Project Plan/ Product Specification

EML 4551C – Senior Design – Fall 2012 Deliverable

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Product Specification

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.

Code of Conduct

The code of conduct is a critical document which is nearly required for a large group to work on a project efficiently. Disagreements over design and implementation are bound to arise and the code of conduct establishes defined rules and boundaries for settling those conflicts.

The code of conduct for our group is unique in that we identified communication as the primary obstacle needed to be addressed. For the first semester of our project, half of our team is living in Brazil and the other half Tallahassee, FL. As such, we came to the conclusion that it is necessary to add the role of Brazil team leader in addition to the standard team leader.

For conflicts between individuals, our team decided on the philosophy that each member must come up with an argument for and against each idea and the group must then decide on which is best. In the case that a unanimous decision still cannot be found, the group will consult the appropriate advisor depending on the conflict.

Problem Statement

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.

Justification and Background

Unmanned Air Vehicles are an increasingly valuable asset in various applications. UAVs eliminate the need for on-board pilots and as such, the limitations associated with providing a livable environment for the pilot. Their use has increased significantly since their inception, and the next step in this developing interest is to apply complete automation to the systems already being used. The current UAV accident rate is 100 times that of manned aircraft, which reveals the current level of this technology as compared to manned flight. The benefits for furthering this technology are plentiful in the private and public sector alike. Scenarios for data tracking, weather crafts and first responder missions have all utilized the UAV. The Association for Unmanned Vehicle Systems International (AUVSI) has created an objective-based competition

that will enable undergraduate students to be introduced to the field of unmanned air vehicles, automation, and image processing. This competition will encourage the development of this technology and give engineering students an opportunity to facilitate an engineering project.

Objective

This is a performance-based competition which will be evaluated in three major criteria: a technical report, a pre-flight presentation and inspection, and the execution of the mission itself. The objectives for this mission are clearly outlined by the SAE Aero Design East committee. The team must design and construct and autonomous UAV that will launch, fly a predetermined path as well as search a specified area, identify targets, provide images of the targets, send these images and location information about the target to a home station, and finally return and land. A time of twenty minutes is allotted for maximum points. The degree of autonomy and quality of launch and recovery will also earn points.

Constraints

The constraints for this project are outlined in the 2013 Undergraduate Students Unmanned Aerial Systems Competition. According to the Seafarer chapter the constraints may change once the final rules and regulations are posted.

- **Gross Weight Limit -** The aircraft may not exceed fifty five (55) pounds in weight.
- **Radios -** The use of 2.4 GHz radio is required for all competing aircraft.
- **Takeoff -** Takeoffs shall take place in one of two designated takeoff/landing areas. Systems which do not require a wheeled landing are permitted to use the grass immediately adjacent to the runway. Takeoffs from moving vehicles are prohibited.
- **Waypoint Navigation -** Air vehicles must autonomously navigate to selected waypoints, and will be restricted to assigned airspace and avoid no-fly zones. A predetermined course which includes changes in altitude and in heading will be followed.
- **Area Search -** Air vehicles must maintain an altitude between 100 and 750 feet MSL, and must avoid no-fly zones.
- **Landing -** Landings shall be performed completely within the designated takeoff/landing area. Control in landing will be graded.
- **Total Mission Time -** Total mission time is the time from the declaration of mission start from the judges and permission to turn on transmitters until the vehicle has safely landed, transmitters are shut off, and a mission data sheet is handed to the judges. Accuracy of results and time required to submit results will be measured. A significant penalty will be imposed for missions lasting over forty minutes, and a sixty-minute mission time will cause a mandatory turn-in of results. If 40 minutes has elapsed after the judges declare mission start and the air vehicle has not achieved flight, the mission will be terminated.

Key Performance Parameters

While these measures will not disqualify a competitor, they are included in these constraints as failure to achieve the following thresholds will incur significant penalty.

- **Autonomy -** Maintain autonomy during way point navigation and area search.
- **Imagery** Identify any two target characteristics (shape, background color, orientation, alphanumeric, and alphanumeric color).
- **Target Location -** Determine target location ddd.mmm.ssss within 250 ft.
- **Mission Time -** Less than 40 minutes total, imagery, location, identification provided at mission conclusion.
- **Operational Availability -** Complete 50% of missions within original tasking window.
- **In-Flight Re-Tasking** Add a fly-to way point.

Functional Analysis

The team has been split up into has been split up in to separate groups and has been tasked to obtain as much information as possible for autonomous aircraft possibilities. Each aircraft is to be analyzed according to their speed, stability, agility, battery power and cost. Once these parameters are found the team is to compare and contrast each vehicle in order to make an educated decision on the appropriate aircraft for this project.

