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Optimization of Micro Air Vehicle Endurance by using Dynamo

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Abstract: ***The potential application for MAV's in military, patrol and civilian are numerous. For most patrol applications MAV's would be controlled by local users, operated by remotes to supply real time data. This paper focuses on a patrol surveillance application that uses either visible or mid wavelength infrared imaging sensors. The propulsion would be provided by a combination of an electrical motor with either an advanced lithium battery or fuel cells. Micro air vehicles flight control would require control surface actuators for effective control. The MAVs uses delta wing design and propeller placed at the rear-end for better control and power production. The whole body of micro air vehicle constructed using glass fiber. Here we present an idea of continuous power supply for recharging the battery using a dynamo. The dynamo will be connected to the main motor through gears. This design increases the operating hours to a minimum of 25% of normal endurance.***

Keywords: ***MAV's, Lithium Battery, Dynamo, Control Surface, Actuators, Remote, Endurance.***

1. INTRODUCTION

Micro Air Vehicle (MAV) is a small, portable flying device which is designed for performing useful work. Its construction should enable a single person to operate it together with a complete ground station. Moreover, MAV should be safe and even collision with a human does not have any harmful consequences.

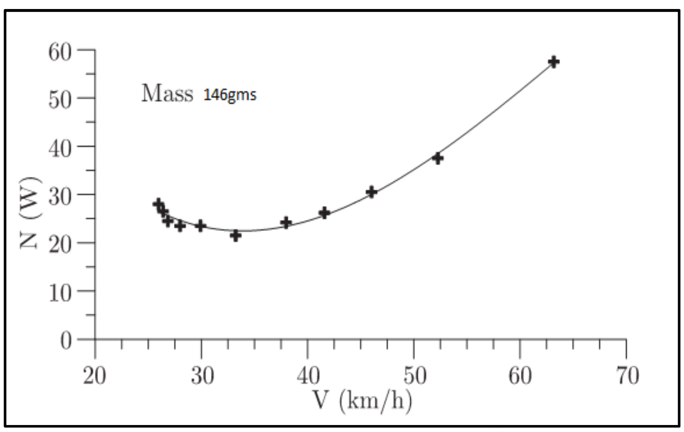

Fig. 1: power required

In most cases, MAVs are envisaged to provide direct reconnaissance in various environments. These environments impose various requirements on the vehicle and hence there are different concepts of MAVs' design exhibiting different characteristics allowing them to match these requirements. However, all these concepts pose certain problems which have to be solved before MAVs can be utilized. This paper attempts to present these problems and show some possible solutions.The speed of MAV is very low and the size is less than 40.1 cm length, width or height. MAVs are not the small versions of ordinary aircrafts but are affordable fully functional, military capable, small flight vehicles in a class of their own.

2. TYPES OF MICRO AIR VEHICLE

The types of micro air vehicle base on the design.

Fixed wing

A fixed-wing aircraft is an aircraft capable of flight using wings that generate lift caused by the vehicle's forward airspeed and the shape of the wing.

Flapping wing

Up and down when flying or preparing to fly. "A pheasant flapped its wings"

Rotary wing

An aero foil that rotates in an approximately horizontal plane, providing all or most of the lift in a helicopter or autogiro.

2.1. Fixed wing MAVs.

This is the best developed type of MAVs. There were several prototypes built and proposed to customers already. They exhibit quite good forward flight capabilities: gliding ratio in order of 8, maximum speed in order of 20 m/s and flight duration in order of 1 hour. They have power loading in order of 13 kg/kW for steady level flight. The below Figure shows the power required for flight measured for the MAV built in the delta wing configuration with weight of 146gms.

3. AERODYNAMICS

The flight regime of MAVs results in a fundamental shift in aerodynamics. Prominently, it is an environment more common to the smallest birds and the largest insects. Basic understanding of the aerodynamics encountered here is at present very limited. The flight behavior of these exotic creatures of nature cannot be predicted with the familiar high Reynolds number aerodynamics commonly used in UAV design. Low Reynolds number aerodynamics of MAVs may result in unusual configurations, Such as low aspect ratio fixed wings to rotary wings, and even more radical concepts like flapping wings.

4. STATUS OF AND PERFORMANCE OF CURRENT MAVS

The development of MAVs has been spearheaded by the Department of Defenses (DoD) need to develop autonomous, lightweight, small-scale flying machines that are appropriate for a variety of missions including reconnaissance over land, in buildings and tunnels, and other conned spaces. Of particular interest is the ability of these vehicles to operate in the urban environment 4-7 and perch on buildings to provide situational awareness to the warfighter. Following DoDs lead, numerous national and international government agencies have initiated activities to develop small autonomous flying vehicles. To establish guidelines for vehicle designs, an urban mission was assumed, and a set of baseline requirements was developed. Vehicles had to be compact, efficient, and simple to design and operate.

5. VEHICLE CONFIGURATION

Propeller

The first two digitsare length (inches) and the latter two digits are circular pitch (inches/10) 96030 (length 6 inches, pitch 0.3 inches)

Dynamo:

Fig. 2: micro dynamo

Power: 1W
Voltage: AC3V ~ 5V (2RPM by hand)
Current: 100-200mA
Rotation Direction: Reversible
Battery (lithium polymer)

Series connected by two 3.7V lithium batteries respectively. The weight including connector is less than 30 grams. The current capacity is above 800mAh.

