Honeywell Puerto Rico Navigation Challenge 2018-2019

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Overview

This poster is the product of a capstone project that was originally proposed to complement the multidisciplinary team created as a result of Honeywell's First Annual Navigation Challenge where different universities from Puerto Rico were given the task of building an unmanned aerial vehicle (UAV) from scratch. The UAV team required people from the following disciplines: Mechanical Engineering, Computer Engineering, and Electrical Engineering. However, the following sections focus on the electrical engineering team's contribution which was the design of a control system through MATLAB/Simulink.

UAV Control Theory

In the case of a UAV, the inputs for the control system to be designed come from the user interface and the remote controller depending on whether the quadcopter is set to run on autonomous or manual mode. The controller is the processing unit to be implemented in which the designed control system is installed. Then, the process is the quadcopter itself. Finally, the output is the pulse width modulation (PWM) to be inputted to each motor and produce the required thrust in each of them to achieve the desired quadcopter state. Through the quadcopter's sensors, the current state of the quadcopter is measured and received as feedback in the control system producing its setpoint. The integration of all the previously mentioned quadcopter elements resembles that of a typical closed-loop control system shown in the following figure:

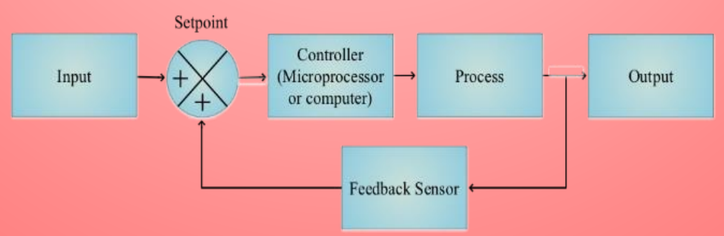

Figure 1: Typical Closed-Loop Control System

The final selection for the control technique to be implemented was the PID technique. This technique is one of the most common control strategies for quadcopters.

Project Solution & Results

As previously mentioned, MATLAB/Simulink was used for the design of the UAV's control system. Various Simulink models were created or adjusted from previous references to evaluate our quadcopter system and its initial parameters. One of the models used for this evaluation is shown in Figure 3. The implemented models had Simulink PID blocks for roll, pitch, yaw and altitude control. Then, the control system outputs were mapped into desired motor speeds according to the appropriate translation and rotation equations of motions.

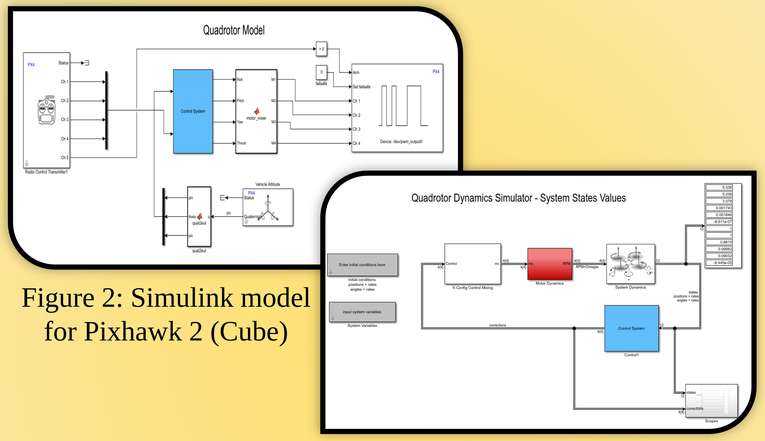

Figure 2: Simulink model for Pixhawk 2 (Cube)

Figure 3: Simulation of Quadrotor Dynamic Model

From the evaluation models, a Simulink model containing the desired PID parameters to be uploaded to the Cube flight controller was devised as shown in Figure 2. However, the upload was unsuccessful, and the team opted to adjust the control system from the Mission Planner ground control station. As a result, successful flight was achieved. The final version of the UAV that was designed and manufactured is shown in Figure 4.

Figure 4: Final UAV Design

Conclusions

Through this project a quadcopter flight simulation was successfully executed through the implementation of MATLAB/Simulink and Mission Planner which facilitated the design of a UAV that has both remote and autonomous features. Consequentially, this project opens the doors to future projects related to the topic of UAV design by serving as a reference. As a recommendation for future projects on UAV design, it is stated that the implementation of Simulink with Pixhawk requires further investigation. Precaution is advised when uploading firmware to telemetry modules since communication problems between the modules may occur if the wrong firmware is installed. Additionally, an alternative to UAV design concerning autonomy could be to program the Ardupilot flight controller using Arduino IDE.

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