Nano Air Vehicles
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Objectives and Purpose

DARPA requirements
* Less than 75mm in length
* Less than 10 grams
* Must include all control systems

Ideas from our designs came from conventional aerodynamics as well as biology

Experimental Setup

Test Stand

65 mm propeller with a 5.8:1 gear ratio
65 mm propeller with a 5.25:1 gear ratio
45 mm propeller with a 1:1 gear ratio

Motors

The motor weights range from 1.50 to 2.73 grams and the propellers range from .37 to .88 grams.

Shroud molds

The rapid prototyped molds are designed for carbon fiber and fiberglass shrouds. The plastic molds were vacuum formed and weight approximately 3.45 grams and 2.17 grams, for the big and small shrouds respectively.

Receiver and Actuators

The receiver and actuators will be supported by 1 mm diameter carbon fiber rods. The actuator weights .29 grams and the receiver/battery combination weighs 3.98 grams.

Results

Once the shrouds are completed the models will be assembled and placed in the test stand where torque and thrust are measured. The actuators are controlled through pwm and the motor through changing the DC input. All components are connected to a computer so that the entire experiment can be run from a single location.

65mm prop with 5.25:1 gear ratio
65mm prop with 5.8:1 gear ratio
45mm prop with 1:1 gear ratio

Additionally, it was found that with a 10 gram vehicle and the experimentally determined thrust values the vehicle only has to be tilted at a 10 degree angle to move with a speed of 2 m/s. This can be done by changing the angle of attack of the actuators or through thrust vectoring. Thrust vectoring can be achieved by modifying the vehicle’s shroud.

Conclusions

From this research we found that this design has a lot of potential due to its simplicity, which allows for an unlimited number of additions to be made. The project is very close to completion of the first few DARPA requirements, and with more work will complete the goals that were established. Through out the research it was found that the weight of the vehicle was the hardest obstacle to overcome because of the materials that were available. It was found that composites offer a very light weight alternative to common materials, but because of the size of the vehicle construction was made very difficult. At the present time the best material found was vacuum formed plastic. Furthermore, in the future experiments will be run without a shroud because it is approximately 40% of the vehicle weight and only gives a limited amount of thrust increase.

To achieve thrust vectoring without modifying the angle of attack of the actuators a wire made of a material known as flexinol will be used to modify the shroud. This material expands and contracts due to the magnitude of the voltage that is run through it. The exact placement and use of the wire was left for future experiments. Overall, the vehicle has much room for improvements, but was considered a success because it was shown that a nano scale unmanned aerial vehicle is possible.