
kPa	–	kilopascal
R_L	–	Load Resistance
V_C	–	Loop Voltage
MHz	–	megahertz
m	–	metre
m/s	–	metre per second
uA	–	microampere
mA	–	milliampere
mm	–	millimetre
mW	–	milliwatts
N/m^2	–	newton per metre square (stress)
ppm	–	part per million

Pa	–	pascal
%	–	percentage
R_0	–	resistance of gas sensor in fresh air
R_S	–	Sensing Resistance
S	–	Sensitivity
α	–	Slope
V	–	voltage

LIST OF ABBREVIATIONS

3D	–	Three dimensional
AC	–	Alternate current
API	–	Application Programming Interface
AUV	–	Autonomous Underwater Vehicles
CFD	–	Computed Fluid Dynamics
DC	–	Direct current
FOS	–	Factor of Safety
GPS	–	Global Positioning Signal
GUI	–	Graphical User Interface
IAEA	–	International Atomic Energy Agency
IDE	–	Integrated Development Environment
REMUS	–	Remote Environmental Measuring UnitS
RF	–	Radio Frequency
RHT	–	Relative Humidity and Temperature Transmitter
UART	–	Universal Asynchronous Receiver/Transmitter
UAS	–	Unmanned Aircraft System
UAV	–	Unmanned Aerial Vehicles
WSN	–	Wireless Sensor Network
PCB	–	Printed Circuit Board
PLA	–	Poly Lactic Acid
PPM	–	Parts Per Million
SMM	–	Sensor Measuring Module
NTC	–	Negative Temperature Coefficient
CAD	–	Computer Aided Design

CHAPTER 1

INTRODUCTION

1.1 Introduction

Environment plays a very important role for human to live without having any difficulties with health and safety. However, in a world in which technology is developing, has an impact on the environment itself as shown in Figure 1. Several measurement should be taken to minimize the impact of development and manufacturing on environment to avoid any potential hazard that can destroy both; environment and humanity. Thus, a new method or way needs to be developed in order to monitor the environment with reliable data and good efficiency.

Figure 1: Impact to environment (water pollution) from factory

Unmanned Aerial Vehicles (UAV) or in commercial name, drone was one of technology that had been developed with variety of features from military to a hobby. In market, the drone price can reach from hundreds to thousands of ringgit depending on their specification. For example, a new drone introduced by DJI, a drone named Mavic Pro as

shown in Figure 2, which can be folded into a size of a book has a price roughly around RM4000. There also different drone products produced by DJI such as Phantom series, one of their main production series in the market.

Figure 2: Mavic Pro, a foldable drone produced by DJI

In addition, it still has some more room for the drone to be developed for environment monitoring purpose. Therefore, in this project, a sensor measuring module is developed as one of drone attachment for environmental monitoring.

1.2 Problem Statements

Even without drone, there are several conventional methods that existed for environmental monitoring. Nevertheless, these methods had critical limitation such as topography of the earth that had uneven ground will give difficulty on helicopter or a survey team to arrive at designed area. Even more, there is satellite imaging for visual monitoring, but having use the satellite system will be very expensive. Besides, the visual taken might has low resolution which is hard to use in analysis.

Thus, by using drone for environmental monitoring, the limitations on current conventional methods can be overcome. As the payload of the drone, a sensor measuring module capable to measure the parameter of the surrounding and simultaneously transmit data to provide real time monitoring while the drone is flying.

1.3 Objectives

The objectives of the project are;

i. To develop a drone system that can be used in environmental monitoring.
ii. To design sensor measuring module's payload that can be attached/detached (portable) on UAV.
iii. To determine the performance and reliability of the sensor measuring module and improvise the system in environmental monitoring.

1.4 Limitation of the Project

i. As the UAV is not a self-built drone, the functions and capabilities of the drone are limited to the specification that had been set by the manufacturer.
ii. For the sensors also depends on the range set by the manufacturer to avoid any damage or errors in taking reading and data collection.

CHAPTER 2

LITERATURE REVIEW

2.1 Environmental Monitoring

Environmental monitoring characterized as the procedures and exercises including to describe and evaluate the nature of the earth. It is utilized as a part of the arrangement of ecological effect evaluations, and now and again which includes human activities those conveying a danger of unsafe consequences for the common habitat.

In thesis by Bader (2011), environmental monitoring can mean the monitoring of any kind of environment, frequently interpreted as the study of natural environments by collection of data as the foundation to enables a better understanding. Environmental monitoring attempts to analysis of a representative sample of the environment determine the status of a changing environment. All things considered, information procurement shapes a noteworthy piece of environmental monitoring. The information obtaining framework being used needs to consider the collection of representative data, which incorporates concerns (Figure 3).

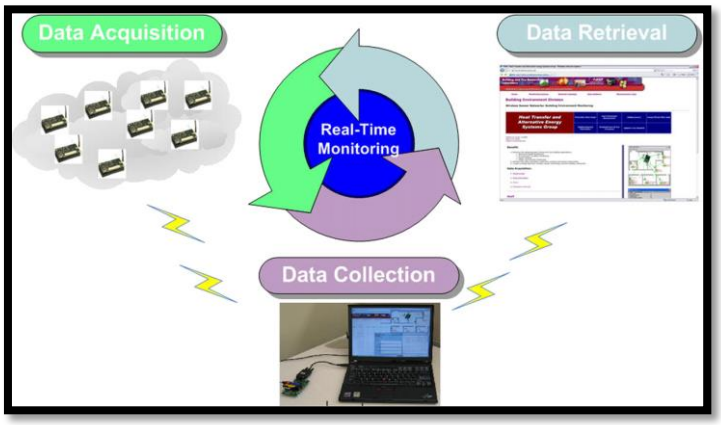

Figure 3: Application diagram for a building monitoring system

2.2 Wireless Sensor Network

In article by Jang, Healy, & Skibniewski (2008), wireless data communication between the sensor and a capacity area opens up a scope of conceivable outcomes in view of the straightforwardness and the minimal effort by which the sensors can be positioned. Significant time savings can be obtained in setting up the sensors where no physical signal wires installation are needed through various parts of a constructed building. At the centre of the system is the wireless sensor device. This piece of equipment includes of the physical sensors, a microcontroller to analysis and generate the data message, a radio frequency transmitter to deliver the data, and a power source.

