Navigation and Control of a Ducted Fan Prototype

Refining the ducted fan prototype and developing a control system for the prototype to hover

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Introduction: The main goal of this project is to develop a controller for the ducted fan prototype developed in the previous project[1]. The prototype should be able to take off and hover in place. To achieve this, a controller must be created to control the prototype's roll, pitch, and yaw angles. By changing these angles, the prototype can achieve translatory acceleration, which moves the prototype in space.

Approach: Time constraints in the previous project led to some unresolved issues with the prototype. These shortcomings must be fixed to enable the prototype to fly. The flight computer's unreliable data logging and the unnecessary FPGA are among the issues that must be fixed. Furthermore, the flight computer software requires expansion for sensor calibration and GPS data conversion, as well as the design of an observer and controller in state space. To design an accurate observer and reliable controller, a simulation of the prototype will be created and refined through iterative testing.

Result: A new flight computer PCB was designed with an additional RP2040 to split the telemetry transmitter and SD card logging. Next, the FPGA was replaced with an RP2040 to read and write 8 PWM channels. Two custom test stands were developed to measure the EDF and flap forces at different velocities and angles of attack. Then, a system model was created, which was used to design an observer and controller. Through multiple flight tests, the model was refined, and a reliable observer and controller was designed. Throughout this process, the hardware and software of the prototype were constantly improved and adapted.

[1] Optimization of a ducted fan prototype, Tobias Rothlin, HS 2023

Updated Flight Computer
Own presentment
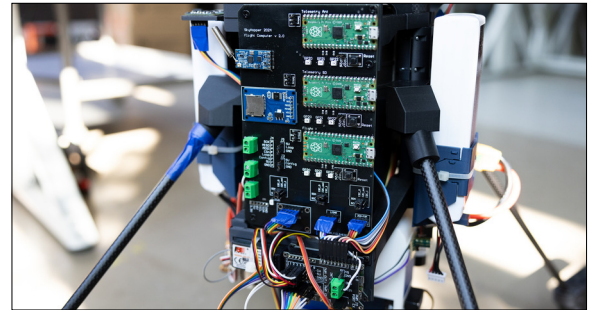
Position Plot during Test Flight
Own presentment
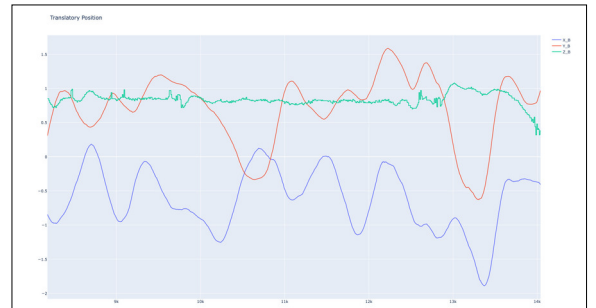
Prototype Hovering
Own presentment

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Subject Area
Data Science