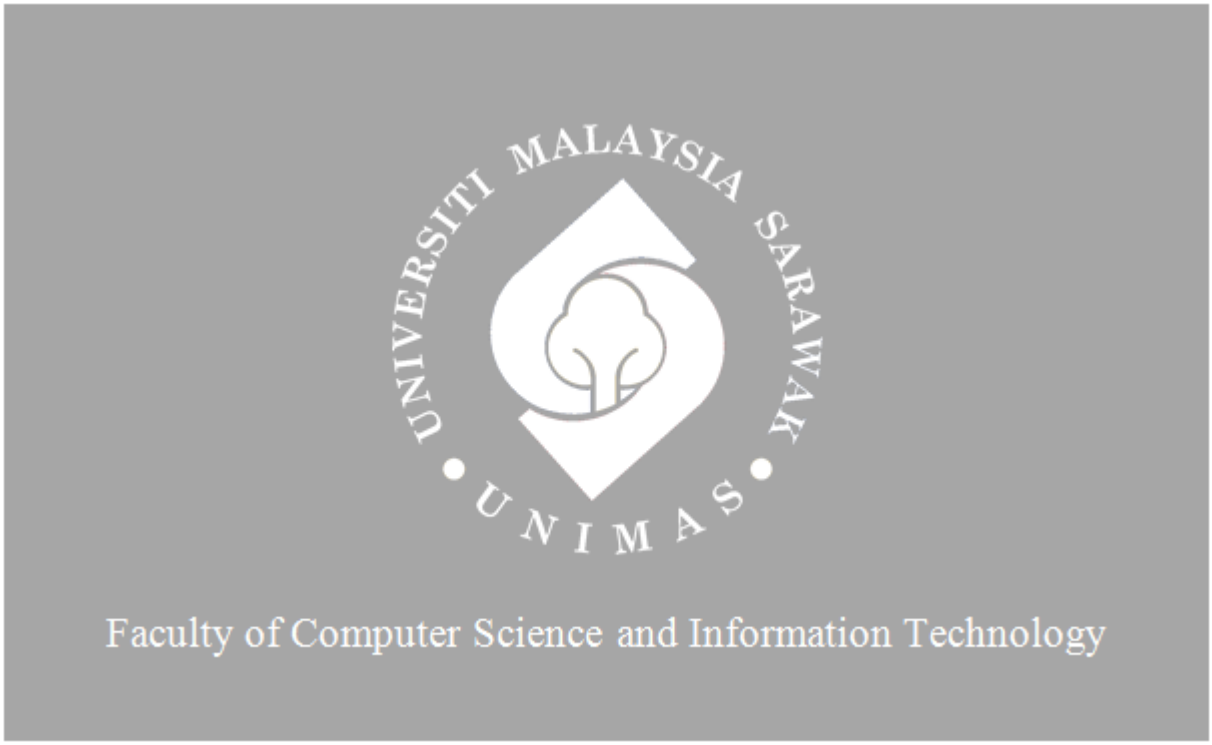

Arduino-based Gamification Tool for Multipurpose Usage in Teaching and Learning at Rural Schools.

Teng Jun Fei

54071

Bachelor of Computer Science with Honours

(Network Computing)

2019

Arduino-based Gamification Tool for Multipurpose Usage in Teaching and Learning at Rural Schools.

TENG JUN FEI

54071

This project is submitted in partial fulfillment of the

Requirements for the degree of

Bachelor of Computer Science with Honours

(Network Computing)

Faculty of Computer Science and Information Technology

UNIVERSITI MALAYSIA SARAWAK

2019

UNIVERSITI MALAYSIA SARAWAK

THESIS STATUS ENDORSEMENT FORM

TITLE ARDUINO-BASED GAMIFICATION TOOL FOR MULTIPURPOSE USAGE IN TEACHING AND LEARNING AT RURAL SCHOOL.

