UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF ELEMENTARY SCHOOL DRONE KIT USING ARDUINO

This report submitted in accordance with requirements of the University Technical Malaysia Melaka (UTeM) for the Bachelor's Degree in Electrical Engineering Technology (Telecommunication) (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial full fillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) (Hons.). The member of the supervisory is as follow:

…….

(Wan Norhisyam Bin Abd Rashid)

ABSTRACT

Quadrotor is one of the famous well known types of Unmanned Aerial Vehicles (UAV) of flying robots. Aerial robotic is the fast growing field robotics and multi-rotor given rapidly growing popularity. This project is focusing on development of elementary drone kit using arduino. This drone will be developing on small scale size and to be controlled on by open source applications. This drone is suitable to be control by elementary student and it a low cost kit. The data collected on analysis behavior of 4 motors and angular speed. The data is taken by using questionnaire on 11 participants who did a pre-test on using this drone kit. Finally, all the recommendation and improvement idea will be concluded at the end of this documentation.

ABSTRAK

Quadcopter adalah salah satu robot kawalan tanpa pemandu yang terkenal di dalam bidang robot udara. Robot udara adalah salah satu cabang bidang robot yang semakin meningkat dan terkenal pada masa kini. Projek ini mengkhususkan dalam mencipta sebuah *Drone* untuk pelajar sekolah rendah dengan mengunakkan mikrokontroller Arduino . *Drone* ini akan dibina dengan saiz yang kecil dan boleh dikawal mengunakkan aplikasi peranti android yang bersifat terbuka.*Drone kit* ini harganya murah dan ianya sesuai untuk di pandu oleh pelajar sekolah rendah .Data keluaran daripada empat motor serta kawalan kelajuan akan di analysis dan d ibincangkan. Maklumat daripada 11 orang pelajar sekolah rendah doperolehi melalu kaedah soal selidik selepas menyertai pre-percubaan kit *drone* ini. Akhir sekali, idea dan cadangan penambah baikan untuk kit *drone* akan disimpulkan pada penhujung dokumen ini.

DEDICATIONS

This report is dedicated to my beloved parents Mr Asri Haron and Mrs Wan Anisah , to my supervisor Mr Wan Norhisyam, kind lecturers and to all friends for their Love, Sacrifice, Encouragement, and Best Wishes.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

PWM	-	Pulse Width Modulation
dB	-	Decibels
°	-	Degree sign
UAV	-	Unmanned Aerial Vehicle
RC	-	Remote Controller
PBL	-	Program Base Learning
GPS	-	Global Positioning System
GUI	-	Graphical User Interfaces
IMU	-	Inertial Measurement Unit
3D	-	Three Dimensions
PID	-	Proportional-Integral-Derivative
DoF	-	Degree-of-Freedom
PCB	-	Printed Circuit Board
ESC	-	Electronic Speed Controller
USB	-	Universal Serial Bus
SDA	-	Serial Data Line
SCL	-	Serial Clock Line
FC	-	Flight Controller
FPV	-	First Person View
Wi-Fi	-	Wireless
SPI	-	Serial Peripheral Interface

CHAPTER 1
INTRODUCTION

1.1 Overview

Quadrotor is one of the famous and well known types of Unmanned Aerial Vehicles (UAV) in flying robots. Basically there are three categories of flying robot. Those three are Drones, UAV and aerial robot. The DRONE is an unmanned aircraft or ship which can be autonomously navigated or remotely guided. Second is the UAV. The UAV (Unmanned Aerial Vehicle) is an air robot which enables it to control by itself. It can be controlled or navigate by flying autonomously based on the pointed location using GPS setup on the air flight plan through computers interfaces. Lastly, aerial robot has almost the same function with UAV but the difference between them is, the functionality of aerial robot depends on the surrounding. The quadrotor system can be defined as the rotary wing system whereby the concept used on the propeller of an aircraft is via the thrust provided by the engine-driven rotors. Thrust will converge by the rotation of blade (propeller) in drone itself. Large scale of drone is like a helicopter, as it enables to carry out large payload.

The words quadrotor is a combination of two words, ―quad" and ―rotor". These two words have their own meaning. Quad means four and rotor means motor. The quad copter or quadrotor robot consist of four rotor and each side of it have own propeller. Usually the frame of drone is on the shape of ‗X'. Previous quadrotor frame is using the ‗+' shape. Quadrotor movement are depending on the motor speed. The hovering of X-shape frame rotor movement will be different in terms of rotation. The front and rear quad motor will rotate counter clockwise and for the left and right

will be rotating towards the clockwise. In order the quadrotor to fly stable, the rotating motor must rotate at the same speed.

There are two methods to control a drone, one is by using radio control (RC) and the other one is autonomous system or autopilot. For manual controlling, there are two elements which are TX (transmitter) and RX (receiver). TX is a remote control whereas the RX is a receiver that mounted on microcontroller board for example at ardupilot and arduino. The remote control (RC) consists up to 9 channels. Channel allocation depends on the price. The advantage of having more channels is it enables user to store multiple drone movement. Movement of quadcopter is based on command by the user. For autonomous movement, it is controlled by flight mission software through computerize equipment. The ground station is setup as a TX whereas the Radio telemetry is the RX that attached at the drone.

