Intelligent Machine Design Lab
Final Report Summary

Daedalus Project

Submitted To:
Dr. A.A. Arroyo

By: Daniel Kent
April 22, 2003

Table of Contents

Abstract

This paper represents a very broad summary of the work I performed this semester in IMDL for my robot. A longer and more in-depth review of this material will be forthcoming. What follows is a guided tour of the triumphs and failures of an exploration into a novel and unique flying vehicle and creating an autonomous control system for it.

Introduction

The Daedalus platform is probably the accomplishment of my life, to date. It represents four and half long months of steady work. Originally I sought to simply scale up in a few key areas a similar vehicle available as a remote controlled toy. The final product resembles the DraganFlyer III vehicle in almost no capacity. Daedalus has provided a very robust education to me in a number of new technologies including Lithium-Polymer batteries and small brushless motors. It has, finally, successfully met several of its design goals including increased payload capacity and flight duration.

The Daedalus platform was completely designed in Pro/Engineer by me and built custom on a rapid prototype machine out of ABS plastic. The original design was built and came in significantly over weight. Three design change iterations later, a vehicle with all the key components has shown the ability to take off and hover. Figure 1 shows the final vehicle configuration.

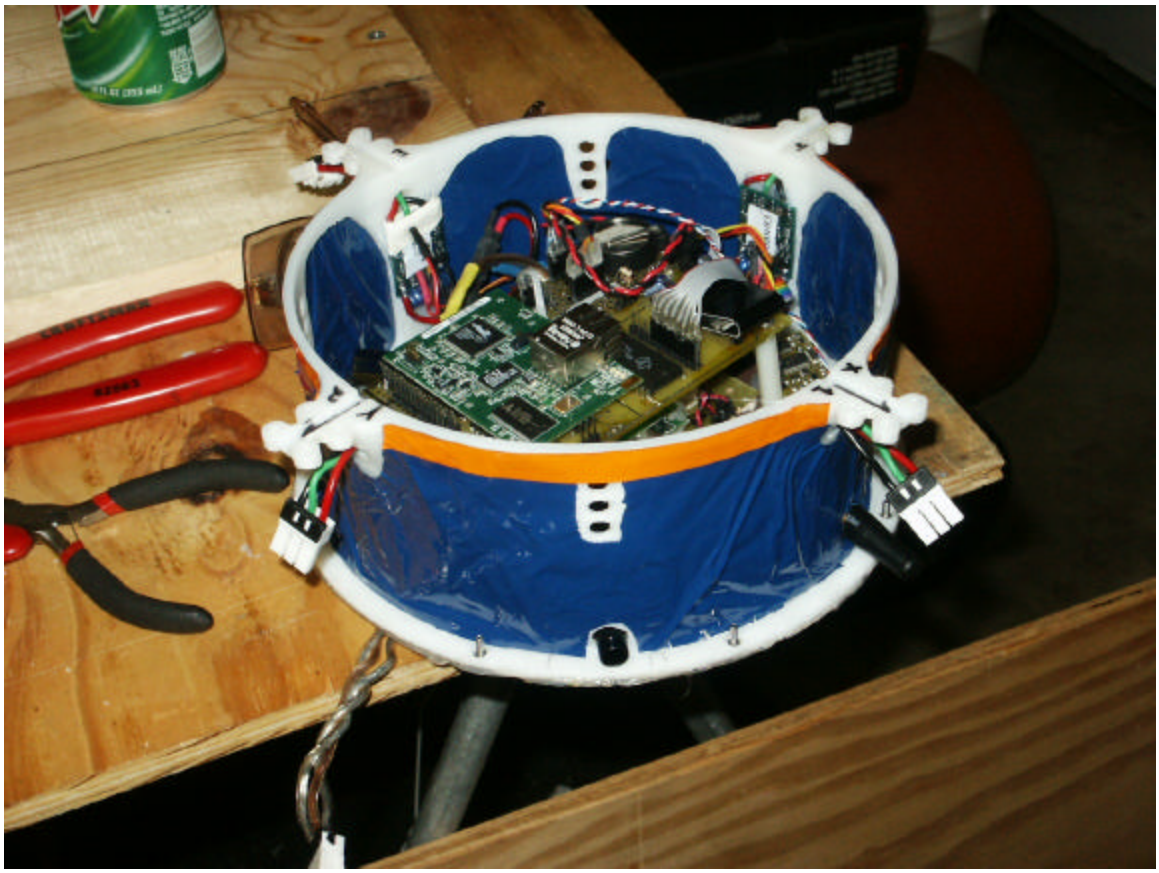

Figure 1 - Vehicle Configuration after third interation

The drivetrain and power systems on Daedalus were also learning experiences for me. The drivetrain was custom designed by for the vehicle's performance needs. It consists of four AstroFlight 010-14T brushless DC motors coupled with a 4.4:1 planetary gear box. Attached to these are 14-inch diameter, 8-inch pitch propellers. The system altogether produces over 1700 grams of thrust.

Power onboard Daedalus was an issue from day one. I quickly learned that lithium-polymer cells offered the highest power density currently available. However they are relatively expensive and require special care in use and while charging. The battery pack

designed for Daedalus has a nominal pack voltage of 7.4 volts and a capacity of 6480 mAh. The pack weighs about 300g total.

Testing

Testing my platform was an adventure. All throughout these four months I have tested and retested components as they came in. About Spring Break time I was finally ready to test a motor running off my microcontroller. A video of this propeller test is included in the accompanying CD.

One unique test came about during a battery testing session. The motors seemed to be producing an unnerving amount of heat. Therefore design changes were done to include a heat sink and cooling system to cool the motors. Each motor was covered in thermal paste and the heat sinks attached. After this a test was done in which a motor was run continuously and the temperature recorded using thermocouples. A picture of this test is shown in Figure 2. The highest temperature recorded was 178°F on the motor casing.

Figure 2 - Thermal Testing

Conclusions and Future Work

The future for the Daedalus project is very bright. I will continue to improve the system performance, refine the control system and redesign the mechanical systems to reduce weight further. It is my hope to use this platform, or what follows it, to do some aerial mapping as a component of my master's research thesis.

Short term plans include more testing of motors to produce thrust and torque curves for each motor and relate that information to current and prop speed. Also to investigate other option in propellers, as they are a limiting factor to this design.

Overall I would like to thank some people for their help and support on this project:

- Dr. Carl Crane – for funding a project like this and having confidence in it
- Dr. Antonio Arroyo – for making a class like IMDL possible and fun

- Roberto Montane – for the use of his garage, his equipment, his expertise, his advice and his optimism at rough times
- Carl Evans – for his help in the electrical design questions and concerns along the way
- Everyone at CIMAR for their help and advice throughout this semester

This summary was just a brief and admittedly poor overview of the work I have done this semester. I will be sure to provide IMDL with a more robust report in the coming weeks for future properity.