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Dualcopter PID Controller

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Abstract: A drone with 2 blades is known as dualcopter. This project is to build a stable dualcopter using PID controller in which it is only can move up and down without a remote control. Arduino UNO is the main components to create self-balancing of the dualcopter. Some practical studies on effect of derivative parameters on the settling time has been done to produce the best three values of PID. The testing of dualcopter to fly in equilibrium has been conducted using three different Derivative value to justify the concept and effect of PID controller in the drone system. Based on the recorded result, PID controller is suitable to be implemented for stabilizing the drone.

Keywords: Dualcopter, PID, Stable

1. Introduction

A drone is described as "an unmanned aircraft or ship steered by remote control or onboard computers," according to multiple definitions from Merriam Webster [1]. In stabilizing the drone from any interruption like wind and to improve its flight time, PID controller is needed in the drone's system. This is because PID controller can make the drone to become more effective and efficient [2]. Therefore, for this project, a simple and useful Dualcopter PID Controller is to be developed in which it can steady in the air and also can determine the settling time by using the derivative parameters. The developed drone in this work can be used for stabilization that can give knowledge about the control system by using Arduino UNO.

Before doing this project, the problems that may be had or faced by the drone should be known. Firstly, drone is unbalanced when flying in the obstacle situations. The drone will be unbalanced when flying in the disturbance situations such as in a high wind speed or even during outdoor flight [3]. Secondly, drone needs the best PID parameters. Therefore, it can become more stable and balance. Lastly, the flight time of drone is short. The drone has the problem of limited flight periods because of the amount of operation energy necessary [4].

The objectives of this project are to build a steady drone that can give a stable impression. Secondly, this project aims to understand the effectiveness of the drone to minimal deflections by using PID controller and finally to analyze the effect of derivative parameters on the settling time.

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This project is built up from a small model of 2 motors and 2 propellers to produce a practical and portable learning model. Other than that, there is not a remote control to control the movement of the dualcopter. Next, only Arduino UNO is used for implementing with the PID controller, which can make the dualcopter to fly equilibrium and balanced by itself. The limitation of this project is the drone is only can move or fly in the direction of up and down and can be stabilized by using PID controller which is used to control the drone.

2. Materials and Methods

Table 1: List of components

No.	Item	Quantity
1	Arduino UNO	1
2	LIPO (Lithium-ion Polymer) battery 2s 4500mAh 45c/90c	1
3	Propeller	2
4	Brushless motor	2
5	Brushless ESC (Electronic Speed Controller) BLheli 20A	2
6	MPU6050 gyro accelerometer sensor module Arduino	1

Table 1 shown the list of components that are used to do the project. Arduino UNO is used to control the PID of balancing the dualcopter meanwhile LIPO battery is used to provide current for the brushless motor. Next, the propellers provide the propulsion to make the dualcopter is able to move up and down through the air while the brushless motors provide the necessary thrust to the propellers. The function of brushless ESC is to control each of the brushless motors and MPU6050 gyro is to measure the orientation of dualcopter.

