UAV Flight Controller Design and Hardware Deployment

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Project Background

Unmanned aerial vehicles (UAVs) are aircraft that can be controlled remotely, or by preprogrammed plans and automation systems that enable them to fly autonomously. Many industries and organizations are adopting this technology, including the military, government, commercial, and recreational users. As engineering students with various interests in said industries, joining this project sponsored by MathWorks was a wonderful opportunity to apply our analytical and critical skills as Engineers.

Figure 1: Members of Group 7C (and Advisor)(from left to right): Saron Gebreslassie, Armine Grigoryan, Antranik Karyan, Mike Thorburn, Gabriel Montañez, Jonathan Jauregui

Project Requirements

Table 1: List of Hardware and Software Components Used for the Pixhawk4 QAV250

Hardware Components Requirements					
	UAV	Receiver	Transmitter	Battery	Radio Controller
Model	Pixhawk 4 Mini QAV250	TBS Crossfire Diversity Nano RX	TBS Crossfire Micro TX II	HOOVO LiPo Battery	RadioMaster TX 12
Specifications	Carbon Fiber 250 Airframe	Weight: 1.8g (receiver only)	Frequency Bands: 915MHz (US)	Dimensions: (103x34x31.5)mm	Dimensions: (170x159x108)mm
	Dimensions: (198x235x85)mm	Size: 24mm x 18mm	Input Voltage: 6.0 - 13V	No. Cells: 4S	Weight: 363g
	Wheelbase: 250mm	Requires: Firmware V2.87	Connector: USB-C	Voltage: 14.8V	Frequency: 2.400GHz GHz
	Weight: 439.8g	Input Power: +3.3V to 8.4V	Dimensions: (65x48x22)mm	Discharge Rating: 50C	Channels: Up to 16
	Pixhawk 4 Mini Autopilot		Weight: 48g		Transmitting Power: 20dbm
			Power consumption: 1.1W (@10mW) - 2W (@100mW)	Capacity: 2200mAh	Range: >2km @20dbm
					External Module: Jr/FrSky/Crossfire
					Radio Firmware: OpenTX
Software Requirements					
Program	MATLAB	Simulink	Stateflow	QGroundControl	SolidWorks

Objective

This project is aimed at developing and deploying a piloted flight control system for a model Pixhawk 4 Mini QAV250 drone. The methodology was developed through constant optimization and iterative techniques that were extracted from engineering principles to assess design analysis, model the system, and evaluate performance of the algorithm using mathematical models in MATLAB/Simulink and design software in SolidWorks.

