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Title
Flapping Wing Micro Air Vehicle

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Flapping Wing Micro Air Vehicle Project

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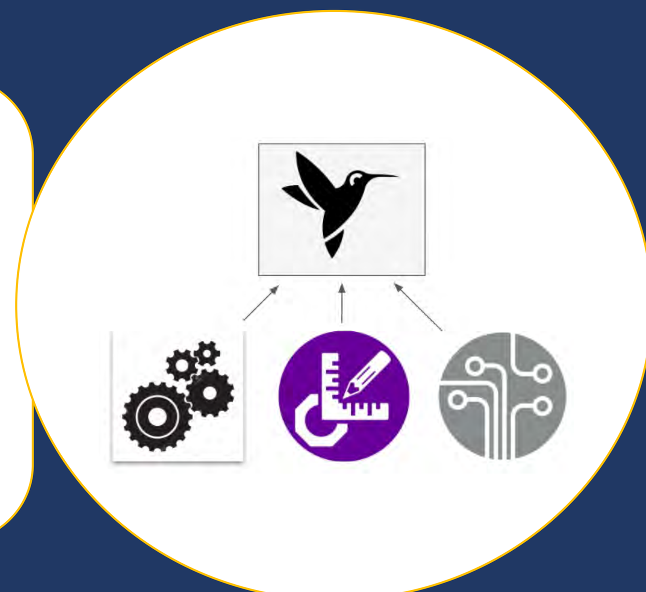
FLAPPING WING MICRO AIR VEHICLE • THE UNIVERSITY OF CALIFORNIA, IRVINE •

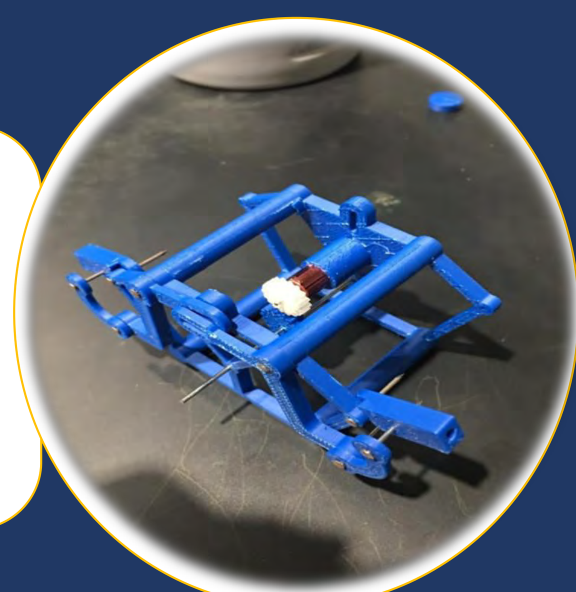
Project Goal

Study motion of a FWMAV mathematically, experimentally, and through design; implement and test our own active pitching mechanism of flight both in a single bird configuration and in a quadflapper.



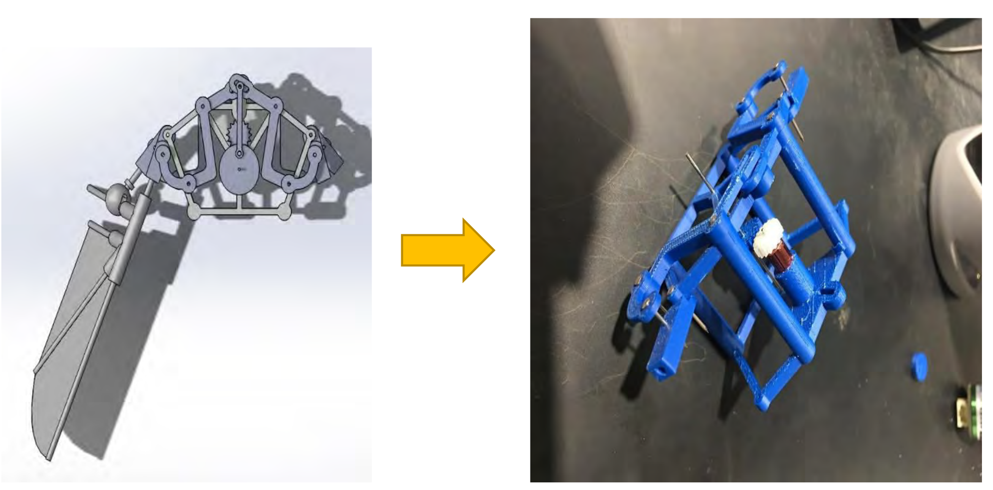
Specifications

Less than 15 cm in length, width, and height
- More than 1 minute hover time
- 2 DOF : Upward and Pitch
- Pitching angle fixed by the mechanism