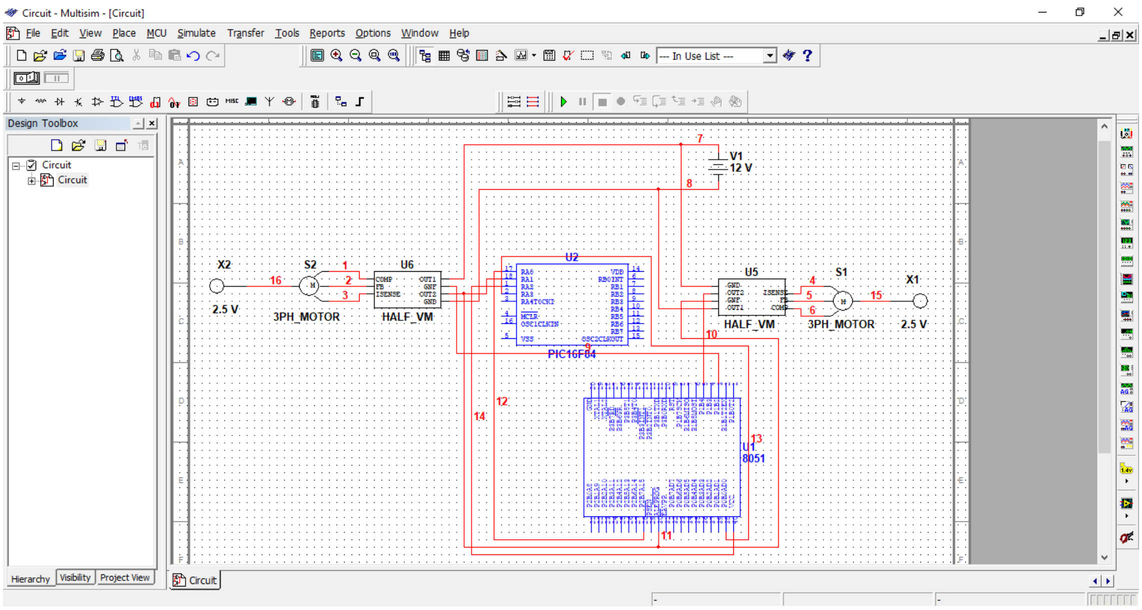


Figure 1: Multisim

Figure 1 shown the software of Multisim. This software is used to design the circuit roughly. **Figure 2** shown the software of Arduino 1.8.15. This software is used to write the code of Arduino and then save and upload the code into the Arduino. On the other hand, there are hardware development processes that involved in this project as showed in part in **Figure 3**.

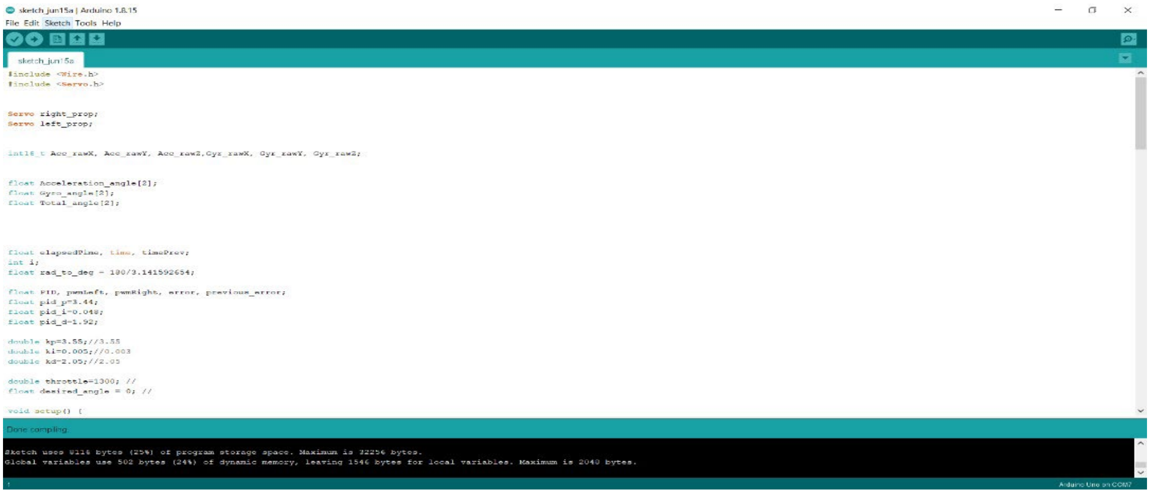
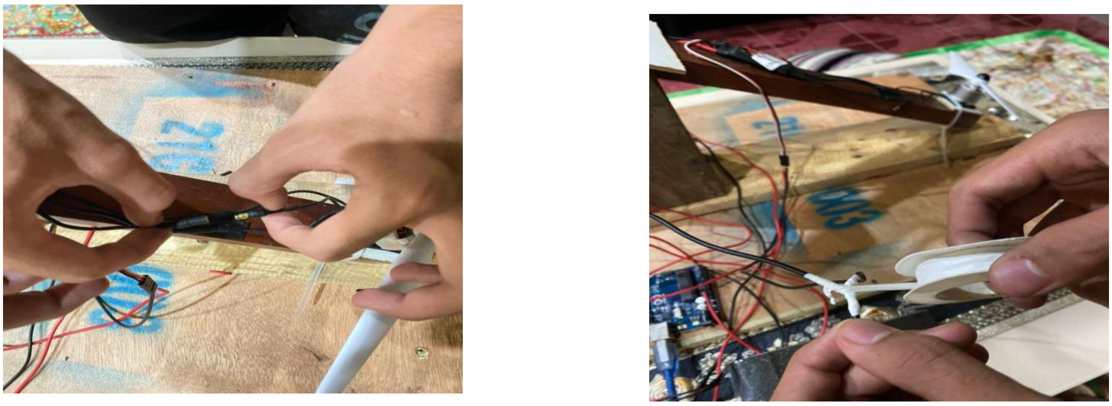


