Team 6 - Autonomous Aerial Vehicle

Restated Scope/Plan Report

Spring Semester – 2013

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Executive Summary

We have identified three major categories in which the success of our mission relies: image recognition, autonomy, and flight itself. In the fall semester, we have made significant advancements in each of the categories.

The team has selected a method by which image processing will be accomplished. This is via open source coding openCV. OpenCV has allowed us to assemble fundamental programs and gather a strong foundation to begin image processing. The previous team has accomplished many goals toward the success of this project, but little in the way of image processing. This semester began with only the acquisition of a camera and no software. Since then, our team has been able to assemble programing algorithms using openCV that can identify colors and shapes in the context of our objectives; two key elements in this competition. Because of the logistical challenges faced with the members of the team working heavily on the programming side of this project being separated from the equipment, much of our development will be tested for the first time this spring. This is also the situation with the autonomy portion of this project.

We have selected and purchased a system to provide guidance to our autonomous aircraft: the ArduPilot Mega 2.5 and the 3DR GPS uBlock LEA-6 will be the hardware and paired with APM Mission Planner software to complete the autonomous phase of the competition. The APM Mission Planner program is a versatile program compatible with these components and provides a user-friendly interface with which to control the waypoints and adjust the search area.

Next are the developments in getting the vehicle airborne. We have decided to change the motor from electrically powered to gas powered. We determined that the flight time with the current battery would be inadequate and additional batteries would be too costly in terms of weight. A few minor repairs and preparations have been done and we expect to be flight-ready in the days to come.

Lastly, we have added a new team member to our group. We are happy to welcome Ernandes Nascimento to team 6. He is visiting from Brazil and is a mechanical engineering student studying along with us for the spring semester. We are confident that he will contribute to the group and be a benefit to all of us.

Project Updates

Scope

The purpose of this project is to design and construct an autonomous air vehicle for the submission into the 2013 Undergraduate Students Unmanned Aerial Systems Competition. The aircraft must adhere to specific tasks and will be evaluated on how well it performs these tasks, as well as maintain consistency with the associated design and technical report.

The autonomous aircraft that team six will be working with is being divided into four main subsystems: the plane, the camera system, the autopilot and autonomous software and the image processing software. Each team member will be focusing talents on a specific subsystem to generate a vehicle that meets the competition guidelines. The primary focus of this project is to bring an aircraft to compete in the AUVSI competition being held in Maryland in June of 2013.

Goals and Objectives

This is a performance based competition where the objective is to design an aircraft that will autonomously follow a previously specified route and therefore avoiding no-fly zones. The aircraft will also be required to locate specific targets based on certain criteria such as location, size, shape, color, orientation, the alphanumeric located on the target, and the color of the alphanumeric. The aircraft must be designed to move quickly and precisely, while following the guidelines given by the SAE Aero Design East committee. Bonus points will be awarded for completely autonomous flight, including take-off and landing, as well as, completing the mission successfully in a designated time frame. Safety will be a major component of the project, as the aircraft must be designed with certain safety features to avoid any possible dangers. The project will be structured around three phases: a technical report, a pre-flight presentation and inspection, and the execution of the mission itself. The goal for team six is to successfully complete all of these objectives by the end of the semester in order to attend the competition in June.

Technical Updates

Propulsion System

A decision was made to change the propulsion system on the aircraft from an electric motor to a wet fuel Magnum XL engine. A cost analysis was performed to determine what needed to be purchased in order to put the plane in the air. After taking into consideration the possibility of needing a flight time at, or exceeding that of 40 minutes, it was determined that purchasing an additional 8-cell Li-Po battery would be necessary. In addition to the Li-Po battery, the proper charger also needed to be purchased. Purchasing both the battery and the charger would have cost over $500. The other option was to switch the engine to a nitro/gas engine. Jim Ogorek, employee at Hobby Town in Tallahassee and RC plane enthusiast, is letting us borrow a spare engine that he had. The engine is a .91 cubic inch Magnum XL 4-stoke, and is very commonly used in RC plane flight. We will borrow the engine in order to flight test it, and if everything works well we will purchase our own. The .91 Magnum XL engines cost approximately $250, including all the additional hardware needed to get it up and running. Therefore by going with the Magnum XL motor we have cut our engine expenses in half. An image can be seen below of the previous electric motor and the new Magnum XL motor.

Figure 1 Left: DC motor that used to be on plane. Right: Magnum XL mounted on plane and fuel tank installed.

