Spring Semester Restated Project Definition and Plan

Team Eight: AUVSI SUAS Competition

FAMU-FSU College of Engineering, Tallahassee, FL

EML 4552C & EEL 4914/5C – Senior Design – Spring 2014

Submitted to: Dr. Shih, Dr. Gupta, Dr. Frank, Dr. Alvi

Authors: David Hegg, Christopher Bergljung, Jermaine Dickey, William DiScipio, Gavarni Leonce, John Murnane, Tavarius Slaughter

Submitted: Friday, January 15, 2015

Table of Contents

Table of Figures

Table of Tables

1.0 Acknowledgement

Team 8 would like to thank Dr. Shih for funding this project and advising Team 8 throughout the process as well as Dr. Frank who has been helpful assisting with the electrical side of the project. Dr. Shih has provided Team 8 with the opportunity to test his personal quad-rotor vehicle in order for the team to acquire a better understanding about quad-copters. Moreover, Team 8 has chosen to design an unconventional aerial vehicle and both Dr. Gupta and Dr. Alvi have offered their opinion about what Team 8 should research for the successful completion of the design. Team 8 has been grateful to be able to have access to an extensive amount of knowledge that would not be accessible without the help of Dr. Shih, Dr. Frank, Dr. Alvi and Dr. Gupta. Team 8 would like to thank them for their continuous support throughout the project.

1. Introduction

Team 8 is multidisciplinary team of engineers whose main objective is to design a vertical takeoff and landing (VTOL) aerial vehicle for the AUVSI competition. Several members of Team 8 are involved in the FIPSE study abroad program. Even with this diverse team, Team 8 has successfully designed the vehicle for the competition and are moving forward to manufacturing the vehicle with goal of finishing the VTOL flight by May 2015.

2. Sponsors Request

After meetings this spring and comments made during the final presentation of fall, the sponsor made it clear that Team 8 needs to keep in mind the ultimate goal which is to compete in future competitions. The sponsor requested that Team 8 stay focused on accomplishing the present goal while keeping in mind the future. To do this Team 8 will create an outline of what has been done and what needs to be done so that the transition between this years team and next years will be smooth.

3. Project Definition/ Goal Statement

"The goal of this project is work effectively as a team to create the best possible aircraft for future success at the 2016 AUVSI SUAS Competition."

Team 8's main project goal at the beginning of the Fall semester was to compete in the 2015 AUVSI competition. Through the Fall semester Team 8, with the help of its sponsor and advisors, decided that it was beneficial for the group and the university to modify the original design and build a design for future competitions. Team 8's new project goal is to modify the existing plane into a VTOL aircraft that will be best suited for the 2016 AUVSI competition. The team plans to finish building the previously submitted design and to have a functioning VTOL aircraft that is capable of vertical takeoff and landing by the end of the semester.

4. Objectives

In order for the team to accomplish the goal set forth in the project definition it must take into account the future of the project as well as the necessary work for this semester. With this in mind, the team has set forth a two year plan with present and future objectives.

Present:

- Review design with current and future goals in mind
- Acquire ordered parts in a timely manner
- Continue stability coding and testing
- Machine and assemble the aircraft for testing
- Test and troubleshoot the system so that vertical flight is achieved

Future:

- Review notes and reports from previous year
- Study new rules for the AUVSI 2016 competition and decide which secondary tasks to pursue
- Begin programming for transitional flight
- Take previous code for autonomous flight and make necessary changes for the new design
- Refer to code and tests done by the 2014 senior design team to optimize the target identification software
- Accomplish all other modifications needed for the secondary tasks selected
- Compete in the 2016 AUVSI SUAS Competition

5. Work Completed

With the spring semester commencing, Team 8 has made significant progress in the steps to completing the overall project. Referring back to the fall semester, the team was able to decide on exactly what direction we wanted to go with for the overall design and concept for the UAV. Team 8 decided it was beneficial to go with a VTOL design for the UAV because it allowed for minimal takeoff and landing area as well as provided a more stable base for autonomous takeoff and landing. The VTOL design also allowed Team 8 to land their vehicle in any condition as it no longer needed a runway. The benefits of this type of design will allow for the ability to be competitive in the 2016 AUVSI Design Competition.