Figure 2: Arduino 1.8.15



(a) **(b)**

Figure 3: Method image of (a) process of connecting brushless ESC to brushless motor (b) process of sorting out the wires

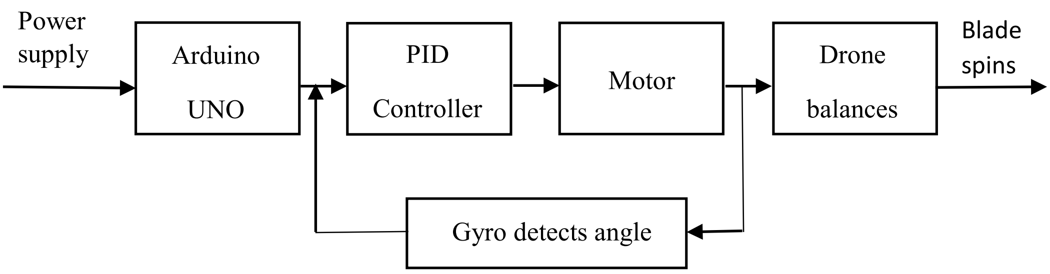


Figure 4: Block Diagram

Figure 4 is the configuration of block diagram of dualcopter. It is a closed loop control system because it has feedback. The input is power supply and the error detector is Arduino UNO. PID controller is the controller and motor are the actuating signal. The plant is drone balances and the output is blade spins. Gyro detects angle is the feedback of this system.

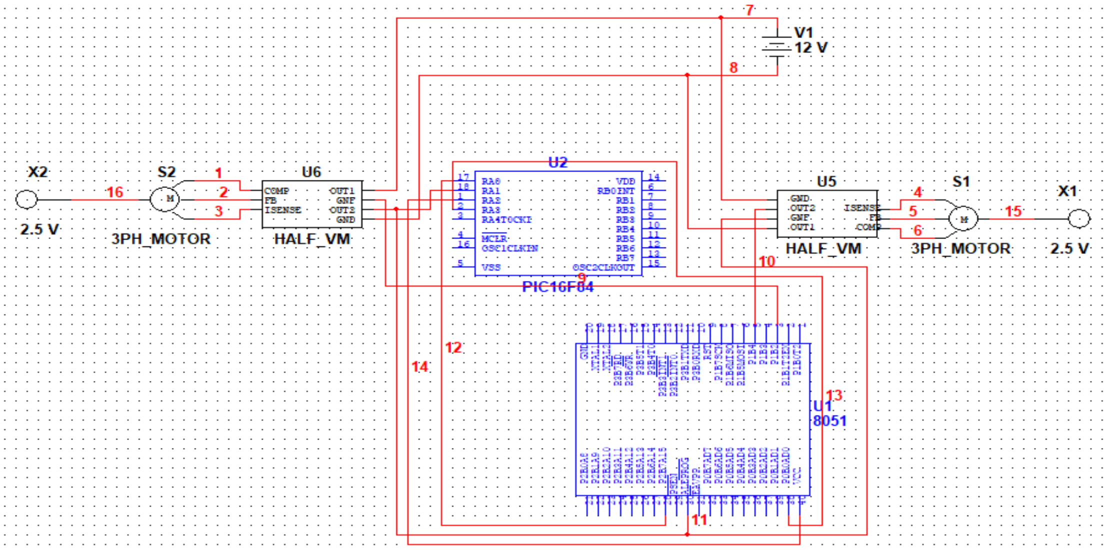
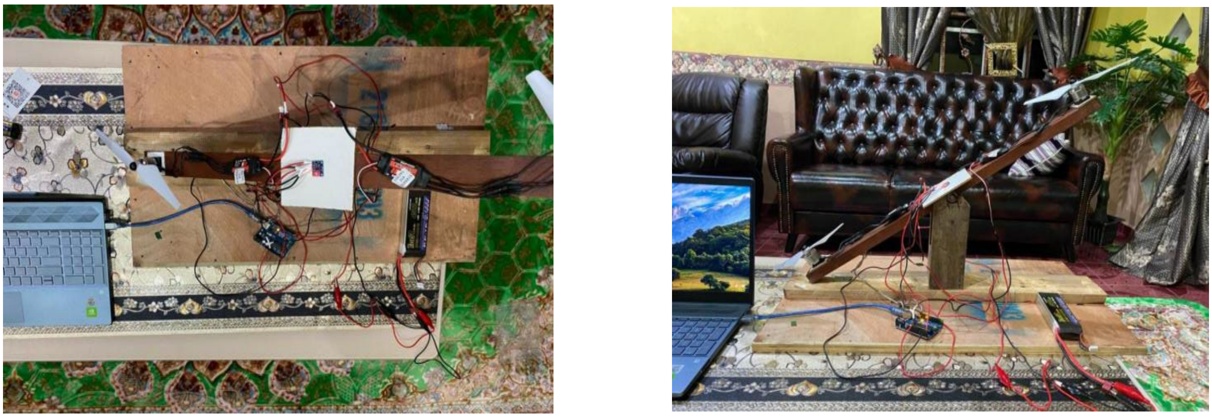


