A. Title Page

Development of a Scalable Long Endurance Vehicle for Military and Environment Surveillance

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B. Restatement of problem researched, creative work, or professional enhancement opportunity

Robotically operated vehicles offer a safe alternative to manned vehicles in many hostile environments. With the recent success of the Predator drones in places like Iraq and Afghanistan it became apparent that robotic aerial vehicles are here to stay and will play an increasing larger role in the conflicts of the future. Additionally, similar unmanned vehicles could be deployed in areas where a natural or man-made disasters (nuclear reactor meltdowns, oil spills, chemical or biological accidents, etc.) have occurred. These vehicles could be used to monitor various environmental conditions (radiation levels, biological exposure, etc.) without putting people in harm's way.

One shortcoming of canard-wing based drones like the Predator is their limited flight time. In some instances it is needed to monitor a specific location for a prolonged time (several weeks) to gather needed surveillance, or environmental data. The Predator drone has a flight time of only 24 hours which limits its capabilities to gather continuous intelligence. A possible solution to this problem is to use so called Long Endurance Multi-Intelligence Vehicles (LEMVs). These aircraft are hybrids in the sense that they use a helium envelope to support the craft and its fuel and use external rotors to support any additional payload that may be necessary or to provide maneuvering thrust. This hybrid design is extremely efficient and can result in continuous flights of 3 weeks or longer. Since the craft is

FIGURE 1 An artist rendition of the *LEMV Floating Sentinel* developed for the U.S. Army.

outfitted with additional thrusters the speed can be as high as 80 knots in short bursts.[1] Figure 1 is an artist rendition of LEMV Floating Sentinel.[2]

In this project we would like to engineer a scalable hybrid craft that can be flown either in remote or autonomous mode and carry an array of sensors.

D. Summary of findings, outcomes, or experiences had.

In order to implement our design we first chose an envelope that would hold the helium gas in our LEMV. The envelope we chose was a seven foot blimp shape made from polyurethane. This envelope has a helium capacity of approximately 24 cubic feet. In general the lift of a helium filled envelope is roughly one ounce of lift for each cubic foot of helium. For this envelope the polyurethane bag has a weight of 8.2 ounces so our vehicle has an extra 15.8 ounces of lift available to hold all of the control electronics, motors, batteries, and sensors.

Our goal was to design a system that could fly in two possible modes: autonomous mode, or remote mode. We also wanted the ability to switch between the two modes during flight. This would allow an operator to save the aircraft if it was unable to autonomously navigate an obstacle. To achieve this we first began by choosing a Polulu TReX Jr Dual Motor Controller. This board allows a user to control two bidirectional motors from a serial line (RS-232 or TTL), radio control (RC) receiver, or an analog voltage source. This is also small and lightweight weighing just around 0.5 ounces.

After choosing an appropriate motor controller, we next chose the microcontroller that will serves as the “brains” for the aircraft. The microcontroller we used was an ATMega328 processor. The processor was mounted on an Arduino Uno development board. This board has 13 digital pins and 6 analog pins that can be used for sensor inputs or controller outputs. In addition to selecting a motor controller and microcontroller, we also selected appropriate dc motors, radio controller receivers, batteries, sonic sensors and micro servos for the system.

Our approach to controlling the aircraft autonomously was to use an array of sonic sensors. Three sensors were mounted on the front of the gondola, each at approximately 30 degrees. These sensors detect if there is an obstacle ahead of the vehicle. If the sensors detect an obstacle the microcontroller implements obstacle avoidance subroutine designed to steer the vehicle around the object. A fourth sensor is mounted on the bottom of the gondola. This sensor is designed to detect if the vehicle's elevation. If the sensors detect that the aircraft has lost considerable altitude the microcontroller will calculate an appropriate course and will have the motors add altitude.

E. Conclusions and recommendations

In conclusion we have been able to show a proof of concept design for a LEMV. This project has a lot of potential. We would like to add a GPS system to our vehicle so a user could program in GPS waypoints and have the LEMV navigate a path to these points. Also the sonic sensors are good for short range obstacle avoidance (~5-10 ft), it would be advantageous to have additional sensors for long range obstacle detection (10-30 ft). This would make the vehicle more efficient resulting in better battery life. Additionally, the helium envelope should be optimize for the load capacity and environmental conditions.

REFERENCES

1. http://www.popsci.com/military-aviation-amp-space/article/2009-06/dread-zeppelin-armys-new-surveillance-blimp

2. http://current.com/science/92582105_new-airships.htm