Along with growing technologies, the drone technologies were also improved. It can be clearly seen that the drone technology are growing rapidly. Nowadays we can see there are a lot of multiple types or variation of drone such as small scale, camera and etc. The drones also have been widely used in industry for works purpose, for example in telecommunication industry it is used as a cable inspection at high tower. As a result, it can reduce men power and also enhance the safety work regulation. In military system, drone has been widely use. For example, the surveillance camera and also the bomb diffuser. Whereas in public application, the application of drone can be used in search and rescue in an emergency, security of petrol pipe line and etc. Therefore drone should be introduced to the children at early stage of their age. The used of drone in education also will help them in improving their knowledge.

1.2 Problem Statement

Nowadays drone are widely used in industrial sector. In telecommunication field, drone is used to check cable line at high tower. In 5 years ago, drone only used

in military system application where they only focus in surveillance purpose. Drone technology has evolved as it now priced economically enough for user to afford as well as easy enough to use without training. However, the existing drone is not convenient for children. Therefore this idea came out, by introducing suitable drone that enable children‘s (elementary school) to handle easily and it is safe for them to control. The drones is formulated in form of hardware design and the software design. The learning process in developing a drone is difficult to understand which includes hardware and software. Therefore, the controlling system of a quadrotor must be easy to control for learning purpose in education. The controller must have advanced features to handle in windy condition. Besides that, quadrotor must be ensured so that it will only fly within the limit, in other words, it must fly under commanded altitude and position. This problem usually occurred when the drone flying in a too angular position. When wind striking the quadrotor, it will affect the direction which lead to resulting loss of control altitude. The quadrotor must be perfectly fit to children and easy to learn and understand in developing a drone.

Thus, this drone kit is suitable to be exposed for elementary student. This kit will enhance the student skills to build up the drone and enables them to expend their creativity. This project also is to support government policies on developing student in STEM education.

1.3 Objectives

The aim of this project is to develop a module which is suitable to be implemented in S.T.E.M education in Malaysia. Second objective, is to develop drone that is suitable to control by underage kid. The quadrotor must be easy to control by elementary student. Student must be easily plug and play the drone and be able learn to program the drone. With a small scale motor, students can easily handle and connect to the frame handily. Next objective is to develop a simple concept of understanding in developing a drone for elementary student. Nowadays the drone or quad-copter is limited and difficult to learn. As it is complicated in programming and complex wiring circuit make it much more difficult to understand, hence this project

will encounter all those problems. With the help of drone library coding, student can easily program the drone without writing the full coding. The drone is convenient and easy to control as it using android phone with open source application.

1.4 Scope of Study

The focus of the project will be on:

- Development of module including hardware and software for full fill the S.T.E.M education of drone kit.
- Development of small scale drone that suitable to handle by underage kid.
- Development of drone kit using Bluetooth to control as it required to student learning and understand by using open source software.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The drone or quadrotor have shown lot of progressives going on for the system improvement. Nowadays, this Unmanned Aerial vehicle (UAV) can be found in variety of colour, specification, price and system. UAV system also has been upgraded from the remote control to the autonomous system. Each UAV has their own function and were able to perform specific task assigned by the controller (human). UAV can be handled in two methods which is remote control (RC) or control process which can be done autonomously with support from ground through mission planner system at PC (personal computer) in order to lead the navigation system [1]. Drone or also known as quadrotor, are not only limited among the hobbyist but it was also introduced in the job sector or even in military department. One of the beneficial using the drones are it is friendlier user. Apart from that, in any critical situation as in ramping rally protection, wildlife monitor, resources managing or advanced research, a small UAV let the handler to experienced real-life event in purposes of making decision without physically being there. Resulting decision may preserve live and contaminated the protection of the surrounding area [2].

Figure 2.1(a) : Drone using in mapping field

The quadrotor only limited to multiple sectors but this technology has not been exposed to the educational system for the purpose of learning. For some reason, they believe by proposing this technology in education system it will most likely gives decisive feedback on student performance for all related work correspond to STEM [3]. And perhaps in future, the robotic field could be one of the major parts applied in education studies. The difficulties faces in robotics learning are; 1.Tough to captivate by the learner for whom is new in these filed 2. Process of delivering the knowledge to the learner [4]. Hence, it will be wise to flourish this knowledge among student at early of age by giving simplest robotic education as an initiative way to overcome the problem. Rizauddin Ramli in his research paper mention about robot LEGO NXT Mindstorms series (LEGO,2010) of where he used that kind of medium for learning process conducted on student at PERMATA pintar Negara. By using LEGO NXT as a medium communication between student and teacher in learning mathematics, science, technology and engineering will open an opportunity for student in creating their own robot design, encourage and trigger their critical thinking which might be helpful for solving problem in a real-world situation [5]. Generally, robotic knowledge can be defined as tools that give multiple benefits which composed variety type of knowledge (mechanical, electrical, computer science, electronic and technologies) in one single system. In this paper, the main objective focuses on developing elementary school drone kit for the learning purposes. There is multiple of research paper, which shows a successful implementation of robotic kit as an education medium in their learning system.