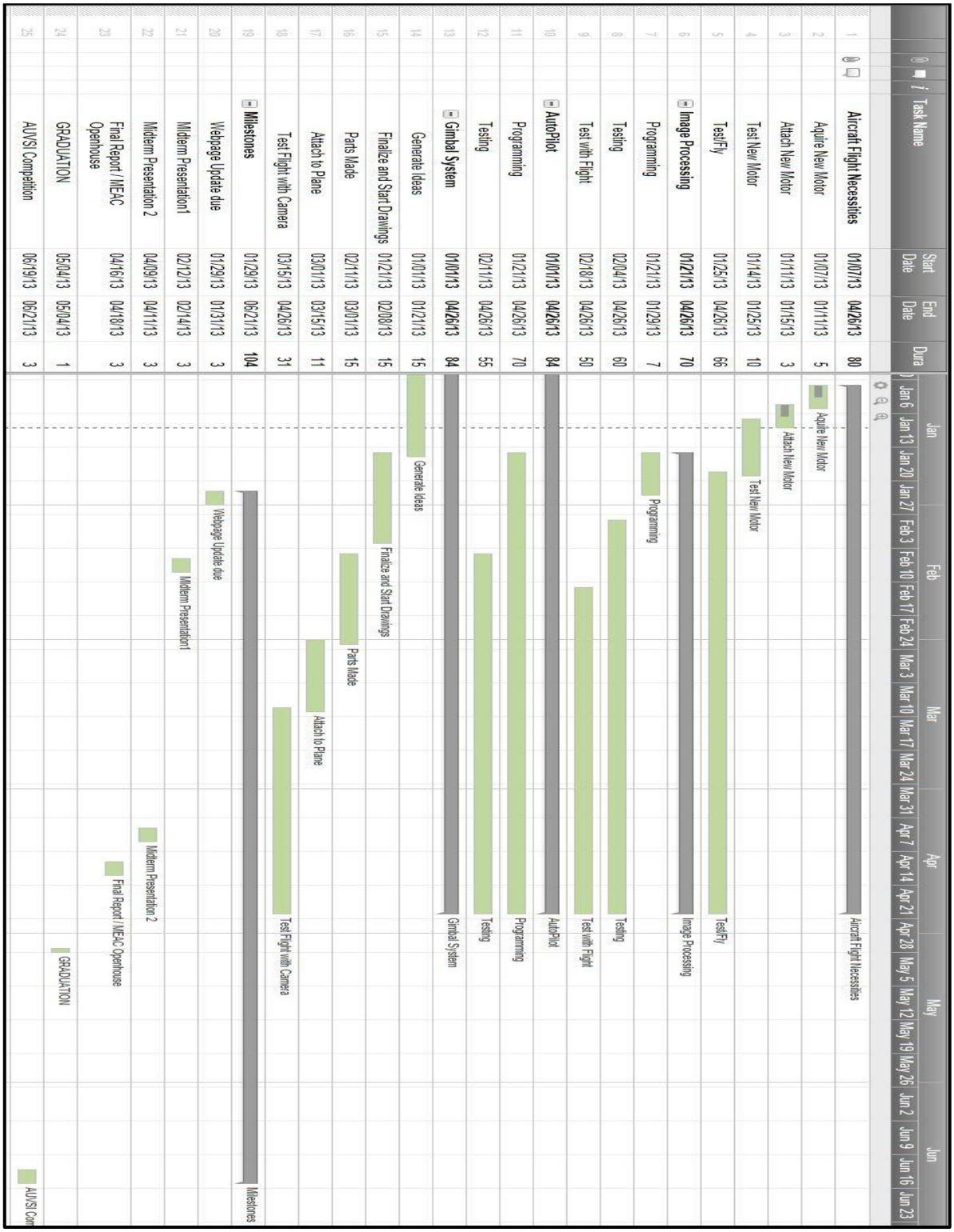
Autonomous Hardware

Most of the theoretical part of the project was done in the first semester and now we will be working on actually implementing the systems that we have been researching. For the autopilot system the software (Mission Planner) has already been downloaded and the hardware (Ardupilot Mega 2.5) arrived over Christmas break. Now our next objective will be to connect the autopilot with the GPS, telemetry kit, gas engine, rudders, etc. After everything is connected correctly we will need to install the APM software along with calibrating and tuning the APM. DIY Drones has a Wikipedia page for the Ardupilot that goes step by step through the setup, calibrating, tuning, etc. so, we will proceed with installing and testing using this page as a reference.

