

**ANALYSIS OF SENSOR ACCURACY ON IOT BASED PADDY
CROPPING MONITORING SYSTEM**

WOO YING YEE

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**ANALYSIS OF SENSOR ACCURACY ON IOT BASED
PADDY CROPPING MONITORING SYSTEM**

WOO YING YEE

**This report is submitted in partial fulfilment of the requirements
for the degree of Bachelor of Electronic Engineering with Honours**

**Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka**

2019

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Analysis of sensor accuracy on IoT based paddy cropping monitoring system
Sesi Pengajian : 2018/2019

Saya WOO YING YEE mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

SULIT*

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD*

(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.)

TIDAK TERHAD

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: Y25,KAMPUNG
BATU 12,JLN
BIDOR,36020
TELUK INTAN,
PERAK.

Tarikh : 31 MEI 2019

Tarikh : 31 MEI 2019

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

DECLARATION

I declare that this report entitled “Analysis of sensor accuracy on IoT based paddy cropping monitoring system” is the result of my own work except for quotes as cited in the references.

Signature :

Author :

Date :

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature :

Supervisor Name :

Date :

DEDICATION

To my beloved parents, siblings, and friends.

ABSTRACT

Nowadays, the high demand for rice is one of the issues facing globally. In order to increase the production of the rice, heavy manpower is needed to ensure the environmental parameters of the paddy field are maintain at the optimum level. In the process of monitoring, some of the farmers will complete their daily job base on their experience. However, this may cause them suffer from financial loss and wasting of fertilizer. Thus, a monitoring system based on Arduino Uno as microcontroller was developed to overcome this problem. In this project, a long-range paddy cropping monitoring system based on Arduino Uno and LoRa was developed to monitor a real-time environmental information included surrounding temperature, air humidity, water level and pH value. This system performs the function to monitor the environmental parameters at multiple parts of the paddy field in real time. Then, the system interchanges the data between nodes through the network protocol provided by LoRa in the range of 2 kilometer and upload to the cloud database via GPRS module. When the environment parameters over the threshold value, a notification will send to the user in the form of SMS. In the other hand, analysis of sensor accuracy was study with implementation at Kalman filter technique to the system. Base on the experimental result, LoRa sender will provide a new reading of the environmental

parameters every 5 seconds to the receiver and receiver will upload the reading to the IoT platform every 20 seconds. Besides, the Kalman filter technique has improved the accuracy of the temperature sensor with tolerance $\pm 1\%$ when compare to the actual reading. In conclusion, this monitoring system able to help user improve the production of the paddy field with less man power involve in practice work.

ABSTRAK

Pada masa kini, permintaan yang tinggi untuk beras adalah salah satu isu yang dihadapi oleh global. Demi meningkatkan penghasilan beras, tenaga kerja amat diperlukan untuk memastikan parameter alam sekitar sawah padi dikekalkan dalam julat optimum. Dalam proses pemantauan parameter alam sekitar, sebahagian daripada petani akan menjalankan pekerjaan harian mereka melalui pengalaman. Namun, hal ini akan menyebabkan kerugian kewangan dan pembaziran baja. Oleh itu, satu sistem pemantauan dengan menggunakan Arduino Uno sebagai mikropengawal telah dibangunkan untuk mengatasi masalah ini. Dalam projek ini, sistem pemantauan padi jarak jauh dengan menggunakan Arduino Uno dan LoRa telah dibangunkan untuk memantau maklumat parameter persekitaran semasa termasuk suhu, kelembapan udara, paras air dan nilai pH. Sistem ini dipasang pada beberapa bahagian sawah padi untuk melaksanakan fungsi bagi memantau parameter alam sekitar semasa. Kemudian, sistem ini akan menukar data antara nod dalam lingkungan 2 km melalui protokol rangkaian yang disediakan oleh Lora dan memuat naik data tersebut ke pangkalan data melalui modul GPRS. Apabila persekitaran parameter melebihi nilai tertentu, notifikasi akan dihantar kepada pengguna dalam bentuk SMS. Selain itu, analisis ketepatan sensor telah dijalankan dengan pelaksanaan penapis Kalman. Berdasarkan keputusan eksperimen, penghantar Lora akan memberikan bacaan baru parameter alam sekitar kepada penerima setiap 5 saat dan penerima akan memuat naik bacaan tersebut ke platform IOT setiap 20 saat. Selain itu, teknik penapis Kalman telah