The work that has been completed in order for this design to be made possible is the research of the Arcturus UAV which allowed the team to know whether or not this design would actually be feasible and beneficial in accordance to competing in next year's competition. After the research was completed, calculations were then done to know exactly what parts could be used to provide the appropriate amount of thrust in order to lift and carry the weight of the plane. Once the calculations were completed, the design of the plane was then completed with corresponding parts that would be used to complete the design of the aircraft. After a final calculation and a verification of those results, Team 8 decided exactly what parts were needed to be ordered and from where so that the order forms could be completed and processed. All the parts have been order to complete the design and the next step is to build the finalized design.

6. Final Design/New Development

The final design will be a VTOL design comprised of two carbon fiber tubes, two aluminum tubes, four cobra 4510 multirotor motors, four 60A cobra ESC's, two 5000mAh battery's, a base plate and the existing Senior Telemaster plane.

With parts being ordered for the preliminary building stage of the project, new developments will be made based off the results of the completed build. Once the manufacturing is properly completed with all the parts required for the design, test flight of the

horizontal design can commence. This will allow for developments of what needs to be done moving forward. This will include replacing parts that may not work or be appropriate for this design, stabilization, battery life, and feedback on how well the overall design works based on the calculations that were made in the design phase. Once the proper corrections are made, along with any necessary additions after the completion of flight testing, the next step of working on the vertical test flight and troubleshooting will become the focus. With the testing and properly working of both horizontal and vertical flight, a finalized build can then be worked on.

Some new developments have been made in to the stabilization of the hybrid vehicle. A testing apparatus has been built to simulate one arm of the quad copter. Using a tilt sensor and a microcontroller, the prop motor combination can balance the arm at a 90˚. This idea can be extended to the rest of the arms on the quad copter to help balance the vehicle during flight. The testing apparatus can be seen in Figure 1.

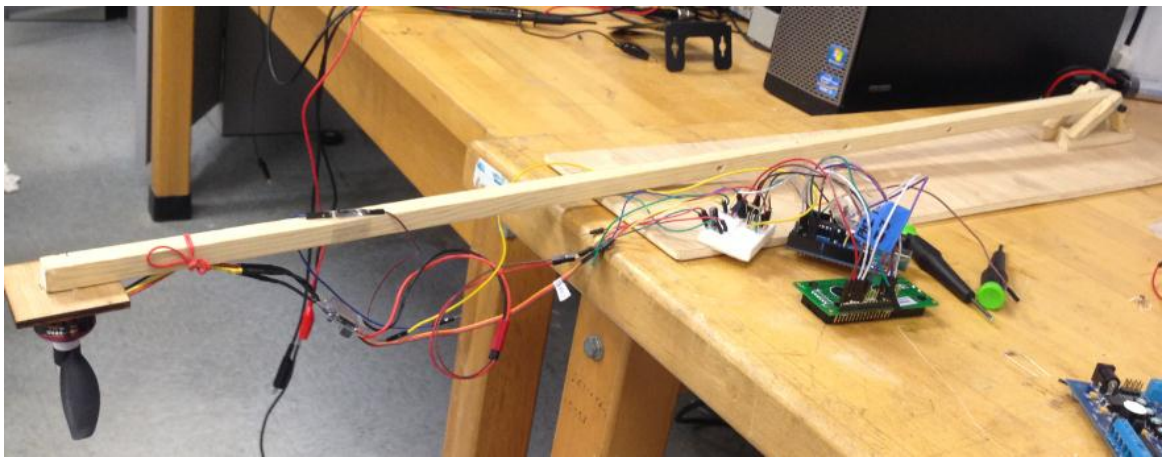


Figure 1: Stabilization Testing Apparatus

7. Procurement

For this project, there are electrical, mechanical, and raw materials that need to be ordered. Below in Table 1 is a breakdown of which parts are needed with the desired quantity and corresponding price. As of now, all the parts listed below have been ordered and are in the process of being shipped to the team. With these parts, to go along with the parts that have been passed down to Team 8, the hybrid plane design will have the necessary components to begin building the design.