ACADEMIC SESSION: 2018/19

TENG JUN FEI

(CAPITAL LETTERS)

hereby agree that this Thesis* shall be kept at the Centre for Academic Information Services, Universiti Malaysia Sarawak, subject to the following terms and conditions:

1. The Thesis is solely owned by Universiti Malaysia Sarawak
2. The Centre for Academic Information Services is given full rights to produce copies for educational purposes only
3. The Centre for Academic Information Services is given full rights to do digitization in order to develop local content database
4. The Centre for Academic Information Services is given full rights to produce copies of this Thesis as part of its exchange item program between Higher Learning Institutions [or for the purpose of interlibrary loan between HLI]
5. ** Please tick (√)

☐	CONFIDENTIAL	(Contains classified information bounded by the OFFICIAL SECRETS ACT 1972)
☐	RESTRICTED	(Contains restricted information as dictated by the body or organization where the research was conducted)
☑	UNRESTRICTED	

(AUTHOR'S SIGNATURE)

Permanent Address

NO18, JALAN INDAH 12/3,
TAMAN BUKIT INDAH, 81200
JOHOR BAHRU, JOHOR.

Date: 13/5/2019

Validated by:

(SUPERVISOR'S SIGNATURE)

TERRIN LIM
Lecturer
Faculty of Computer Science and Information Technology
Universiti Malaysia Sarawak

Date: 14/5/19

Note * Thesis refers to PhD, Master, and Bachelor Degree
** For Confidential or Restricted materials, please attach relevant documents from relevant organizations / authorities

DECLARATION OF ORIGINALITY

I hereby declare that this research together with all of its content is none other than that of my own work, with consideration of the exception of research-based information and relative materials that were adapted and extracted from other resources, which have evidently been quoted or stated respectively.

Signed,

…….

TENG JUN FEI

Faculty of Computer Science and Information Technology 14/5/2019

University Malaysia Sarawak.

ACKNOWLEDGEMENT

Hereby, I would like to express my deepest appreciation to all those who provided me the possibility to complete this Final Year Project. A special gratidude gives to my Final Year Project supervisor, Mr Terrin Lim, whose contribute a lot in stimulating suggestion, solution and encouragement to help me coordinate my project and writing this report.

Besides, I would like to acknowledge Final Year Project Coordinator, Dr Wang Yin Chai for conducting workshop and briefing to guide in completing my Final Year Project.

Furthermore, I would like to thank my parents for their mental support, give me advise and motivation when I stressed out.

I would also like to acknowledge my lectures and friend that give me related idea and useful information. Last but not least, my grateful acknowledgment gives to the public journals, articles, websites and conferences that provide review and knowledge for my Final Year Project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLE

ABSTRACT

The purpose of the project is to develop an Arduino-based gamification tool for multipurpose usage in teaching and learning at rural schools. In fact, rural schools that do not receive fair share of education funding directly lead to lack of basic infrastructure, no clean water supply and no 24-hour electricity supply. Thus, student in rural school eventually do not have chances to access to latest technologies to aid in learning. With the problem statement, the objective for the project is to develop a gamification prototype system using Arduino to learn physic STEM topics, develop an interactive interface to facilitate student's learning in the topics and also create a low energy mini-projector/OHP as a solution to electricity deficient areas. Gamification through education is one of the great innovative technique that used to improve quality of education. Gamification is a way uses game thinking and game mechanic in a non-game context to engage user's involvement. Gamification in education will motivate student in learning process and improve classroom interaction and engagement. This gamified prototype is developed using Arduino which acts as mini projector and also an overhead projector. Hence, student in rural schools able to learn STEM physic subject in Light reflection and refraction in a more interactive way. The prototype is tested at semi rural schools Sarawak and the feedback collected from the teachers and students is good and met expectations.