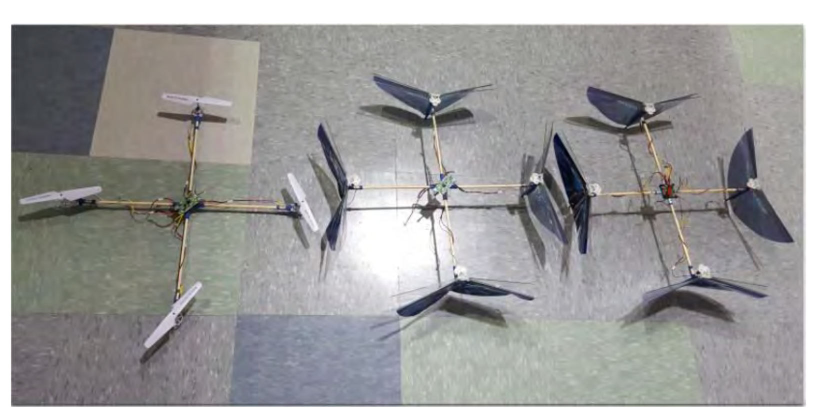
Innovation and Progress

ULB Design and Fabrication



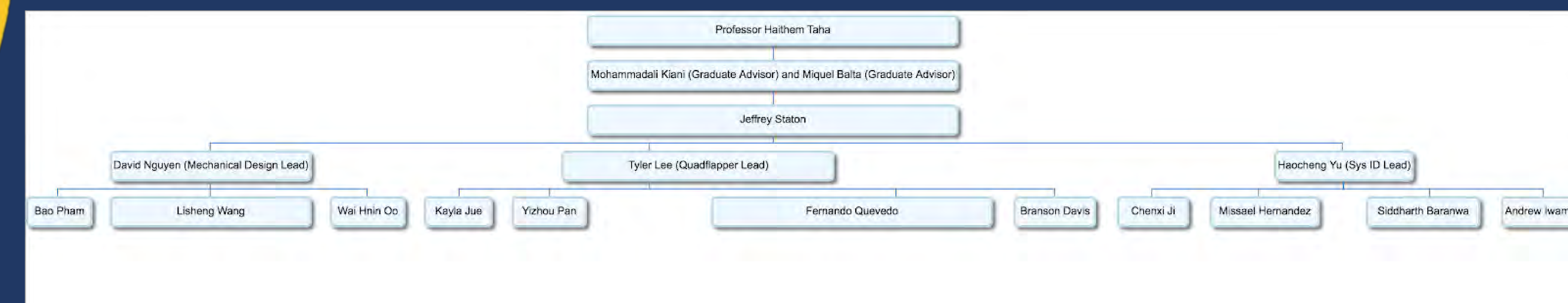
This design features a motor-driven central shaft. The central shaft then drives a top and bottom level that drives the active pitching motion.

Quadcopter vs Quadflapper Analysis (Passive Pitching Angle)



Performance Test	Units	H31 Quadflapper	H31 Quadcopter	TW Quadflapper
Weight	grams	53.88	57.51	53.97
Flight Time	minutes	1	8	6
Maximum Thrust	grams	72.5	119.42	103.32
Minimum Thrust	grams	54.29	112.83	-
Average Thrust	grams	64.95	117.19	-

Physical tests to be complimented with program-aided analysis using BetaFlight.



Background

Micro Air Vehicles (MAV) are a class of mini UAV's that have a size restriction. They are used for commercial, research and military purposes. A motivation to use them would be where the environment is blocking access for ground vehicles.