The budget for this project was set to be $1500. The total cost of all the ordered parts comes out to be $887.12 which leaves the team $612.88 of excess money. This money can be used to order replacement parts if a part breaks or if any unexpected parts are needed they can easily be ordered with the excess funds.

Table 1: List of Parts

Ordered Parts		
Part	Quantity	Price
Cobra 60 amp ESC	4	$191.96
Venom Flight Pack Battery	1	$119.99
Cobra 420 Kv Motor	4	$299.96
APC 18x5.5" Props	6	$64.32
Quick Recovery Foam	1	$35.26
6061 Aluminum Tube	3	70.14
Carbon Fiber Tubes	2	$71.71
Industrial Strength Velcro	1	$21.79
Orange Epoxy	5	$11.99

8. Schedule

This project's goal is to compete in the AUVSI competition in the summer of 2016. With that being said, the current team schedule is to complete the vertical takeoff and landing of the hybrid vehicle by May 1, 2015. The major aspect of this project are laid out in the Gantt chart (see Appendix) for the spring semester as well as next year to ensure this year's team and next year's team can finish this project on time. By completing the objectives by the stated dates, the hybrid plane can be ready for flight in next year's AUVSI competition.

9. Conclusion

In summary, Team 8 has ordered all the necessary parts for the hybrid plane that it did not possess from previous years teams. Once all the parts are received, the team will begin the manufacturing process of the hybrid plane. This includes machining parts, running wires, and manually modifying parts. This step should take about two weeks to complete once the parts arrive.

While the team waits on parts to be shipped, research into stabilization of the vehicle has begun. A testing apparatus has been built to simulate one arm of the hybrid vehicle. With this idea as a basis, Team 8 can build off this to build future stabilization code and fixtures that will help balance the hybrid plane during the VTOL operation. Having begun stabilization already, Team 8 is in good position to achieve the goals laid out in this report for the Spring semester.

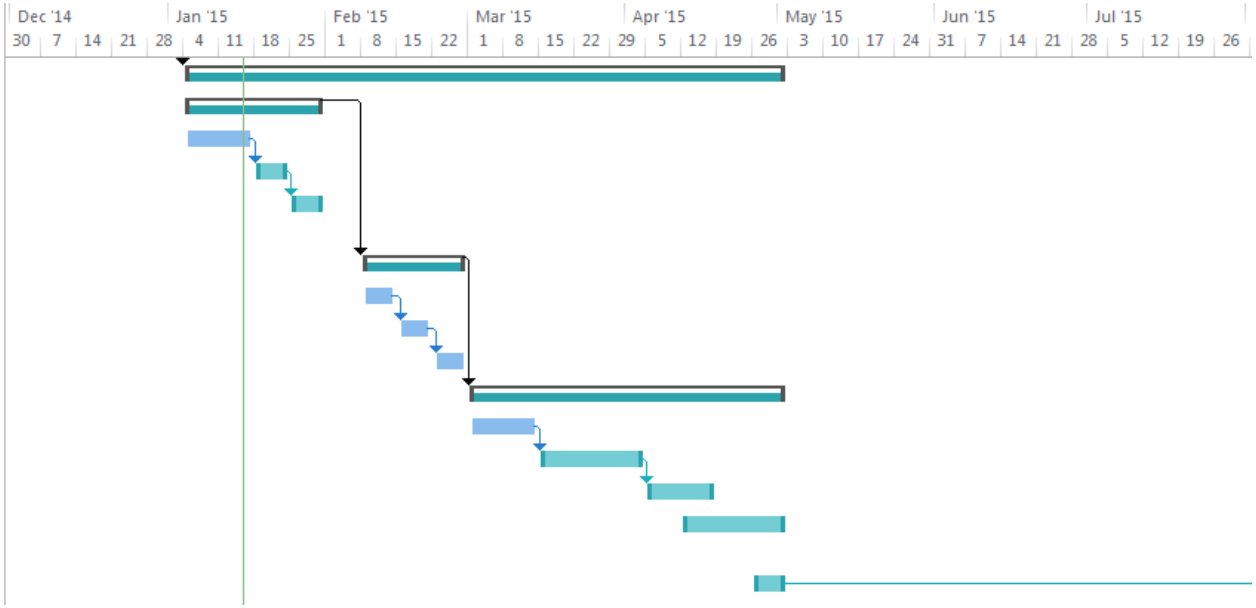
References

1. AUVSI SUAS. "2015 Rules for AUVSI Seafarer Chapter 13th Annual Student UAS (SAUS) Competition." DRAFT 2015 Rules for AUVSI Seafarer Ch(n.d.): n. pag. AUVSI Design Competition. AUVSI, 22 Sept. 2014. Web. 16 Jan. 2015.