meningkatkan ketepatan sensor suhu dengan toleransi $\pm 1\%$ apabila dibandingkan dengan bacaan sebelum. Sebagai kesimpulan, sistem pemantauan ini dapat membantu pengguna meningkatkan penghasilan sawah padi dengan mengurangkan tenaga kerja.

ACKNOWLEDGEMENTS

First of all, I am grateful to the God that giving me a good health along the duration completing my project and thesis. Next, I would like to express my depth gratitude to Faculty of Electronic and Computer Engineering for giving me an opportunity to study the knowledge of engineering.

Besides, I am highly indebted to my supervisor Dr. Abd Shukur Bin Jaafar for the continuous support for my degree study and project. He always giving me guidance and advises from the beginning of the project until the completion of this report.

Other than supervisor, I would like to thank to my panels of my final year project Dr.Imran Bin Mohd Ibrahim and Mr A.Nasoruddin Bin Mohamad for giving me some suggestions to improve my project and thesis writing. I also like to offer my special thanks to technicians Mr. Imran Bin Mohamed Ali who guide me in the fabrication process.

Last but not least, I wish to thanks my parents and my lovely friends who give me support and encouragement during my study life. I would like to thanks my course -mates who have helped me along the work complete.

TABLE OF CONTENTS

Declaration	
Approval	
Dedication	
Abstract	ii
Abstrak	iv
Acknowledgements	vi
Table of Contents	vii
List of Figures	xii
List of Tables	xiv
List of Symbols and Abbreviations	xv
List of Appendices	xvii
CHAPTER 1 INTRODUCTION	1
1.1 Background of project	1
1.2 Problem statement	3
1.3 Objective	4
1.4 Project Scope	4

1.5	Organization of Thesis	5
1.5.1	Chapter 1: Introduction	5
1.5.2	Chapter 2: Literature Review	5
1.5.3	Chapter 3: Methodology	6
1.5.4	Chapter 4: Result and Discussion	6
1.5.5	Chapter 5: Conclusion and Suggestion	6
	CHAPTER 2 BACKGROUND STUDY	7
2.1	Traditional Method Used for Paddy Monitoring System	8
2.2	Related project	9
2.2.1	Paddy Crop Field Monitoring System by Using Zigbee Network.	9
2.2.2	Monitoring System Using Automatic Tracking Solar Power Panel.	10
2.2.3	Paddy Monitoring System by Using Microcontroller Raspberry Pi.	11
2.2.4	Paddy Monitoring System Work Under Movable Server.	12
2.3	Effect of Environmental Parameters to The Growth of Paddy Field	13
2.3.1	Air Temperature	14
2.3.2	Air Humidity	14
2.3.3	Water Level	15
2.3.4	Potential Hydrogen (pH)	16
2.4	Sensors	17
2.4.1	Temperature and Humidity Sensor	18

2.4.2	Water Level Sensor	19
2.4.3	pH Sensor	20
2.5	Microcontroller	21
2.5.1	Arduino Uno R3	22
2.6	GSM SIM 900A	23
2.7	Internet of Things (IoT)	24
2.7.1	Bluetooth	27
2.7.2	Zigbee	27
2.7.3	Sigfox	28
2.7.4	LoRaWAN	28
2.8	LoRa Bee 433MHZ	29
2.8.1	Specification	29
2.9	Method to Improve Accuracy of Sensor Value	30
2.9.1	Kalman Filter	30
CHAPTER 3 METHODOLOGY		32
3.1	Overall Project Development	32
3.1.1	Project Flow Chart	33
3.1.2	Block diagram of the system	36
3.1.3	System Flow Chart	38
3.2	Software Development	41