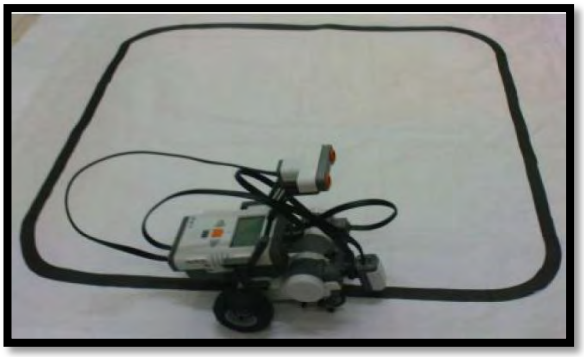

Figure 2.1(b) : Line Follower robot NXT mindstorm.

2.2 Methodology

STEM (Science, Technology, Engineering, Mathematic) will be proposed as a method applied in the control environment of curriculum study. There are several technique used in robot learning that relates with STEM, recorded over the past few years. Donald C. Richter, Hani S. Saad, Martin W. Weiser (2013) in their research paper, they were using PBL (program base learning) as an approaches to teach their engineering student through Robix kit[17]. The process work of applying PBL theoretically and practically need to be continuous in way to let the student get used with the Robix kit. Robix kit consists of servo motor, dc motor and frame body. Mentioned too in the research paper, the students need to construct their own design and program it within 2 weeks. The first activity will be evaluated base on student creativity and their understanding on robotic system using the robix kit. The following week (3-8), a task will be given where student need to control the industrial robot using their own knowledge (programming). Throughout this method, student are assured to gain more experiences and knowledge regarding of robot system. Apart from that, the implied technique will also increase their interest to innovate and explore more on their field of studies rather than relying on the common and old method used in their daily basis studies.

In another research conducted by Emily Hamner and Jennifer Cross (2013), develop an approaches focusing on teachers where they can actually become the innovator to write their own curricular that weaves technology in classroom lesson.

In way to do so, teachers are required to attend 6 week residency courses that cover the usage of hardware component, software environment, robot development, built early Arts and Bots lesson plan for classroom, and test the plan in mock classroom. Followed after that are, 6 week of Educational Robotics for the Classroom which aiming to attract more teachers to get involve and at the same time help them to acknowledge and discover key knowledge and skills required for better and successful implementation in the classroom. Direct instruction on all hardware components contained in the kit, challenges to build a robot through given theme or may so built a robot that were envision by their student and the complexity involve to make it from the visionary perspective into functioning working system are one of the challenges that need to be faced by them. Thus, results an experience gained in manipulating Arts and Bots hardware based on their major of any engineering field. Aside from that, it is necessity for them to make educator understand the full capabilities and limitations of Arts and Bots programming before proceed any further in developing their expected robot design. Sort of way are used to do so where first, educators will have a walkthrough in programming the mini-bot that only consist servo motor with an attached LED. Upon accomplishment of learning mini-bot programming structure, teachers will inherit an experiences and general concept of programming which will then be applied to their own specs system built on the robot. Consequently, this method eliminates many common misconceptions that occur when usually programming were taught right after the robot construction. Elaboration on the courses studies generally brought an understanding where this Arts and Bots program will provide an enhancement of classroom experience collaborate with the implementation of technology for the modern concept in learning process. One of the objectives listed on 2011 by AP computer Science are, student can use computing tool and technique for creative expansion. This particular objective will be one of the reasons why it is necessity to imply this program on student for a better process of learning that fit well with the evolving modern technology era. A close-up example happened in one rural area where, K-8 school implemented this method through given scope which is their historical figures provided by the teacher. And with helps by the teacher, one historical figures form in their creative mind lead up to one robot model creates by the student itself.

The other related works are produced by 6 teachers. In their studies, relevance with learning robotic in classroom environment objective, they came out with an idea of Active Learning Environment with robotic Tangibles (ALERT) [20]. The ALERT is a system where student learned by applying a concept of human – robot interaction and tangible instruction. The idea encourage student to learn from different type activities that combine both play and real-life experience. They used low cost robot and user friendly known as iRobot Create. In order to make it more interactive, the robot was designed with animal ‗cosplay'.

Figure 2.2: Animal design

The robot was attached with camera and an environment interface that can be view from the laptop provided in class. The instructed robot was controlled by placing fiducially markers in interface software (made up by them using Java and Max-MSP) from the computer. Each fiducially will represent own function command robot for example ―forward" and ―backward". The function of this method is to teach geometric concept. The children will be given a task to solve the problem of where they need to program the movement of robot such as performing (draw) triangles. In other words, robots involvement in education and motivation shows an important role play in educational process [21].