As mention in article by Lambebo & Dc (2014), the application of WSN for environmental monitoring has been studied in the writings. In the paper, the implementation and testing of a real time environmental monitoring system capability of measuring temperature and greenhouse gas concentration levels including CO, CO2 and CH4 levels is presented by using wireless sensor networks. A ZigBee wireless communication module, based on IEEE 802.15.4, is used as the wireless communication unit in the sensor nodes as shown in Figure 4. The collected information is made accessible to the client through a realistic application programming interface (Programming interface). The composed system is appropriate for the checking of temperature and gases in distribution centers and processing plant settings.

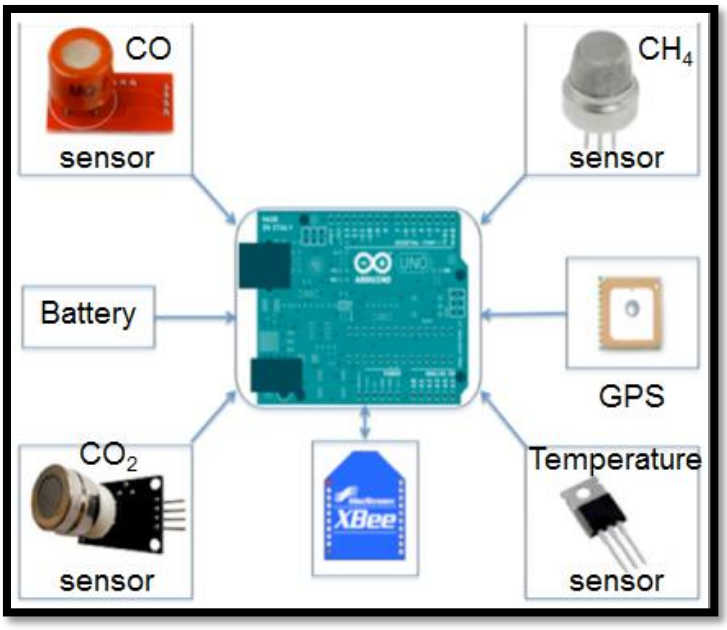

Figure 4: Structure of transmitter node

2.3 Graphical User Interface

From Martinez (2011), A GUI (pronounced ‘gooey’) is one of a way to interact and communicate between humans and computers. GUIs take advantage of the graphics abilities of computers by hiding the parts of the programming language from the user to make the communication easier. Windows, icons, menus, buttons, drop-down lists, dialog boxes, and more, as are use as means for communication between humans and computers. These graphical widgets are usually triggered when the user operates them with a mouse and keyboard (Figure 5).

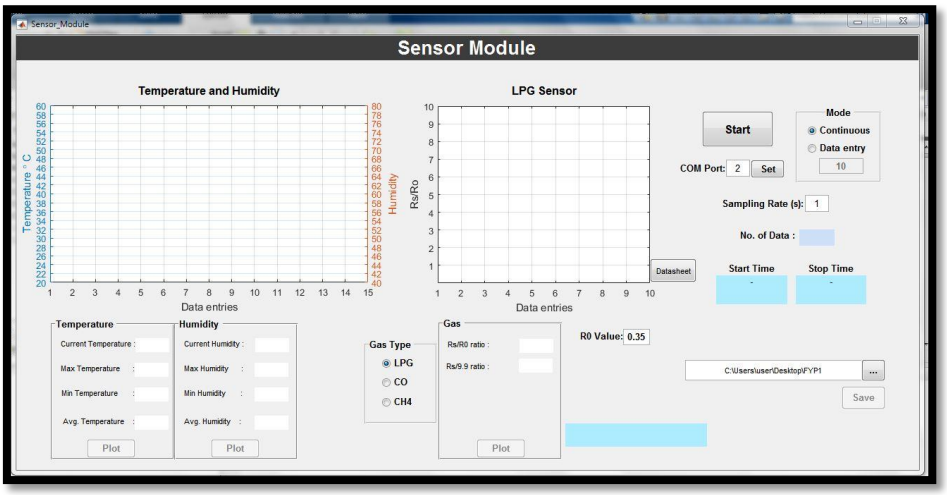

Figure 5: Graphical User Interface by using Matlab

GUIs are ordinarily occasion driven, which implies that some undertaking is performed at whatever point an occasion is identified, for example, the client tapping on a taskbar button. For instance, PC projects can be opened and executed by tapping on their symbols, or when a menu thing is chosen, pop up boxes can be displayed.

It may contrast a GUI with the command line interface. With command line interface, the client is given a clear screen and an insight. All interchanges with the PC are proficient by means of the console, where orders are entered by the client. The summon line interface accept that the client knows the language required to speak with the PC and to accomplish the assignments. A few cases of order line interfaces are the MS-DOS and Linux (in comfort mode) working frameworks (Martinez, 2011).