Image Processing

The start of the second semester marks a fundamental shift in the development of our image processing system. With time becoming a major constraint on our project, the focus of our efforts has shifted from design work and development, to implementation. Tasks still needed to be done include, but are not limited to, successful wireless transmission of video feed from camera to ground computer, attaching camera body to fuselage of air vehicle, along with further development on target recognition modules.

Gantt chart


Task Name
Start Date
End Date
Dura
Jan
Feb
Mar
Apr
May
Jun
Jan 6
Jan 13
Jan 20
Jan 27
Feb 3
Feb 10
Feb 17
Feb 24
Mar 3
Mar 10
Mar 17
Mar 24
Mar 31
Apr 7
Apr 14
Apr 21
Apr 28
May 5
May 12
May 19
May 26
Jun 2
Jun 9
Jun 16
Jun 23
1 Aircraft Flight Necessities 01/07/13 04/26/13 80
2 Aquire New Motor 01/07/13 01/11/13 5
3 Attach New Motor 01/11/13 01/15/13 3
4 Test New Motor 01/14/13 01/25/13 10
5 Test/Fly 01/25/13 04/26/13 66
6 Image Processing 01/21/13 04/26/13 70
7 Programming 01/21/13 01/29/13 7
8 Testing 02/04/13 04/26/13 60
9 Test with Flight 02/18/13 04/26/13 50
10 AutoPilot 01/01/13 04/26/13 84
11 Programming 01/21/13 04/26/13 70
12 Testing 02/11/13 04/26/13 55
13 Gimbal System 01/01/13 04/26/13 84
14 Generate Ideas 01/01/13 01/21/13 15
15 Finalize and Start Drawings 01/21/13 02/08/13 15
16 Parts Made 02/11/13 03/01/13 15
17 Attach to Plane 03/01/13 03/15/13 11
18 Test Flight with Camera 03/15/13 04/26/13 31
19 Milestones 01/29/13 06/21/13 104
20 Webpage Update due 01/29/13 01/31/13 3
21 Midterm Presentation1 02/12/13 02/14/13 3
22 Midterm Presentation 2 04/09/13 04/11/13 3
23 Final Report / MEAC Openhouse 04/16/13 04/18/13 3
24 GRADUATION 05/04/13 05/04/13 1
25 AUVSI Competition 06/19/13 06/21/13 3
Aircraft Flight Necessities
Aquire New Motor
Attach New Motor
Test New Motor
Test/Fly
Image Processing
Programming
Testing
Test with Flight
AutoPilot
Programming
Testing
Gimbal System
Generate Ideas
Finalize and Start Drawings
Parts Made
Attach to Plane
Test Flight with Camera
Milestones
Webpage Update due
Midterm Presentation1
Midterm Presentation 2
Final Report / MEAC Openhouse
GRADUATION
AUVSI Com

Appendix 1 Budget

Since we have decided to switch our propulsion system to a gas engine, a few extra items were added to our budget to accommodate for this change. We purchased a few screws, fuel tank, fuel hose and a bracket for the elevator cables. Luckily, we were given a motor, a starter, plane caddy and fuel so those are extra purchases that were not needed to come from our budget. Another purchase we see that we might need in the near future is a receiver.

One of our most recent purchases was the registration for the AUVSI competition in June for $500. This fee was not taken from our budget; instead it was given to us through our mentor and sponsor, Dr. Shih. This allows us to be able to keep most our remaining budget for supplies that we might need upon putting the plane together.

Autonomous Aerial Vehicle Budget

Team six

FIPSE Budget	$2,000.00
Remaining Budget	$1,598.43

COMPANY	ITEM	ITEM #	QUANTITY	AMOUNT	ITEM TOTAL
Tower Hobbies	Battery	LXH348	1	$37.99	$37.99
	Plane Bands	LXJC77	1	$2.59	$2.59
UDrones	APM 2.5 ArduPilot Mega Fully Assembled		1	$179.99	$179.99
	uBlox LEA-6H GPS module		1	$50.00	$50.00
	3DR Radio Telementry 915 Mhz		1	$85.00	$85.00
	Airspeed Sensor		1	$28.00	$28.00
Hobby Town	Screws, Fuel tank & hose, bracket		1	$18.00	$18.00
				Total	$401.57

Figure 2: Current Budget Outline