ABSTRAK

Tujuan projek ini ialah manghasilkan alat Arduino yang pelbagai penggunaan untuk menagajar dan belajar di Kawasan kampung. Sebenarnya, Kawasan kampung tidak menerima kewangan Pendidikan yang adil dari pihak kerajaan. Oleh itu, sekolah di kampung tidak ada kuasa elektrik, air yang bersih dan asas infrastruktur. Secara langsungnya, pelajar di sekolah kampung tidak ada peluang untuk mengakses teknologi terbaru. Projek ini dapat membantu pelajar sekolah kampung untuk belajar laksatif, menarik minat untuk belajar tentang pantulan dan pembiasan cahaya.

CHAPTER 1: INTRODUCTION

1.1 Project Title

Arduino-based Gamification Tool for Multipurpose Usage in Teaching and Learning at Rural Schools.

1.2 Introduction

Nowadays, one of the breakthroughs and development of our society is the incorporation of modern technology into education. Technology has been in schools in decades, but the evolution of technology like projectors, typewriters, OHPs and chalk boards play an important role in education in our country. Traditional education bound to be evolved with new learning models and technology available. Technology provide personalized learning models which can accommodate unique learning styles. Many schools utilizing gamification in the learning models. The collision of playing and learning makes difficult subject more interactive and interesting. Through the digital transformation and the evolution of the education technology, many schools have making radical change in form of education methods and models, instruction, assessment and even the physical of classroom. Schools are providing computers and devices to the student in the classroom now. Thus, student will not need to bring own device and no longer need to go to the computer lab for access to the computer. With all this progression, but still most of the rural schools in Sarawak is using traditional education methods and not yet access to the latest technology.

Rural school play key role in educate people in rural areas. However, government is still paying less attention to the rural school. (Theobald, 2005) This is due to the office of education is mostly located at urban areas and (Mitra, Dangwal, & Thadani, 2008) the

remoteness of rural schools. (Ling, 2018) The Education, Science and Technological Research Minister said that many rural schools in Sarawak lack of proper infrastructure and basic facilities which 70% of the schools are physically battered and 375 no electricity supply.

To help rural school's student access to some latest technology, An Arduino-based Project is developed for Physics STEM Learning that serves as well as a Mini Projector or an OHP. Due to lack of resources or constrains such as frequent electricity disruptions (or no electricity at all), shortage of basic teaching materials, etc. this proposed prototype would be helpful in assisting in the teaching and learning activities in these rural schools. Firstly, this project is to develop a prototype using Arduino to help student to learn physic STEM topic in a more interactive way. Secondly, it is multipurpose enough to be used as mini projector or an OHP where reusability is widely appreciated by these teachers in remote locations.

1.3 Problem Statement

In fact, student in rural school do not have access to latest technologies to aid in learning STEM subjects. Introducing latest technology to the rural schools will be first step to improve education level and quality in rural schools. Since, electricity in concern in rural areas, a low energy prototype is developed to fulfil the constraint. Besides that, rural schools lack of infrastructure and basic facilities, (Romano, 2014) Arduino boards will be the best choice to develop in rural schools which are relatively cheap compared with another microcontroller platform. Using projector and gamified software in learning class will set up electronic media and virtual learning environments in rural schools which is more interesting compare to traditional education method.

1.4 Scope

- This project in used for Physics STEM Learning in rural school.
- This project mainly focused on Arduino hardware kits and software.

1.5 Objective

To create a gamification prototype for the use in STEM Learning specifically in Physics that has the capability functions as a teaching aid for teachers. Thus, the detailed objectives of this project are as follows:

- To develop a gamification prototype system using Arduino to learn physic STEM topics.
- To develop an interactive interface to facilitate student's learning in the topics.
- To create a low energy mini-projector/OHP as a solution to electricity deficient areas.

1.6 Methodology

Waterfall model referred to as a linear-sequential lifecycle, each phase must be completed before the next phase begin. Figure 1.1 illustrate the different stage of waterfall model.

