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STUDY OF MICRO AIR VEHICLE

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ABSTRACT

This paper presents the progress of an electrically operated micro air vehicle (MAV) with a wingspan of 360 mm. A small flight control system including a self-made micro video image system especially suitable for MAV is developed. The aerodynamic shape performance of several airfoil sections at low chords Reynolds number is analyzed in order to find an most advantageous airfoil section for the MAV prototype. A small-sized propulsion testing setup is built to calculate the performance of the motor-gear-propeller-battery grouping so that an efficient propulsion system can be obtained. In the real-time flight with the help of TH360 MAV with a payload of a self-made micro color video image system has been successfully tested, where use of board video camera is transmission of real time target images to the ground. A new family of Micro-Air Vehicles (MAVs) that are at least an order of magnitude smaller than current flying systems (less than 150 mm in any dimension) will be developed and demonstrated. The capability to accomplish exclusive military missions as diverse as covert imaging in biological-chemical agent detection, constrained areas and characterization, remote precision mines, and urban battlefield interactions enhancement, will be stressed through an examination of a variety of vehicle concepts. The resulting capacity should be especially advantageous in the emerging urban war fighting environment, characterized by its complex topologies, confined spaces and areas (often internal to buildings), and high civilian population. The MAV program will focus on the technologies and components required to enable flight at these small scales, including flight control, propulsion and lightweight power, navigation and communications. These will build upon and exploit numerous DARPA technology development efforts, including advanced communications and information systems, , Micro electro-mechanical Systems (MEMS), high performance computer technology efficient high density power sources advanced sensors, advanced electronic packaging technologies lightweight.

Keywords: Aerospace control, Micro robots, Velocity Control, Prototype, Propulsions testing.

I. INTRODUCTION

very small flight vehicles called micro air vehicles (MAVs). Hover capability is highly desirable with respect to the mission requirements of these vehicles. Due to the small size of MAVs and the low Reynolds number regime in which they operate, scaling down conventional rotorcraft configurations to the MAV scale may not yield optimum performance. Unconventional vehicle configurations can be explored to realize high endurance hover capable MAVs. There is build and test fly a Micro Air Vehicle (MAV) with awing span under 30cm.

II. LITERATURE REVIEW

In order to have a appropriate related study on technologies available for study of Micro Air vehicle, literature review is carried out to know its various applied method throughout the globe, they are summarized below. The study was shown by Raymer, Daniel,P (1989) Aircraft Design: A Conceptual Approach. American Institute of Aeronotics and Astronautics. In this process deep study of air motion. It use basic principle of Aerodynamics. The study was caried by out IRA H Abbott & Albert E Von Doenchoff, Theory of Wing Section. Dover Publications Inc.

III. METHODOLOGY

A Research and evolution of design

First we read up on various aerodynamic theories and researched on other MAV designs. The most important parameter to consider for such a small plane is lift. The bigger the wing, the more the lift, so the most lift comes from a flying wing design or a biplane. But both the designs are unstable and difficult to control in flight, so we decided on a conventional monoplane design with large wings, which could carry a smaller load. After experimentation with higher aspect ratios which we found out had too little lift, we settled for an aspect ratio of about 2 (30cm wingspan divided by 15cm chord). Larger planes usually have aspect ratios of 6 or higher for lower drag and better efficiency1. Higher aspect ratio means wing area affected by wingtip vortex is proportionally lower2, but we needed the extra lift at the expense of more drag. For the most important component, the powerplant, we first chose electric motor as we hoped to power both the motor and the radio receiver by the same battery (in this case a flat lithium-ion Motorola Startec handphone battery weighing only 24g). The motor chosen was the most powerful for the size and weight limitations, a Tamiya Plasma motor with a rated voltage of 1.5V, rated speed of 25,000 rpm and rated torque of 20g-cm. However no single small and light battery could power both the motor and receiver. More importantly, the thrust generated was not enough to overcome static friction and start the MAV moving on flat ground, even after experimentation with other batteries. This is probably due to the motor is not designed for MAV, and the propeller used maybe too big (both in diameter and pitch) which reduced the performance of the motor. Finally we had to switch to a light petrol engine, the Cox 0.02-cubic inch Pee Wee, rated at 20,000 rpm. Once decided on the design, we started to select the lightest possible radio control components. We bought Multiplex Pico 3/4 receiver (7g) and Futaba S3103 micro servos (9.5g) with their associated Multiplex Pico transmitter handset. We also found a smaller battery for the receiver, a nickel-cadmium weighing only 18g.

Material selection

The most important criteria is light weight, for the MAV to have sufficient lift and better flight characteristics. Big parts like the fuselage and tail would have to be made of balsa wood, both light and strong. For other parts like the wing structures, wing leading edges and engine mounting, we compared a few materials (balsa, styrofoam and plywood) from the aspects of weight, strength, stiffness and ease of fabrication. The tables in the next section (results and discussion) summarize the comparisons. As with all material selection some compromises had to be made. We finally decided on balsa for the wing structures (light and easy to fabricate), styrofoam for the wing leading edges (ease of fabrication) and plywood for the engine mounting (strength).

IV. FABRICATION

So we first cut 5-mm balsa into airfoil ribs and glue them together with spars in the wing structure. After sticking the styrofoam leading edge in front we wrap the two wings in heat-shrunk plastic foil. For the fuselage, we cut a half-inch balsa and cut holes in it to fit snugly the various MAV components, and sand the sides to give a ten-degree dihedral to the wings. After gluing the horizontal and vertical tailplanes (with their respective elevator and rudder control surfaces) to a tail spar, we put the whole plane together: engine and its mounting at the front of the fuselage, wings at both sides, tail at the rear, receiver and battery inside, and 2 servos underneath. Finally we glue the main landing gears to the front of the fuselage, rear landing gear to the rear of the tail spar, and put in connecting rods to transfer servos movement to the tail control surfaces.

4.1 The Benefits of Micro Air Vehicle

- Maximise performance due to optimum combination of planform shape.
- Low Raynolds number

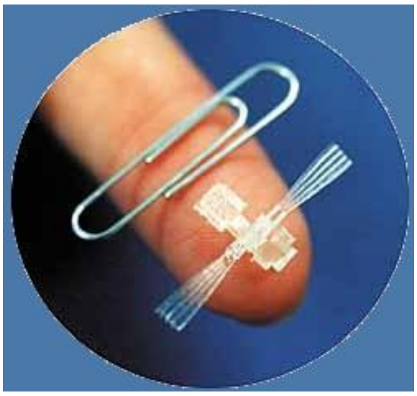
LIMITATIONS

- Highly skilled manpower required.
- High initial investment.

4.2 Application & Scope

a) Military applications

- Micro Air Vehicle use as upgrated technology like optical cameras, signal boster.
- It is usefull in taeget finding, to know position of enemy.
- Following image shows Micro Air Vehicle which is use in military applications.



b) Civil Application

- Using MAVs with flapping wings (Entomopters) to explore mars is a project already underway.

V. CONCLUSION

In conclusion, we have met the objectives of buildings and test-flying a few MAV prototypes with wingspan of under 30cm, in the process learning a lot about the fabrication and characteristics working of a MAV. The MAV was not very stable, which might be remedied our knowledge on some theoretical and other aspects like aerodynamics, avionics, flight measurements and power plant. Overall this topic has been a valuable experience for us in research, development,implimentation and experimentation.

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