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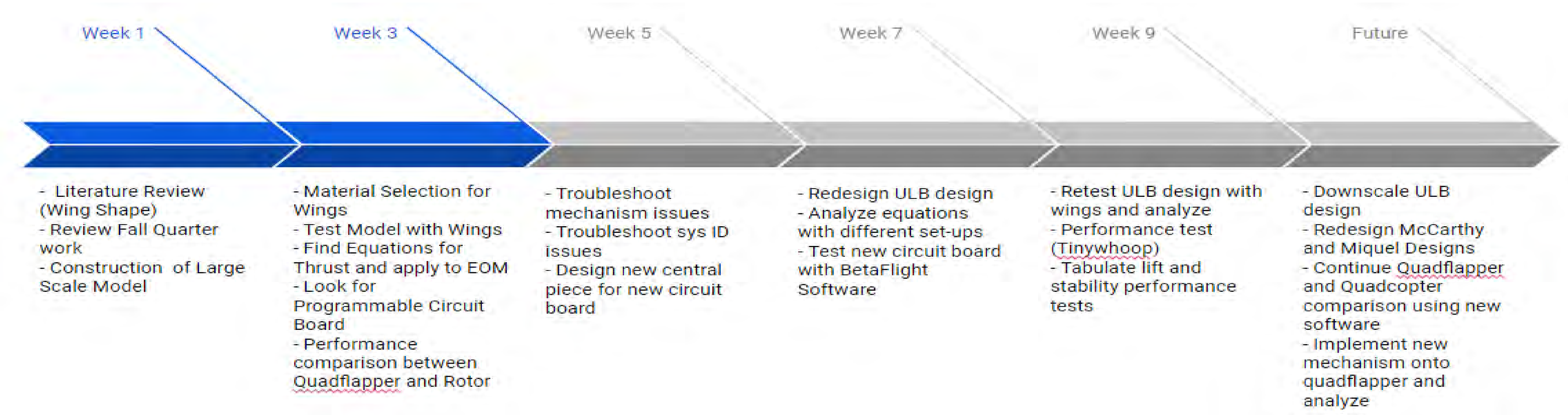


Budget

Budget: ~$900 (15 members, 9 SDP Members $100 fee each)

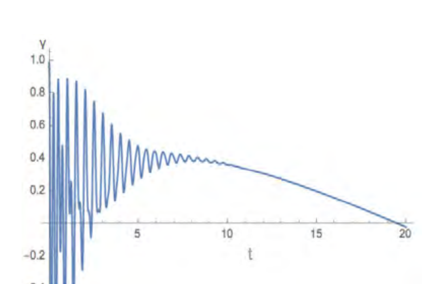
Thrust Equation and Finalized ODE Equations of Motion

$$\ddot{\gamma} = \frac{-dg^2 m(-T + dgm\theta dot^2)\mathrm{Cos}[\gamma-\theta]^2 + \mathrm{Cos}[\gamma-\theta](-dg^2 g m^2 \mathrm{Sin}[\gamma] + (T - dgm\theta dot^2)(I3 + dg^2 m \mathrm{Sin}[\gamma-\theta]^2)) + \frac{1}{2}m(-2gI3\mathrm{Sin}[\gamma] + dg(-2dtT\mathrm{Sin}[\gamma-\theta] + dgm(l\gamma dot^2 + g\mathrm{Cos}[\gamma])\mathrm{Sin}[2(\gamma-\theta)]))}{lm(I3 + dg^2 m\mathrm{Cos}[\gamma-\theta])}$$

$$\ddot{\theta} = \frac{-2dtT + 2dglm\gamma dot^2\mathrm{Cos}[\gamma-\theta] + dggm\mathrm{Cos}[2\gamma-\theta] + dggm\mathrm{Cos}[\theta] + dgT\mathrm{Sin}[2(\gamma-\theta)] - dg^2 m\theta dot^2\mathrm{Sin}[2(\gamma-\theta)]}{2(I3 + dg^2 m\mathrm{Cos}[\gamma-\theta])}$$

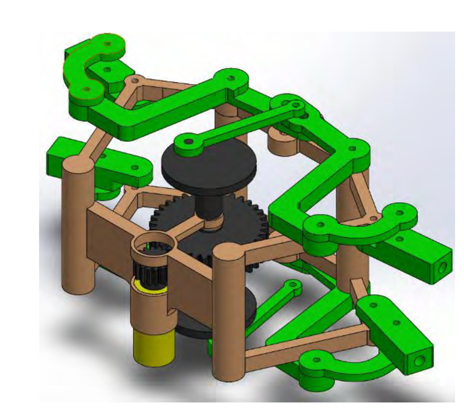
MatLab and Mathematica used to analyze EOM's and generate thrust equation

$$T = \sin(\eta)\sum_{0}^{n=20} dF_{x,n}' + \cos(\eta)\sum_{0}^{n=20} dF_{y,n}'$$



Simulate in Constant Thrust Conditions (e.g. γ(t))

Next Steps



Mechanical Design: Redesign ULB design to produce wider pitching angle and decrease friction between moving parts

Quadflapper: Continue TinyWhoop Quadflapper testing. Become familiar with BetaFlight program.

System Identification: Simulate motion of wing in MatLab using governing equations.

Future Implications

The active pitching angle flapping mechanism could offer better efficiency and/or more maneuverability than a traditional aircraft vehicle. Its small size is useful in military application/reconnaissance.