



Temasek Defence Systems Institute

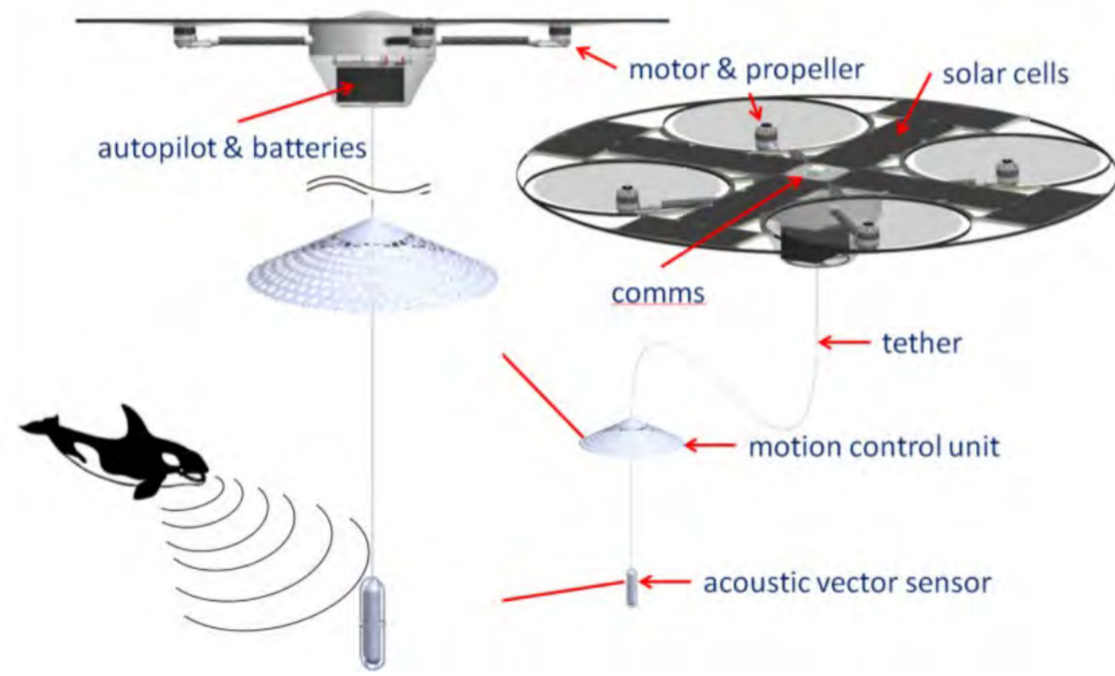
FLIGHT POWER REQUIRED FOR AQUA-QUAD (SOLAR-POWERED QUAD-ROTOR UAS)

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Background

The Aqua-Quad concept pairs small drone & solar power technologies in an innovative quadrotor system that can be launched from water or land for persistent & autonomous Intelligence, Surveillance, & Reconnaissance operations. Without the need to refuel, the Aqua-Quad can easily be employed as a swarm.



Aqua-Quad Conceptual Design

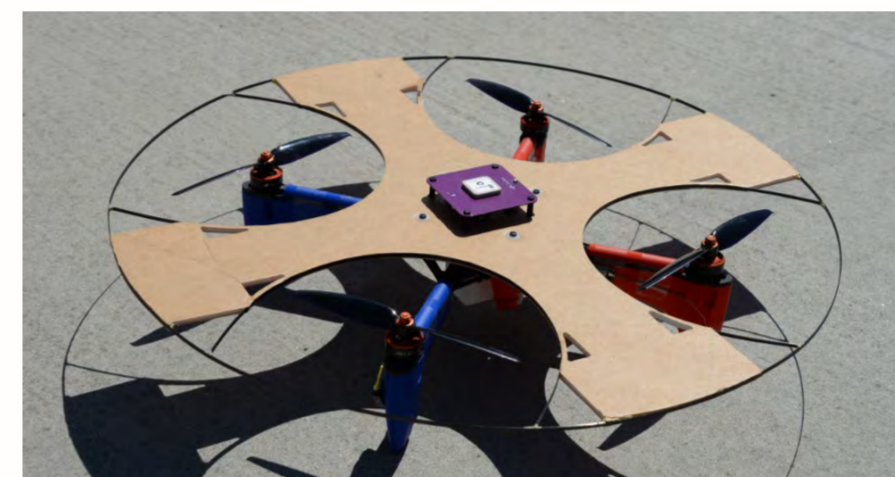
The primary energy consumption stems from the thrust required to balance weight & drag during cruise flight. Analytically, this study used actuator disk theory to derive the power requirements based on the thrust & airspeeds during cruise & flight phases.