Design Approach

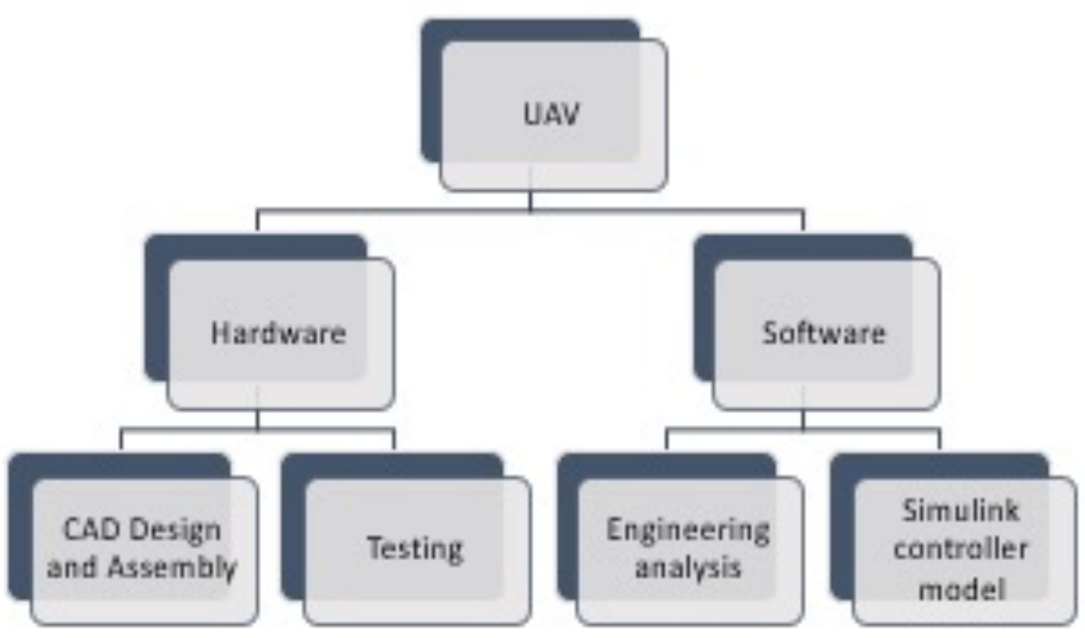

Figure 2: Block Diagram Detailing the Project Management

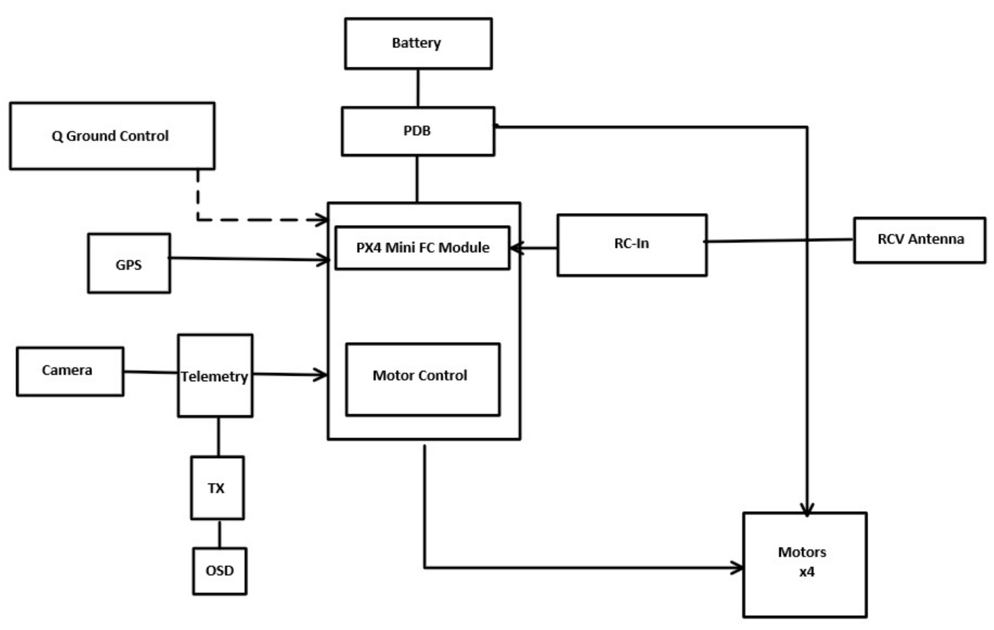

Figure 3: Hardware Schematic for the Pixhawk4

Figure 4: SolidWorks Model of the Pixhawk4 QAV250

Results

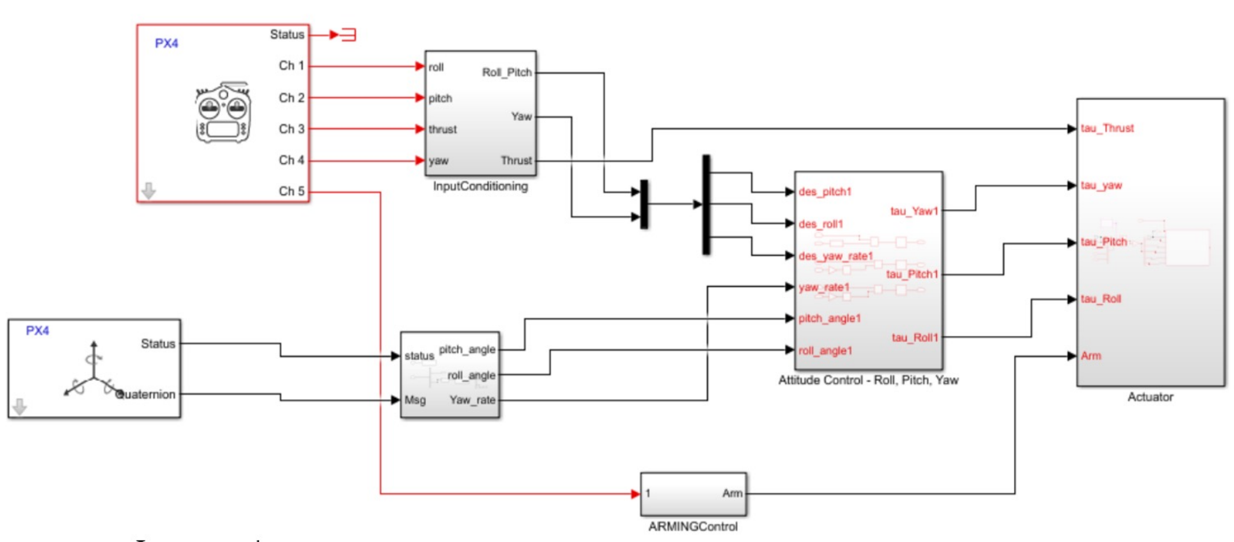

Figure 5: Simulink Controller

Table 2: Mass Properties of UAV, obtained from SolidWorks Model

Mass Properties					
Mass [g]	Volume [mm^3]	Surface Area [mm^2]	Center of Mass (X,Y,Z) [mm]		
681.50	214904.63	185889.86	-0.18	-4.96	-28.52
Taken at the Center of Mass					
Principal Axes of Inertia [mm]		Principal Moments of Inertia [g.mm^2]			
Ix = (1.00, 0.00, 0.00)		Px = 1966248.28			
Iy = (0.00, 0.00, -1.00)		Py = 2096366.19			
Iz = (0.00, 1.00, 0.00)		Pz = 3412558.24			

Figure 6: Radiomaster TX12 and Pixhawk4 QAV250

Conclusion

The team has fully assembled the UAV and has completed the calibration process, required prior to operation. In addition, a SolidWorks model was developed to obtain physical properties that were implemented in the Piloted Mode Flight Controller model in Simulink. The team is currently in the testing stages of the project.

Acknowledgements

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