Individual Tasks and Assignments

As stated in the product specifications the project is being split into 4 main components. The Brazil team is in charge of gathering the appropriate information on the autopilot/GPS system that will be used. Once the system is chosen it will be up to the electrical engineers to complete the programming and code with the assistance of the mechanical engineer to couple the software with the mechanical components of the aircraft.

The Tallahassee team is responsible for acquiring the aircraft and learning how to fly it via remote control for testing purpose. The plane also needs to have a camera system mounted to it; therefore a mounting system is being worked on to utilize the existing camera that was used in last year's project. The camera also needs to be connected appropriately which will consist of contacting the manufacturer to get assistance in connecting a remote camera system.

Design Concepts Development

Since this project is competition based it was important to make contact with last year's design team. The advice that was given was to focus primarily on the competition guidelines and not design and build an aircraft. With this advice, the project will use an existing aircraft and will not have a concept generation to design the aircraft. However, different airfoil concepts are being considered and will be researched throughout the semester.

Concept Evaluation and Selection

Once contact was made with the sponsor it was learned that there was equipment left from last year's project. This included a remote control airplane that is currently in operable. The team has made the decision to continue with the use of this plane and make the appropriate modifications in order to get it airborne. Once the plane is airborne, it will be evaluated to find out if a modification to the airfoils will be needed.

Midterm Presentation / Report

The midterm presentation/report will be the summation of all planning and initial designing efforts. The presentation will cover the type of aircraft selected, including wing type and selected motor. Once all of the additional hardware is chosen, weights will be considered, and overall lift generated by the aircraft will be calculated to insure stable flight. Other wing configurations will be considered (i.e. larger aspect ratio) if a larger C_L is needed. The midterm report should also have an initial list with descriptions of all the hardware being used.

The report will be broken up into sections equally between group members here in Tallahassee and in Brazil. Each person will be responsible for their section of interest. The report, though put together by all six group members, will be presented by the three members here in Tallahassee.

Performance and Functional Specs

The performance, maneuverability and functionality of our aircraft will be evaluated once the plane is equipped with the additional hardware (or weight equivalent) and is in the air. Before the planes autopilot system is turned on, we need to have flight trials to insure stable flight.

Once stable flight is achieved, the onboard camera will be equipped and turned on. A transmitter will send a live video feed to a ground terminal. The quality of the video will need to be assessed and deemed acceptable to target recognition.

After the aircraft is capable of transmitting a live video feed in stable flight, the autopilot system will be integrated. Since the autopilot system will most likely be purchased, there is not much programming that will be necessary for autonomous flight. However, we will need to test the accuracy of the autopilots capabilities. This is an important test since a disqualification from the competition is possible if the aircraft travels outside the permitted fly zone.

Product Specifications for Hardware

The majority of the specifications for our hardware (or at least their capabilities) have been specified in the competition guidelines/rules. The motor that will be chosen to fly our plane must have plenty power to generate enough lift to carry the aircraft and all of its components. Once the weight of the aircraft is determined, an adequate motor can be chosen.

The GPS/autopilot system that is to be used must have the capability for waypoint navigation, area scan, and autonomous takeoff/landing. Lastly, the autopilot system must have the capability to be updated in real time to account for additional "pop-up targets"

Gantt Chart

This Gantt chart is currently a work in progress for team six. We have recently found out that we are able to use equipment and software from last year's group. This has dramatically changed how we are going to continue with making progress on this project. Once we have obtained a better grasp on our new current situation we will be able to better apply new tasks to the Gantt chart.

Team 6- UAV Project: Gantt Chart	Duration	Start	Finish	Milestone date
Code of Conduct	8.00	11-Sep	19-Sep	9/20/2012
Needs Analysis	6.00	9/20/2012	9/26/2012	9/27/2013
Concept Generation and Selection	62.00	10/2/2012	12/3/2012	10/11/2012
Team Evaluation Report	13.00	10/16/2012	10/29/2012	10/30/2012
Presentation to MEAC	7.00	11/1/2012	11/8/2012	11/8/2012
Interim Design Review Presentation/ Report	14.00	30-Oct	11/13/2012	11/13/2012
Ordering Hardware/Materials	14.00	11/13/2012	11/27/2012	11/27/2012
Final Design Presentation & Report	13.00	11/20/2012	12/3/2012	12/3/2012
Gant chart	175.00	10/8/2012	4/1/2013	4/1/2013

Team 6- UAV Project: *Gantt Chart*