Aqua-Quad Quadrotor Prototype (1.1 x 1.1 m, ~3.5 kg)

Flight Testing

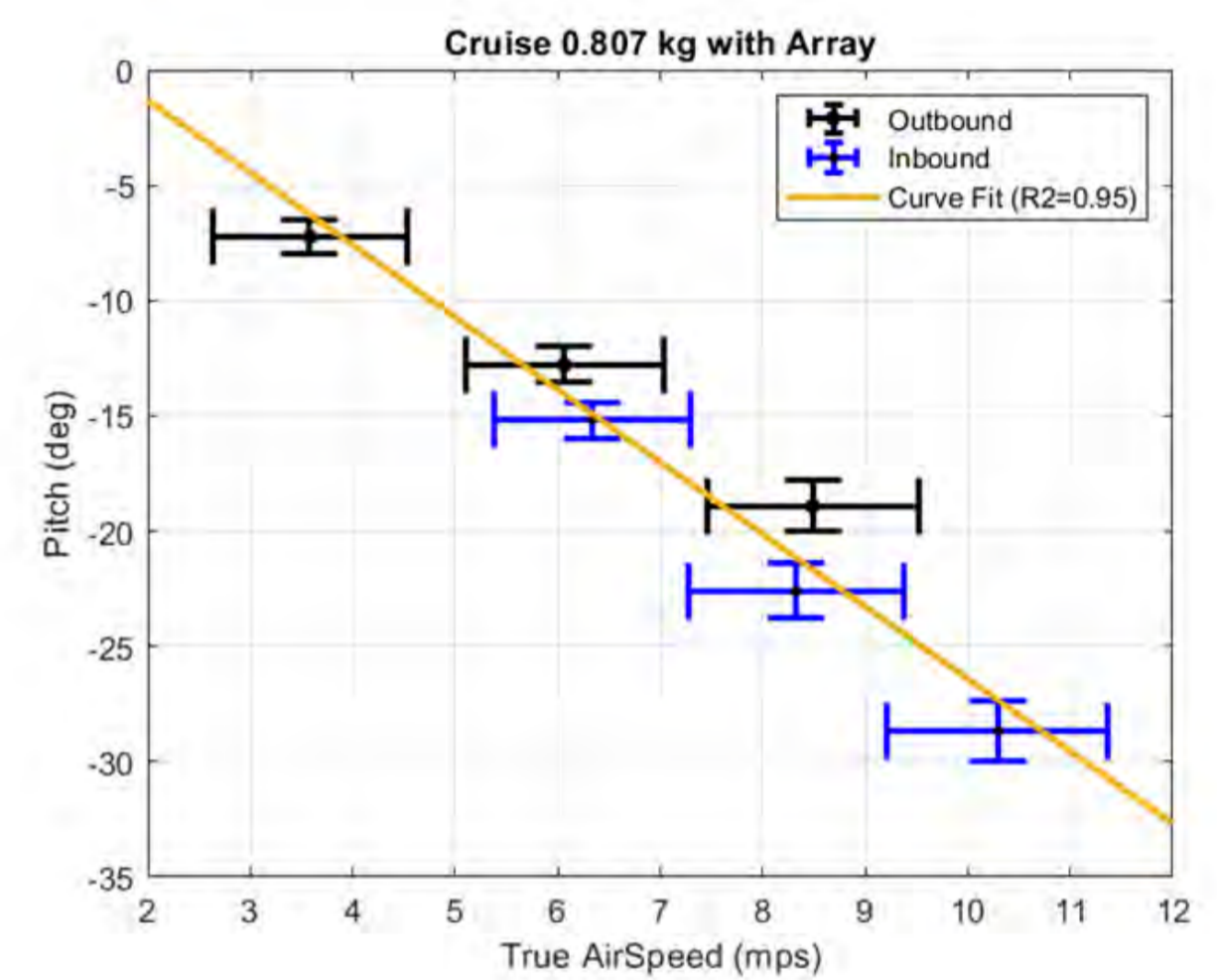
- Climb, descent, & cruise profiles conducted at outdoor test sites at Fort Ord & Camp Roberts.
- Flight testing mainly using scale model
- Validated power models & provided empirical inputs (Efficiency Factor, Pitch-Speed Relationship, Lift & Drag)



