CRAIG LAB
DySMAC

VT ROBOTIC BIRD

Virginia Tech

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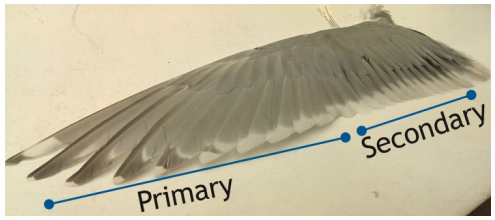
PROBLEM

Design a fully articulated bio-fidelic robotic bird that produces positive lift for flapping flight while maximizing aerodynamic performance.

A robotic analysis defined a 4 DOF wing motion separated between the primary and secondary portions of the wing, as well as 1 DOF for the tail.



Secondary	Primary			Tail
Lift	Lift/Thrust	Drag Reduction	Thrust	Stability

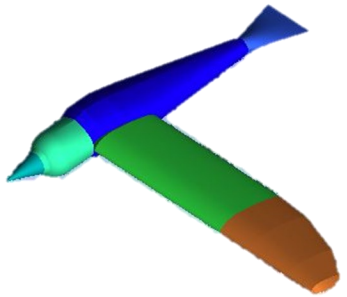
CFD ANALYSES

ANSYS Fluent was used for running simulations in 2-D and 3-D.

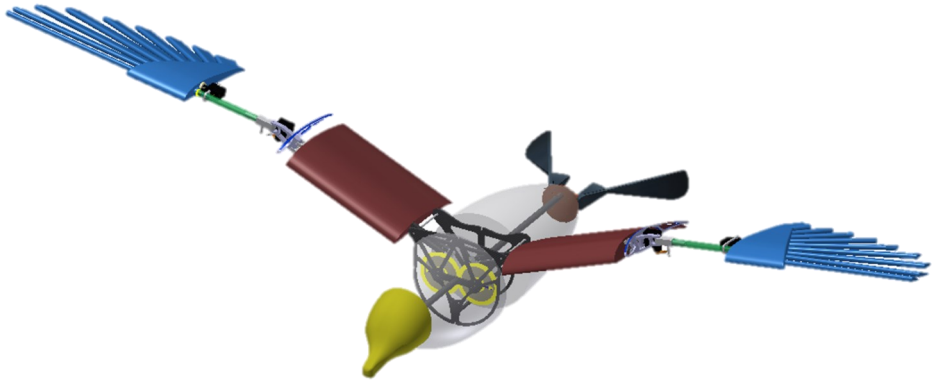
Plunging motion for secondary portion of wing maximizes lift, with an angle of incidence of 0°.

Primary wing section produces minimal drag and thrust at target velocity.

3-D model will be used to validate idealized 2-D model, and compared to our physical prototype's aerodynamic properties.



PROTOTYPE DESIGN & CONTROLS



New skeleton weighs roughly 0.15 kg for a 42% total reduction in mass.

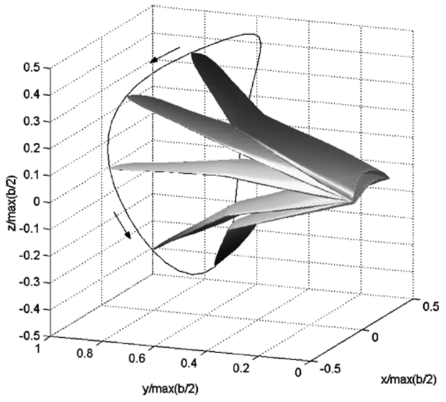
Compression spring assists transition from downstroke to upstroke.

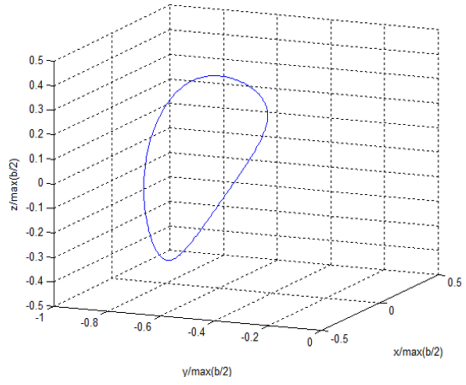
Feathered wing tips allow for air flow on upstroke while maintaining lift on downstroke.

Servos added for back sweep motion, wing tip torsion, and tail control.

Electronics powered by AT Mega 2560 and contains motor driver, motor encoder, quadrature encoder, accelerometer/gyroscope, and servo control.

RESULTS





Verified wing tip trajectory from Liu's model (left) to a dynamic simulation from Inventor and plotted within MATLAB (right).

Analyzed flapping flight aerodynamics with 2-D and 3-D simulations.

Minimized weight while maintaining structural integrity and maximizing aerodynamic performance.