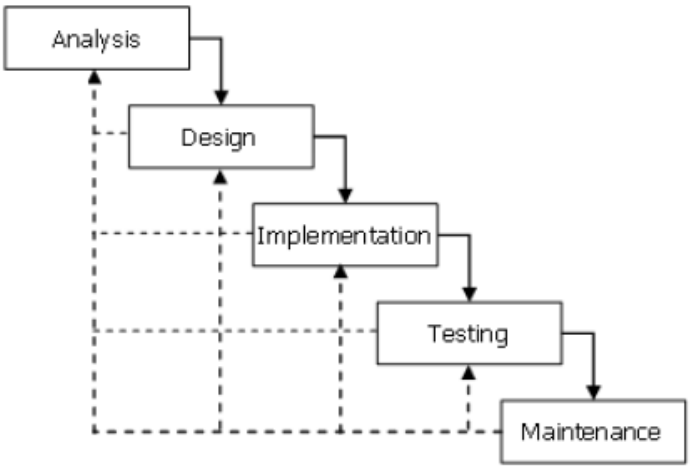

Figure 1.1 (Bassil, 2012) Waterfall model.

At Requirement Analysis phase, gather all the possible requirement of the prototype system to be developed. They requirement is then studied to get more complete understanding.

System Design phase, system design in developed. This phase helps to specify the hardware, software and requirement of the project and develop overall system architecture.

Implementation phase is the phase to start implement the hardware and software of the prototype. Using the system design, the physical prototype, software which is the interface for input, mini projector and the Bluetooth module is then developed. Each of this small program is tested for its functionality.

Testing phase is where all the small program is integrated become the full prototype system. Then the integrated system is tested for faults and failures. Testing of the prototype will be used in semi-rural school to get approval from relevant authorities.

Maintenance phase is where there is some issue from user, the issue is then fixed, and the new patches are released.

Waterfall model is simple and easy to understand. Each phase is processed one at a time. Thus, it is more manageable and works well for small project whereas the requirement is well understood.

1.7 Significance of Project

The significance of this project is to develop a prototype used to learn physics STEM topics which is refraction and reflection of the light for the rural schools. Using the prototype student in rural area have the chance to access to latest technology of Arduino. Besides, this prototype also acts as low energy projector which able to project image from devices. Nowadays, the internet and smart device is widely used. There are a lot of information and knowledge waiting to be explored. Hence, teacher can use the projector to show related information or knowledge from internet to the student. Using technology in education will surely yield twice the result with half the effort and bring huge impact on future pillars of society not just in urban area but also rural area.

1.8 Project Schedule

Table 1.8 Project Schedule

Task	Task Name	Duration	Start	Finish	Predecessors
1	Identity Project Title with Supervisor	3 days	Thu 13/9/18	Mon 17/9/18	
2	Prepare brief project description	9 days	Tue 18/9/18	Fri 28/9/18	1
3	Submission of brief Project proposal	2 days	Mon 1/10/18	Tue 2/10/18	2
4	Approval and comments from examiner and supervisor	5 days	Wed 3/10/18	Tue 9/10/18	3
5	Prepare full proposal	7 days	Wed 10/10/18	Thu 18/10/18	4
6	Submission Final Full Project Proposal	1 day	Fri 19/10/18	Fri 19/10/18	5
7	**Chapter 1: Introduction**	**6 days**	**Sat 20/10/18**	**Fri 26/10/18**	
8	Identity project requirement	2 days	Sat 20/10/18	Mon 22/10/18	6
9	Collect and analysis data	1 day	Tue 23/10/18	Tue 23/10/18	8
10	Identify User and environment	2 days	Wed 24/10/18	Thu 25/10/18	9
11	Submission of chapter 1	1 day	Fri 26/10/18	Fri 26/10/18	10
12	**Chapter 2: Literature Review**	**16 days**	**Sat 27/10/18**	**Fri 16/11/18**	
13	Introduction	2 days	Sat 27/10/18	Mon 29/10/18	11