Scale Model Aqua-Quad (0.6 x 0.6 m, ~0.6 kg)



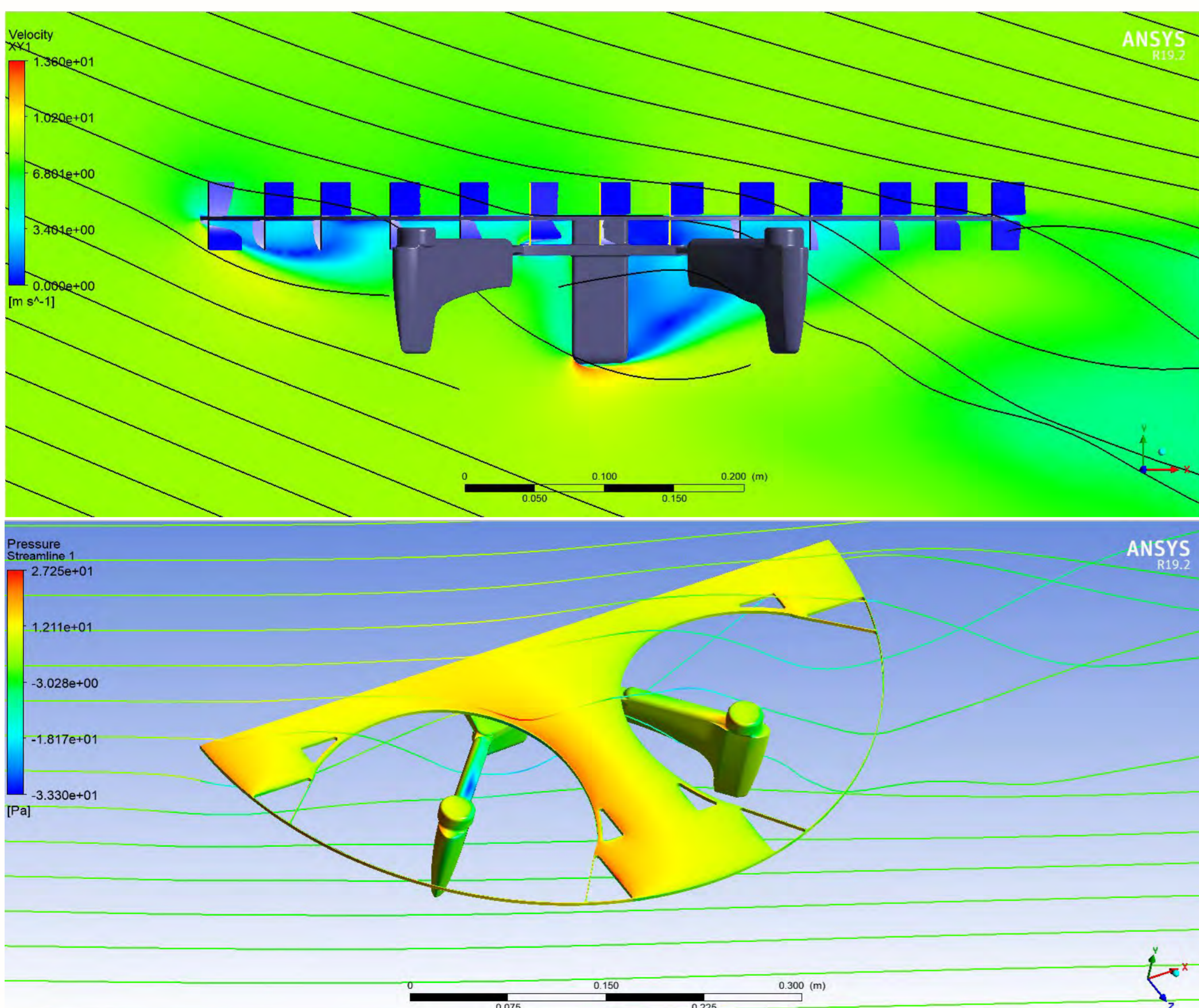
Profile of a Flight Test at Camp Roberts, California



Pitch Angles for Different True Air Speeds – Input for Power Model to Fill in Gaps in Analytical Models

