Integrated pid controller for altitude control of quadrotor system

Ahmad Faiez Husni @ Rusli, Mohd Shahrieel Mohd Aras*, Muhammad Nizam Kamarudin, Muhammad Wahyuddin Nor Azmi

Centre for Robotics and Industrial Automation (CeRIA), Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

*Corresponding e-mail: shahrieel@utem.edu.my

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ABSTRACT— Quadcopter sometimes known as quadrotor helicopter or quadrotor. Quadrotor is an improved version of helicopter. Quadrotor also known as Unmanned Aerial Vehicle (UAV) with rotors. UAV has been popular lately as its fast-growing sector. Market had offered many possibilities for the off-the-shelf UAVs such as quadrotors. Since the last decades the number of UAV in the market has increased steadily. When UAVs has shown the advance capabilities such as autonomous collision, they can be categorized and limited to flight in controlled environment. There are many control techniques used in quadrotor such as PID, LQR, H-infinity and nonlinear control. Proportional Integral Derivative (PID) controller have been mainly used in quadrotor. In this paper, integrated PID controller has been proposed **to** control the altitude for quadrotor system.

1. INTRODUCTION

Quadrotor has become attention by many researchers because the application for quadrotor to improve is enormous. The quadrotor has four rotors. The rotors are directed upwards and they are placed in a square formation with equal distance from the center of mass of the quadrotor. The four rotors are spun by electric motors and controlled by adjusting the angular velocities of the rotors. There are a several numbers of publications elaborate the mathematical modelling, simulation and control of quadrotor UAV [1-3].

There are many applications that can be improvised with based on quadrotor. There was working class, observation class or special use. Observation class for quadrotor can be categorized into two dynamics that is motion control and surveillance vision.

In this paper, the focusing is based on PID controller which is comparison of single looping and double looping. Commonly used PID are single looping PID which is mainly used because it easier to setting for getting better result. But in double looping PID, the result even better for quadrotor in altitude control than single looping.

The objectives of the study are to design the model of quadrotor for altitude control based on Integrated PID controller. The model for altitude control is design using MATLAB System Identification Toolbox. The second objectives are to get best value in single and double looping Proportional Integral Derivative (PID) for altitude control. The altitude of the quadrotor has been tune using PID tuning in MATLAB/Simulink. From MATLAB/Simulink, the model can be obtaining from various basic PID model into altitude control model of quadrotor for this paper. The third objective is to determine which is more suitable PID controller for altitude control.

2. COMPARISON BETWEEN SINGLE AND DOUBLE LOOP PID CONTROLLER

The rigid body dynamic of the quadrotor UAV oversees the reaction of attitude control. The modelling process of quadrotor via system identification from MATLAB. The process of selecting the controller parameters to meet given performance specifications is called PID tuning. Using those tuning rules, delicate & fine tuning of PID controllers can be made on-site. Also, automatic tuning methods have been developed and some of the PID controllers may possess on-line automatic tuning capabilities.

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The mainly used PID controller is using single loop PID because the reasons of its success are mainly its simple structure, good performance-cum-robustness for several processes, reasonable knowledge and ease of tuning even with the low accuracy knowledge of the system model, etc. Single loop PID controller that show in Figure 1 show the example modelling of quadrotor. The PID control technique are used for altitude control and mainly used to achieve stable operation. [4]. The transfer function represents only one motor of the quadrotor. As for quadrotor, there will be four same transfer functions to control the altitude.

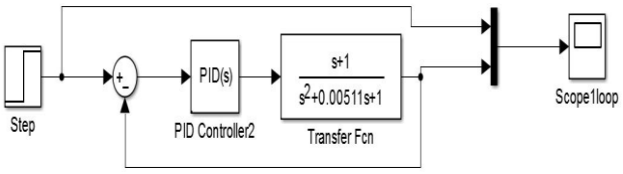

Figure 1: Single Loop PID Controller

The double looping PID show in Figure 2. Double loop PID control system consist of speed control loop and current control loop. In order to achieved both speed and current role of negative feedback, the system set up two

PID controller or hybrid fuzzy PID controller to adjust the speed and current independently [5]. In this case the second controller were use as Gain2 block shown in the diagram.

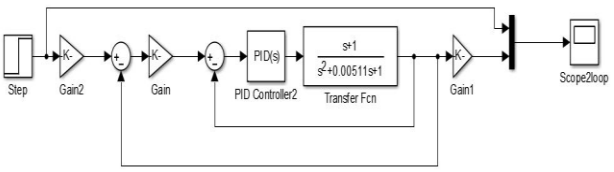

Figure 2: Double loop PID Controller

3. RESULT AND DISCUSSION

The output for both single loop and double loop PID controller is setting as same for transfer function and the value for P, I, D is the same. Both controllers are run using MATLAB software. Figure 3 shows the output of the single loop PID controller. Where Figure 4 shows the double loop PID controller. The graph in Figure 3 shows the rise time slower the Figure 4. Rise time in Figure 4 shows higher but the overshoot for both graphs is the same. The graph in Figure 3 shows slower to achieve steady state other than Figure 4 achieved faster steady state. Table 1 shows Performance parameters of each controller

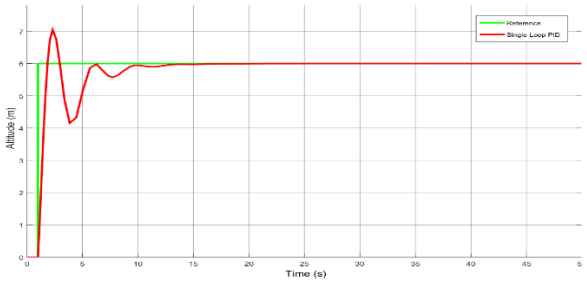

Figure 3: single loop PID controller graph

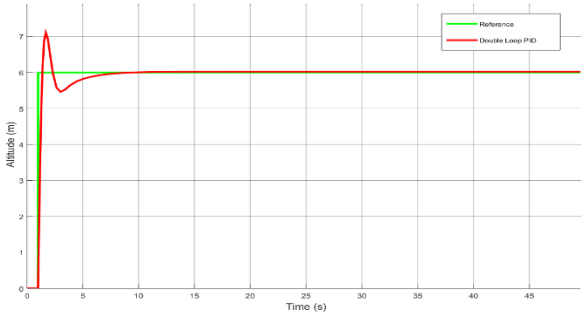

Figure 4: double loop PID controller graph

Table 1 Performance parameters of each controller

Controller	Rise Time (s)	Percent Overshoot (%)	Settling Time (s)
Single PID	2.255	17.059	13.677
Double PID	1.353	18.452	7.763

4. CONCLUSION

Quadrotor has been popular as a testbed for small UAV development, there were many researchers pursue to improve and use this application to upgrade into another level of innovation. Although many other good paperwork, this paper focused on comparison between single loop and double loop PID controller. In this paper, the dynamic model of altitude control was presented. As display on the graph the single loop PID controller are less effective than double loop PID controller. The double loop PID show more effective in rise time and steady state error. This work will be carried out for further analysis and experiment to validate the double loop PID controller more suitable for altitude control in quadrotor.

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