Motor

The motor chosen to be used in thisstudy weighted 30g, its maximum rotationspeed is 21000RPM (withoutloading); maximum current is7A.9 poles brushless high magnetouterrotor motor, statorisprotected by high strengthres into resist high temperature and create low vibration

6. SPECIFICATIONS

Servo	- 6gms (Three)
Motor	- 30gms
ESC	- 40gms
Propeller	- 15gms
Dynamo	- 14gms
Battery	- 26gms
Air frame	- 15gms
Total	=146gms

7. DESIGN OF MAV

The Design of Our MAV Uses a dynamo. The Dynamo Acts on a Continuous Supply of Power to the Vehicle, then Allows it to stay in the air for a Considerable Period Of a time. The Design is a simple one as in the Conventional Model airplanes; the exception is use of propeller at the back end of the plane. This Propeller design allows the surveillance camera to be placed in front of the aircraft for covering wide camera angles and good visibility. The plane also Carries an on board battery (Rechargeable) which acts as a capacitor for energy storage.

The battery is supplied with its power through the use of dynamo running. The dynamo is run using the rotation of the propeller. As the propeller turns, the dynamo is charged. A (IC 7805) Regulator is used to convert the voltage in the dynamo to a smaller value. The reduced voltage (5V) is send to the battery

Which rotates the propeller this primarily a continuous closed circuit. Since there is a continuous flow of current to the propeller, the endurance ability of the plane can be improved. The camera Located in the front is place within the underside of the fuselage. This Placement allows for a clear view without the disturbance from the head wind.

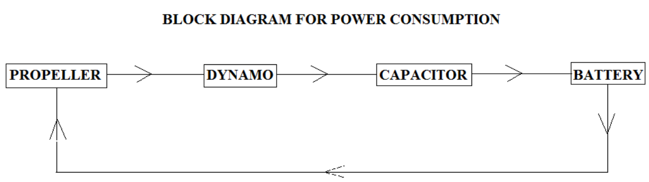

Fig. 3: block diagram for power Consumption

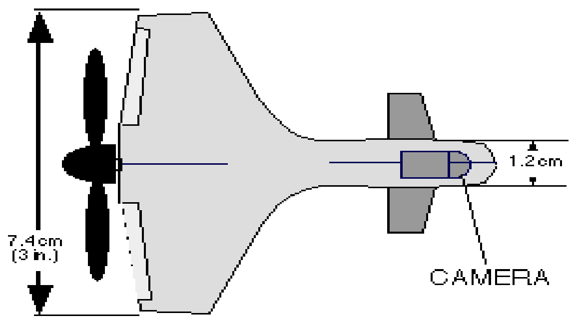

Fig. 4: Mav design

7.1 Camera

The CM-588 (16*8*8mm, 2.5gr) camera was chosen. It has over 380 lines of resolution and works with a 6V DC power supply, 35mA current draw. The LUV 1000S video transmitter is used to send data to a ground station.

A rotating system was made so that the camera is capable of 90 degree rotation for a better view of the targets. The servo in the rotating system is controlled manually by the pilot.

6.2 Actuator

The actuator system is a very important part in our whole system configuration, as it is used in all of our control surfaces (rudder and elevens). The actuator will be controlled by the autopilot to change the flight altitude if necessary.

Of primary importance in the selection of the actuator is the size. It is likely that the actuator will have to be embedded into the wing and thus a small actuator would be extremely desirable. There are many types of actuator available for use and three popular options will be considered in our design,

A traditional actuator which is powered using a servo motor, an advanced design incorporating Memory Alloy technology and linear servo track.

Nano Muscle Actuator has much lower rated force at peak power compared to the normal actuator. These two types of actuator have the same size, however the Nano Muscle actuator is much lighter. The final decision is Nano Muscle Actuator because it can gives more input voltage and current draw, also lower rated force as we only need very small rated force in our design. Besides, this type of actuator is much cheaper than the normal one.

8. TYPICAL APPLICATIONS MAVS

Photogrammetry – remote sensing – measurement – GIS, Search & rescue tasks, Inspection, protection & security tasks, Surveillance & monitoring, Research & development, Aerial photography & video.

The tasks envisioned for MAVs are radically different from those of other flight vehicles. The main motivation for the development of these vehicles arose from military battlefield requirements. MAVs are expected to be a great asset to the platoons and to a single soldier too. These will give the individual soldier information about his surroundings, resulting in better situational awareness.

MAVs have more applications besides military-based ones. MAVs can deploy a useful micro payload to a remote and hazardous location, where it may have to perform a variety of missions, like reconnaissance and surveillance, targeting, tagging and biochemical sensing.

9. CONCLUSIONS

The use of dynamo in the design enhanced the loitering capability of the aircraft. The placement of Propeller and the Camera add an advantage of packing good picture for relaying to the transmitter. The size of aircraft allows for it are in closed areas like urban environment. The ability of aircraft to send emergency message like forecast, fire, accident, and other natural disorders to the concerned authorities will make way for a better resource under the circumference.

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