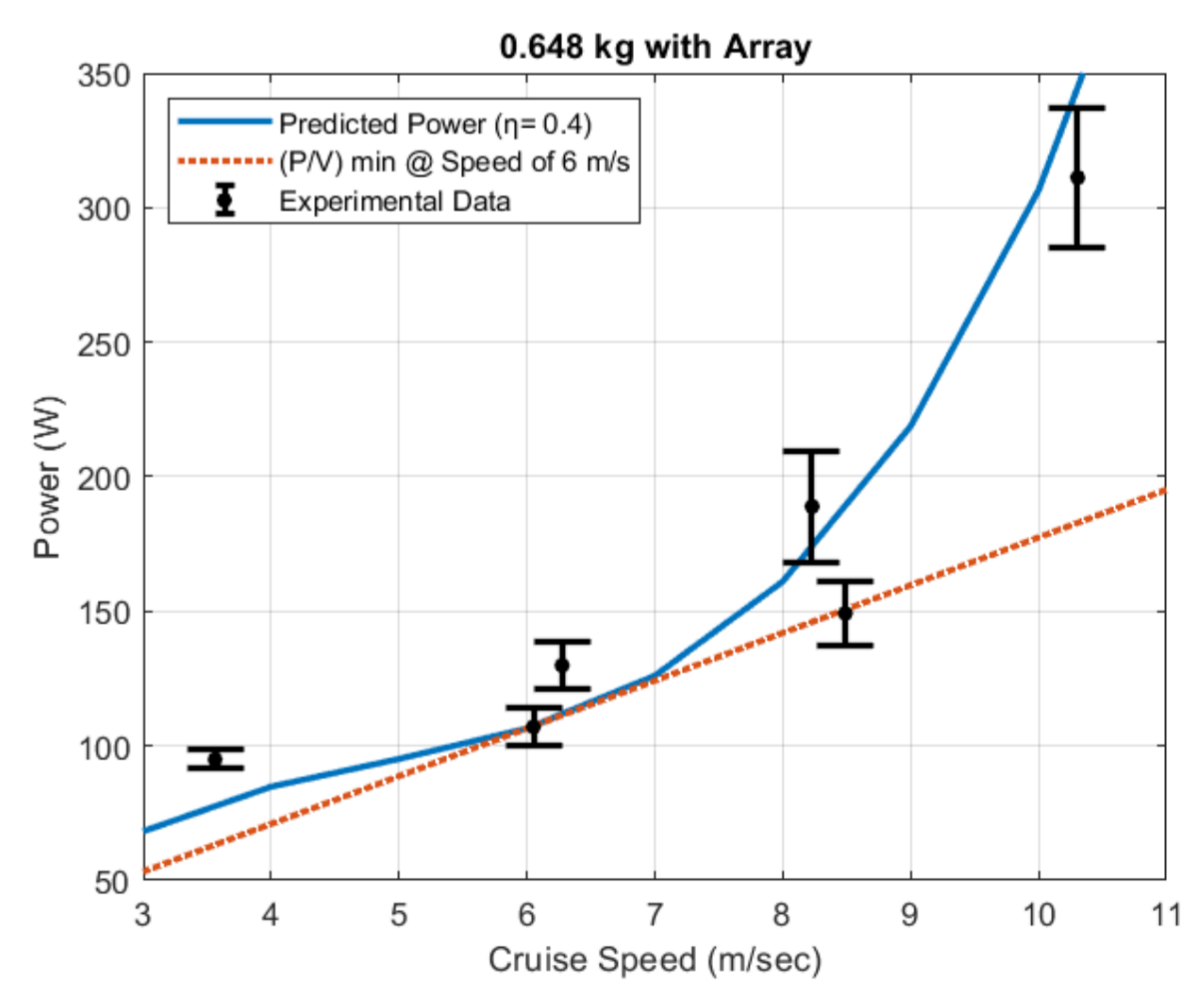
Computational Fluid Dynamics

- Support and refine estimates for lift & drag of Solar Array
- Analyze aerodynamics of Solar Array
- Benchmark CFD as a design tool for Aqua-Quad



Results

- Validated models of power for Aqua-Quad flight at different speeds & weights.
- Determine range & endurance for mission planning & design optimization.
- Can be generalized for small VTOL UAS used by industry, commerce, & military.



Cruise Power Model vs Empirical Results