14	Review on Arduino	4 days	Tue 30/10/18	Fri 2/11/18	13
15	Review on rural schools	3 days	Sat 3/11/18	Tue 6/11/18	14
16	Review on Physic theory	3 days	Wed 7/11/18	Fri 9/11/18	15
17	Review on Education through gamification	2 days	Sat 10/11/18	Mon 12/11/18	16
18	Comparison and reviews on existing system	2 days	Tue 13/11/18	Wed 14/11/18	17
19	Conclusion	1 day	Thu 15/11/18	Thu 15/11/18	18
20	Submission Chapter 2	1 day	Fri 16/11/18	Fri 16/11/18	19
21	**Chapter 3: methodology**	**17 days**	**Sat 17/11/18**	**Sat 8/12/18**	
22	Introduction	4 days	Sat 17/11/18	Wed 21/11/18	20
23	Overview of methodology	2 days	Thu 22/11/18	Fri 23/11/18	22
24	System development life-cycle	3 days	Mon 26/11/18	Wed 28/11/18	23
25	Graphic user interface	2 days	Thu 29/11/18	Fri 30/11/18	24
26	Overall functionality	3 days	Mon 3/12/18	Wed 5/12/18	25
27	Use case model	1 day	Thu 6/12/18	Thu 6/12/18	26
28	Flow Chart	1 day	Fri 7/12/18	Fri 7/12/18	27
29	Submission Chapter 3	1 day	Sat 8/12/18	Sat 8/12/18	28
30	Final Year Project 1	6 days	Sun 9/12/18	Fri 14/12/18	29
31	Submission FYP1 final report	1 day	Sat 15/12/18	Sat 15/12/18	30
32	FYP 1 Presentation	2 days	Thu 20/12/18	Fri 21/12/18	31
33	**Chapter 4: Implementation and testing**	**66 days**	**Sun 23/12/18**	**Fri 22/3/19**	
34	implement the hardware of the system	30 days	Sun 23/12/18	Thu 31/1/19	
35	programming	20 days	Fri 1/2/19	Thu 28/2/19	34
36	debugging	10 days	Fri 1/3/19	Thu 14/3/19	35
37	testing	6 days	Fri 15/3/19	Fri 22/3/19	36
38	**Chapter 5: Conclusion and Future work**	**42 days**	**Sat 23/3/19**	**Mon 20/5/19**	
39	Present system to Supervisor and	2 days	Sat 23/3/19	Mon 25/3/19	
40	Identify new user requirement	3 days	Tue 26/3/19	Thu 28/3/19	39
41	Improving system	18 days	Fri 29/3/19	Tue 23/4/19	40
42	Prepare FYP 2 Full report	4 days	Tue 23/4/19	Fri 26/4/19	41
43	Submission of FYP2 report	0 days	Sat 27/4/19	Sat 27/4/19	42
44	Presentation for FYP2	1 day	Thu 2/5/19	Thu 2/5/19	43
45	Final adjustment of FYP2 Report	12 days	Fri 3/5/19	Sun 19/5/19	44
46	Submission of FYP2 hardcopy	0 days	Mon 20/5/19	Mon 20/5/19	45

Project schedule Gantt chart will be show in Appendix A.

1.9 Expected Outcome

The expected outcome for this project is to build a prototype that can read the input value, move the lens according to the input and perform projection of the image. Therefore, student in rural school able to learn physic STEM topics using Arduino in a more interactive way. The proposed project will consist of two main components:

- Hardware part: Arduino board with Bluetooth module connect to a mini projector which also function as an OHP. Bluetooth module allow the prototype to connect with a Smart Devices.
- Software part: Interactive, Ease-of-Use interface for gamification in learning STEM Physics (light and prism topics).

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, background study and literature review are carried out to total achieve the objective of the proposed project. Some existing system that related to the purposed project has been reviewed to converge the information and comparison with the purposed prototype. Literature review is based on various resources such as journal, article and website to have clear overview of the strength and weakness of existing system and produce solution to improve the purposed prototype. The purpose prototype environment will be Sarawak's rural schools. Thus, the background study for rural school around is reviewed to gather the constraint and requirement for the rural school. In order to ease the teaching and learning in rural school, a gamified STEM physic learning prototype is purposed. To develop a fully functional prototype, research on the Physic theory of the reflection and refraction of the light is fundamental.