Figure 5: Circuit design

Figure 5 is the example of circuit that is drawn in the software of Multisim. The components that drawn in the Multisim is only the representative view for the real components of dualcopter.12V (V1) is represents the LIPO battery while 2.5V (X1) and (X2) are represent the propellers. 3PH_MOTOR, S1 and S2 are represent the brushless motors. Next, the 2 Brushless ESC BLheli 20A are represented by the HALF_VM, which are U5 and U6. PIC16F84 (U2) is represents the MPU6050 gyro accelerometer sensor module Arduino while 8051 (U1) is represents the Arduino UNO. Meanwhile **Figure 6** is shown the structure of the project with two different perspectives. As can be seen, the basic framework of this project is made of wood.



(a) **(b)**

Figure 6: Prototype image of (a) Top View of Prototype (b) Front View of Prototype

3. Result and Discussion

Table 2: Result with Pre-determined PID Value

P (Proportional)	I (Integral)	D (Derivative)	Time of drone to stable (s)
3.40	0.005	1.00	5.55
3.40	0.005	2.00	4.67
3.40	0.005	3.00	4.24

Table 2 shown the result of time of drone to stable when the power supply is switched on. The time of drone to stable is recorded by using the timer of handphone. The value of P and I are constant while the value of D is different. When P = 3.40, I = 0.005 and D = 1.00, the time of drone to stable is 5.55 seconds. When P = 3.40, I = 0.005 and D = 2.00, the drone takes 4.67 seconds to steady. When P = 3.40, I = 0.005 and D = 3.00, the time of drone to stable is 4.24 seconds.

As shown as the result in **Table 2**, when the value of D is becoming higher, the time of drone to stable is becomes lower, as the value of P and I are constant. This is because D reacts to the rate of change of error, in which to minimize the overshoot by slowing the correction factor applied as the target is approached. P involves to correct a target proportional to the difference and I attempt to remedy this with the cumulative error result from the P action to increase the correction factor. Therefore, the bigger the value of D, the quicker the time of D to react to the rate of change of the process variable. Indeed, the D has its greatest influence when a process variable is rapidly changing in connection to the oscillatory nature of the P and I response. For example, in the most common application, which is temperature control, D is used to fight the inertia that the temperature controller is built up [5].

4. Conclusion

In conclusion, the dualcopter is built successfully which it can stable in the air and gave a steady impression. Next, the concept of the drone to minimal deflections by using PID controller can be understood and applied. Meanwhile, the effect of derivative parameters on the settling time can be analyzed. The best values of PID are produced, which are the value from the fast settle time but makes overshoot, minimum overshoot but high settling time and best setting parameter. The settling time can be determined based on the different value of derivative and the constant value of proportional and integral. There are some deficiency parts that are needed to be improved for future research. It would be good to use quadrotor in order to see the efficiency of this system and the accurate results could be obtained. Furthermore, it is recommended to use the oscilloscope to plot the result of feedback in the proper and specific graph. This is because in this project, the oscilloscope is difficult to use in the analysis process for this project due to the limitation of access to the laboratory during the period of this Movement Control Order (MCO) 3.0.

Acknowledgement

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