3.2.1	Arduino Software	41
3.2.1.1	Project Code Description	41
3.2.1.2	Code Design of Air temperature and Humidity Sensor	42
3.2.1.3	Code Design of Water Level Sensor	44
3.2.1.4	Code Design of Potential Hydrogen (pH) Sensor	46
3.2.1.5	Code Design of LoRaBee 433 Module	48
3.2.1.6	Code Design of GSM SIM 900A Module	48
3.2.2	Thingspeak	50
3.2.3	Matlab	51
3.2.3.1	Kalman Filter Algorithm	52
3.2.3.2	Code Design of Kalman Filter in Matlab Software	54
3.3	Circuit Development	54
CHAPTER 4 RESULTS AND DISCUSSION		57
4.1	Introduction	57
4.2	Analysis of the sensor	57
4.2.1	Temperature and Humidity Sensor	58
4.2.2	Water Level Sensor	61
4.2.3	pH Sensor	62
4.3	Prototype Design	63
4.4	Kalman Filter Analysis Result	67

	xi
4.5 Sustainability and Environment	68
CHAPTER 5 CONCLUSION AND FUTURE WORKS	71
5.1 Conclusion	71
5.2 Recommendations and Suggestions	72
5.2.1 Improvement on Input Power Supply	72
5.2.2 Improvement on Processor	73
5.2.3 Improvement on Output Data Display	74
5.2.4 Improvement on Network Protocol	75
REFERENCES	76
APPENDICES	78

LIST OF FIGURES

Figure 2.1: Insight view of temperature and humidity sensor.	18
Figure 2.2: Overview of the Arduino Uno board.	22
Figure 2.3: The pin mappings of Arduino Uno[18]	23
Figure 2.4: Overview of the GSM SIM 900A.	24
Figure 2.5: Survey of potential economic impact of size IoT application	26
Figure 2.6 : The pin mapping for LoRa Bee 433Hz	29
Figure 3.1: Overall project flowchart.	33
Figure 3.2: Flowchart of analysis of accuracy of the sensor.	35
Figure 3.3: Block diagram transmitter part	36
Figure 3.4: Schematic diagram of transmitter	36
Figure 3.5: Block diagram receiver part.	37
Figure 3.6: Schematic diagram of receiver	37
Figure 3.7 Library of temperature and humidity sensor inserted to system.	43
Figure 3.8: Code Arduino Uno read temperature and humidity value	44
Figure 3.9: Define the output pin for ultrasonic sensor	45
Figure 3.10: Ultrasonic sensor code when detecting the water level.	46
Figure 3.11: Code pH sensor read pH value.	47

Figure 3.12: Code to set up LoRa in sender and receiver part.	48
Figure 3.13: Code to upload data to Thingspeak Channel	49
Figure 3.14: Set the user phone number for alert message	50
Figure 3.15: Example code for 2 conditions to send the alert message.	50
Figure 3.16: Thingspeak channel for project.	51
Figure 3.17: Algorithm of Kalman filter	53
Figure 3.18: Layout Proteus for transmitter part.	55
Figure 3.19: Receiver layout in Proteus.	55
Figure 3.20: Step of fabrication.	56
Figure 4.1: Comparing the reading DHT 22 sensor with standard digital thermometer.	59
Figure 4.2: Comparing sensors reading and standard digital thermometer.	60
Figure 4.3: Comparing the sensors reading with standard air humidity instrument.	60
Figure 4.4: Comparing reading ultrasonic sensor with standard tape measure.	62
Figure 4.5: Output voltage of pH electrode against pH value of the solution.	62
Figure 4.6: Overview of the paddy monitoring system.	63
Figure 4.7: Circuit connection of sender part.	64
Figure 4.8: Sensors reading update each 5 seconds in sender part.	64
Figure 4.9: Circuit connection of the receiver part.	65
Figure 4.10: Data receiver by LoRa in receiver part.	65
Figure 4.11: Data successful upload to Thingspeak with GSM module.	66
Figure 4.12: Message send from GSM module when water level is low and pH value is acidic.	67
Figure 4.13: Reading of the sensor and reading after apply Kalman filter.	68