Currently, rural schools in Sarawak lack of proper infrastructure and basic facilities which most of the schools are physically battered and without electricity supply. This leads to poor quality and level of education and the student in rural school does not have chances to access with the latest technology. Projector is inconvenient to used which rural area is lack of electricity and spend more expenses on cost. Other than that, student in rural school lack of learning motivation. Gamification is the use of game design and mechanic to enhance non-game context by improve the user participation and engagement. Games in any kind of form increase motivation through engagement. Introduce gamify education in rural school will be helpful to motivate and attract interest of student in learning STEM subject.

Nowadays, there were countless existing gamified education tools, applications and resources. However, some of the requirement and constraint is not suitable in rural areas. Lack

of devices, internet access and electricity supply will be the main constraint to develop the prototype. The purposed project is to develop a prototype system using Arduino to learn Physics STEM subject with interactive interface that include gamification and low energy consumption mini-projector and also an Overhead Projector (OHP).

2.2 Arduino

2.2.1 What is Arduino

(Arduino, n.d.) Arduino is an open-sources electronic platform based on easy-to-use hardware that is used to develop electronic project or prototype. Arduino consist of two part which are the physical programmable circuit board as the microcontroller and the software part call the Integrated Development Environment (IDE). IDE run on computer, used to write and upload code to the Arduino board. Arduino designed to create interactive prototype with the environments. Complete Arduino project or prototype consist of the microcontroller, sensor and the actuator. Arduino sensor module function to react with the environment or the user to retrieve or receive input. Example of sensor: laser sensor, heat sensor, smoke sensor, RFID sensor, etc. Connective modules lie Wi-Fi and Bluetooth module allow Arduino board to have wireless connectivity with other devices. Whereas the actuator like LED board, Servo motor, etc. will produce the result or output.

(Gibb, 2010) In these modern days, Arduino used wisely in microcontroller programming among various type of embedded system and prototype due to its user friendly and ease-to-use settings. Arduino does not need separate hardware in order to load new code into the board unlike most old type programmable circuit board. Programme code can be upload to board via USB cable and Arduino IDE uses simplified version of C++.

2.2.2 the Arduino Hardware and Software

Arduino hardware part which is the Arduino board consist of several component that works together.