Appendix A

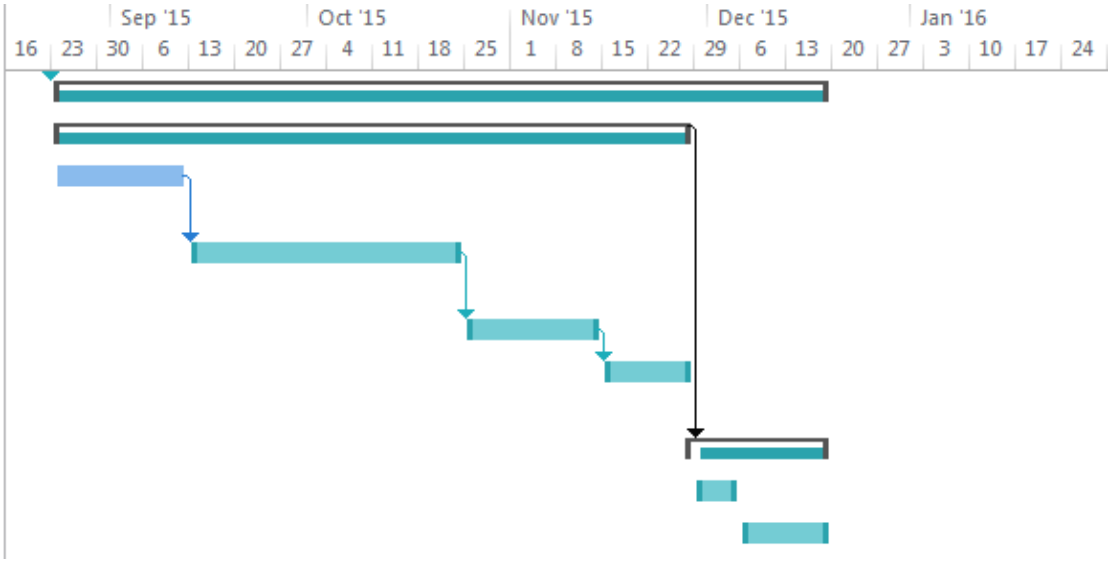
Spring 2015 Gantt Chart

Task Name	Duration
Spring Semester 2015	**17 wks**
Build Design	**4 wks**
Complete design build	2 wks
Drawings of assembled design	1 wk
Troubleshoot and order supplementary parts	1 wk
Forward Flight Test	**3 wks**
Test forward flight	1 wk
Troubleshoot	1 wk
Supplemental test if necessary	1 wk
VTOL Test	**9 wks**
Mount Motor/Rotors to Frame	2 wks
Test VTOL/Stability	3 wks
Touble Shoot	2 wks
Supplemental Test for VTOL/Stability	3 wks
Assessment and Future Plans	1 wk



Fall 2015 Gantt Chart

Task Name	Duration
Fall Semester 2015	**17 wks**
Transitional Flight	**14 wks**
Research Transitional Flight Options	3 wks
Implement the best option for transitional flight	6 wks
Test Transitional Flight	3 wks
Troubleshoot and supplemental test	2 wks
Competition Secondary Task	**3 wks**
Research and select secondary task	1 wk
Designs for secondary Task	2 wks



Spring 2016 Gantt Chart

Task Name	Duration
Spring Semester 2016	**17 wks**
Autopilot	**8 wks**
Optimize autopilot code	5 wks
Test Autonomous Flight	2 wks
Troubleshoot Autonomous Flight	1 wk
Secondary Task	**7 wks**
Build/Code Secondary Objectives	3 wks
Test Secondary objectives	2 wks
Troubleshoot/optimize design	2 wks