LIST OF TABLES

Table 2.1 Classification of suitability classes of maximum temperature and relative humidity for growth of paddy field[14]	15
Table 3.1: Specification of DHT11, DHT22, LM 35.....	42
Table 3.2: Features of HC-SR04, Seeedstudio PING sensor AND Maxbotic LV-Max Sonar EZI(MB1010).	44
Table 3.3: Characteristics of pH sensor (SEN0161)	46
Table 3.4: Relationship between the output voltage and pH value.....	47
Table 4.1: Specification of standard digital thermometer.....	58

LIST OF SYMBOLS AND ABBREVIATIONS

IoT	:	Internet of Thing
GPRS	:	General Packet Radio Service
SIM	:	Subscriber Identity Card
SMS	:	Short Message Service
GSM	:	Global System of Mobile
pH	:	Potential of Hydrogen
LoRa	:	Long Range
LPWAN	:	Low Power Wide Area Network
LoRaWan	:	Long Range Wide Area Network
MCMC	:	Malaysia Communication and Multimedia Commission
LCD	:	Liquid crystal Display
ADC	:	Analog to Digital converter
DAC	:	Digital to analog converter
3G	:	Third generation of Wireless Mobile Telecommunications Technology
LAN	:	Local Area Network
NTC	:	Negative Temperature Coefficient
CTD	:	Conductivity, Temperature and Depth
RAM	:	Random Access Memory

ROM	:	Read Only Memory
CPU	:	Central Processing Unit
RTC	:	Real time clock
PWM	:	Pulse Width Modulation
USB	:	Universal Serial Bus
IDE	:	Integrated development environment

LIST OF APPENDICES

Appendix A: LoRa Bee 433MHz datasheet	78
Appendix B: DHT 22 Temperature and Humidity sensor datasheet	79-87
Appendix C: Ultrasonic sensor HC-SR04	88-89
Appendix D: pH sensor SEN0161 datasheet	90-93
Appendix E: Coding sender	94-99
Appendix F: Coding receiver	99-105
Appendix G: Coding Matlab	105-107

CHAPTER 1

INTRODUCTION

1.1 Background of project

From the year 2017's, population of Malaysia recorded at 32 million and increase to 32.4 million in year 2018. The population growth around 1.1% each year[1]. The increasing of the population in Malaysia will cause the food consumption increases. In fact, most of the people who stay in Malaysia will always choose rice as their first choice of the food. In this case, population increase will cause the rice demand increase.

In order to increase the production of paddy field, a monitoring system should introduce to the agricultural field. This system should consists of a few parameters of the paddy field to observe and analyze the growth of paddy field. Besides, the

monitoring system can implement the concept of internet of thing (IoT) to ease the researches and farmers during monitoring and obtaining the data. These features will maximize the crop of paddy field with minimum resources such as water and fertilizer used.

Internet of thing (IoT) is data collecting from the world through network device or router that connected and ability of sensing and collecting the data and then share the data across internet to cloud which certain people can read the data for various purposes. The continuous growth of technology and internet in the world, the versatility of Internet of thing (IoT) has become more popular. Internet of thing (IoT) was applied into various fields such as industry automation, smart cities, health care and smart agriculture.

Since the application of Internet of thing (IoT) demand is very high among the community, this project is applied in agricultural field which is paddy monitoring system. The implementation of Internet of thing (IoT) will help user to monitor the condition of paddy field all the time. This can improve the quality and quantity of yield. The monitoring system include a few physical parameters such as water level, pH level of the soil, temperature and air humidity of the paddy field. The data collect from different sensors will be read by microcontroller and transmit to another node by implement the concept of long-range technique and upload the data to cloud database via internet base on General Packet Radio Service (GPRS) network. At the same time, an alert message will be sent to user via Short Message Service (SMS) once the parameters excess or less than the threshold value.