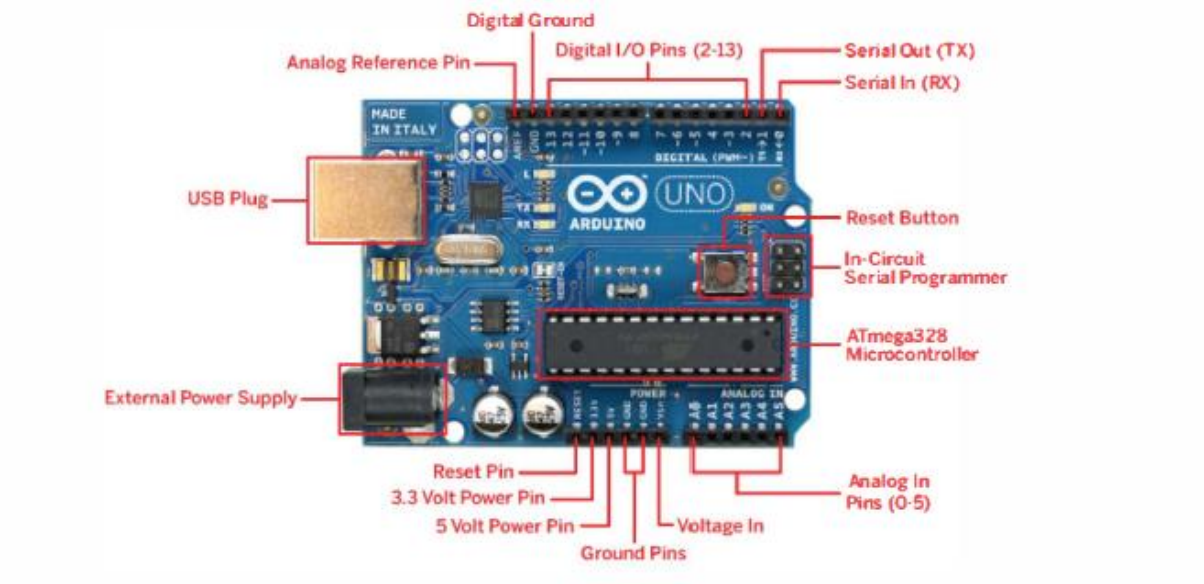

Figure 2.2.1 Arduino board

(Image source: http://arduinoarts.com/what-is-arduino/)

Figure 2.2.1.1 show the image of an Arduino UNO board. The component on the board:

- USB plug: Function as to upload programme code to the microcontroller and regulated voltage of 5 volts.
- External Power Supply: ONLY used to power the board which regulated 9 to 12 volts of power.
- Reset Button: Used to resets the Arduino.
- Microcontroller: The main brain of Arduino which receive/send information/command to the respective circuit.
- Analog Pins: Analog input pins from A0 to A5.
- Digital I/O pins: Digital input or output pin from pins 2 to 13.
- In-Circuit Programmer: Another source to upload programme code.

- Digital and Analog Ground pins (GND)
- Power Pins: one 3.3v pin and one 5v pin.

(Boxall, 2013) The Arduino IDE is a software which act as a set of instruction that communicate and give instruction to the hardware. Arduino IDE consist of three main part:

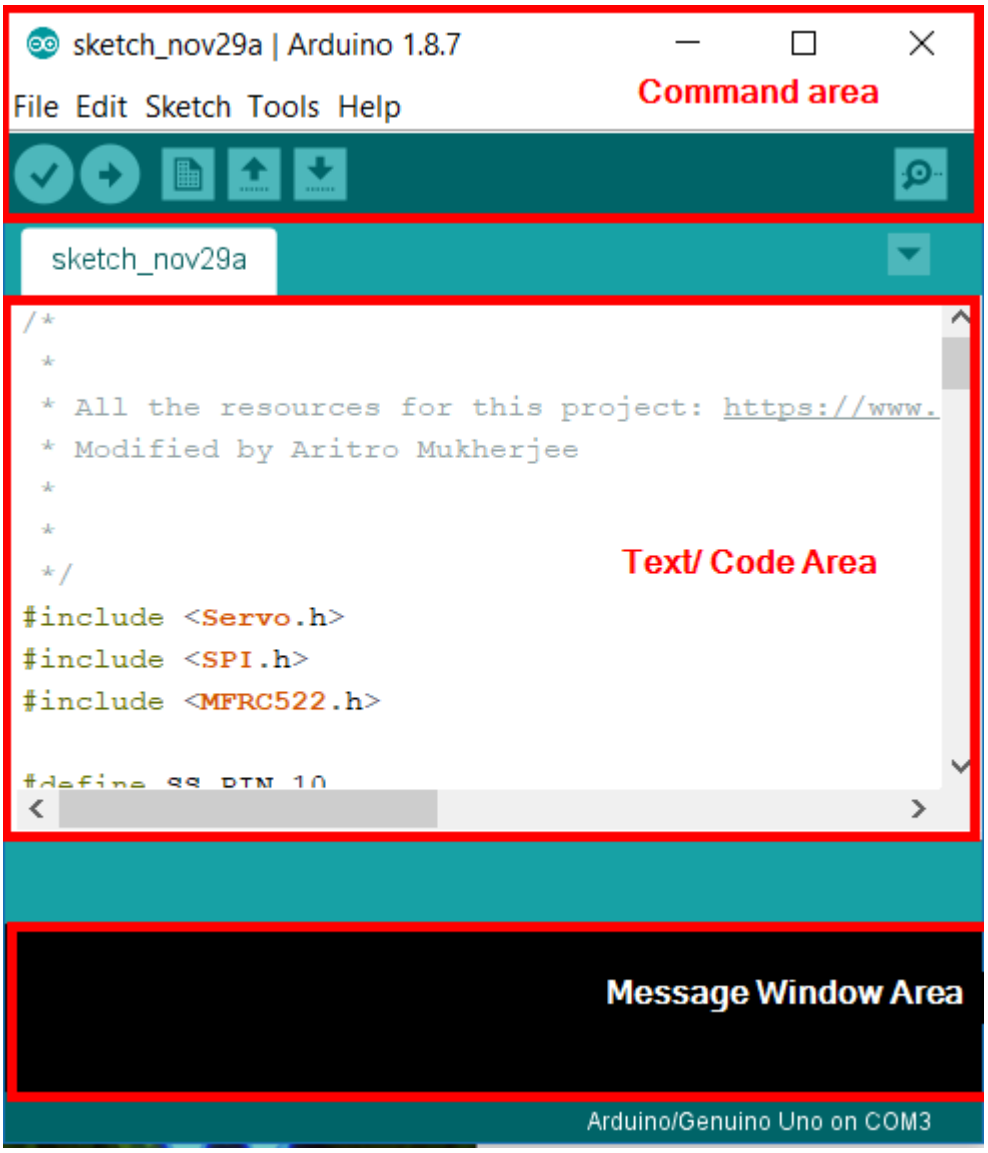

Figure 2.2.1.2 IDE software on PC

- (Yusuf, 2014) Command area – consist of menu item like File, Edit, Sketch, Tools, Help, Verify button for code verification. Upload Button to upload code to the board, New, Open, Save and Serial Monitor which function as passing data between Arduino and the IDE.
- Text Area – place to write code which uses simplified C++ programming language and call as sketch. Two main function in IDE:
    1. Setup function – Initial condition of variable is set, and the preliminary code only run once. Variable must be initialized before setup and assign to used.
    2. Loop routine – Loop that run or execute the main code repeatedly.
- Message Window Area – Verification code and shows error in coding.

2.2.3 History of Microcontroller

Early of 70's, both Intel and Texas instruments started developing the higher integrated microprocessor. (Siewiorek, Bell, & Newell, 1982) Intel continue the development of microprocessor while Texas decided to add built in memory to the microprocessor which become the microcontroller.

Microprocessor is basic for a more powerful computer which need to cooperate with other chips to work. On the other hand, (IEEE, 2014) microcontroller is an all-in-one approach which less rely on other chips but has limited functionality. Starting from develop microcontroller in simple calculators, microcontrollers now can be found in countless electronic devices and embedded systems.

2.2.4 Arduino As a Learning Tool

(Arduino, n.d.) Massimo Banzi is an interaction designer, teacher, maker, bottleneck and also the Co-founder of Arduino. Arduino was founded and formed when Massimo Banzi's student unable to find affordable and efficient microcontrollers for the project. (Arduino, n.d.) Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino and David Mellis which is one of the Banzi's student create the first and very own board and writing the programming language for the board. Arduino soon become popular due to it easy-to-use and does not need much computer programming and electronic knowledge. Thus, Arduino with others type of module would be handful in developing or designing new prototype. (Galadima, 2014) The number of project Arduino can be work on are endless and are limited only by one's imagination.

2.2.5 Why Arduino?

Why use Arduino? What makes it different with others? With countless microcontroller around us, reason for Arduino have been choose in this project is:

- There were active community users of Arduino. Thus, it will be easy to get help on troubleshoot which similar issue might face by others. (Rodriguez, 2014) "What you find is that if you can create a community around an open source project then it becomes really alive because everyone starts to contribute. If you do not have an ecosystem, the platform will not be successful. If you start charging for everything, everything dies very quickly." says Banzi, Arduino Co-founder.
- Arduino would be ideal for newcomer to get start quickly since Arduino was developed in an educational setting.