

AUVSI Design Competition



Figure 1- Senior Telemaster Plus¹



Team 8

Submitted: 9/26/14

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Table of Contents

Abstract.....	iii
1 Introduction.....	1
2 Project Definition	
2.1 Background research.....	1
2.2 Need Statement	1
2.3 Goal Statement and Objectives.....	2
2.4 Constraints	3
2.5 Methodology.....	3
2.6 Expected Results.....	4
2.7 Schedule.....	5
3 Conclusion	6
4 References.....	7

Table of Figures

Figure 1: Senior Telemaster Plus.....	Cover Page
---------------------------------------	------------

Table of Tables

Table 1: Schedule for Competition.....	5
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Abstract

The Association for Unmanned Vehicle Systems International (AUVSI) hosts an annual Student Unmanned Aerial Systems (SUAS) competition for teams to design and build an autonomous aerial vehicle. The competition aims to test the Unmanned Aerial Vehicle's (UAV) ability to fly autonomously and complete several tasks. Flight missions include: autonomous navigation and search, target identification, and remote payload drop. These missions demonstrate a wide range of UAV capabilities. This needs assessment report will create a foundation for Team 8 to compete at a high level at the annual AUVSI SUAS competition.

1.0 Introduction

Unmanned Aerial Vehicles (UAV) are used in military applications (ie. reconnaissance and payload delivery, all while reducing risk on pilots); as well as civilian applications (ie. film making, surveying and even shipping). UAV's have such wide potential and endless possibilities in many markets. The AUVSI Student Unmanned Aerial Systems (SUAS) competition goal is to stimulate interest in autonomous aircraft with the hope of allowing students to take UAV technology to new heights. Multidisciplinary teams of students combine their knowledge to solve these complex engineering problems. The electrical and computer engineers will support the coding, power delivery, vehicle control, image recognition system and other related concepts. The mechanical engineers will focus most of their efforts on the physical and dynamic aspects of the project. With the combined ability of all members, Team 8 will be able to safely and effectively present a fully capable UAV in the 2015 SUAS competition.

2.0 Project Definition

2.1 Background Research

A UAV is an aircraft that does not contain a human pilot. Its flight can be controlled remotely by a pilot or autonomously by a computer.² The idea of developing an unmanned aircraft started in the early 1900s. Aircraft companies were enthusiastic about the possibility of reducing human casualties in warfare. The UAV's during World War II were used in a simulation program for future pilots.³ The United States began deploying UAV's in Vietnam for survey missions. The first rendition of the UAV was not capable of flying independently, as they were controlled by a human pilot stationed on the ground. Additionally, modern UAV's are hybrids of both an autonomous system and a remote control system. A computer can be used to monitor speed, stability and response to external changes in the environment. Furthermore, UAV's can be autonomous in planning its flight course, communicating with its mother base, and analyzing collected data.² UAV's can be utilized in civil applications to track hurricanes and assisting local governments in managing criminal activities.

2.2 Needs Statement

The objective of this project is to build, design, modify, and program an Autonomous Aerial Vehicle. This UAV will be used to compete in the 2015 SUAS competition by the AUVSI. The aircraft will be designed to follow and complete specific system, flight, and task-based mission requirements provided by the SUAS competition rules. Primary tasks of the project involve autonomous takeoff and landing of the UAV, autonomous navigation, and implementation of

completing specified tasks. The team will be required to provide methodology, system engineering facts, and how challenges were addressed during the project.

The project will implement the use of physical and electrical design aspects in conjunction with programming to produce the desired results for the UAV. With access to the previous years' research and finished drone, this year's team can decide whether to modify what was designed in the past or start over with a new design concept. After the final decision is made from analyzing the data and current condition of the drone, the aircraft will be designed or modified, tested, and finally implemented in the 2015 SUAS competition.

The mission of the SUAS competition is to "stimulate and foster interest in unmanned system technologies and careers."⁴ Unmanned aerial vehicles are still a growing concept, and much research and development can be added to improve existing systems.

"There needs to be further advancement in the design and control of autonomous aerial vehicles."

2.3 Goal Statement and Objectives

The goal of this project is to design and build a fully autonomous aerial vehicle to compete in the AUVSI competition in the summer of 2015.

To reach this goal, the objectives are:

- Determine feasibility of previous UAV from last year team and decide on whether to use a rotorcraft design or optimize previous team's fixed wing design.
- Apply for AUVSI competition and submit all supporting document needed.
- Ensure design of new plane or existing plane will meet all the rules of the 2015 AUVSI competition⁴
- Determine new parts that will be needed and collect price quotes, shipping estimates, and performance specifications of new parts.
- Build, program and test an autonomous aerial vehicle that meets all requirements of the SUAS competition.

By completing these objectives before the end of the fall semester, it will put team 8 into excellent position to compete at a high level at the AUVSI challenge. The optimal goal would be to place in the competition.

2.4 Constraints

Several constraints impact the creation of an aircraft able to compete in the 2015 AUVSI Student Unmanned Aerial Systems Competition. Most of the design constraints were defined in the competition's rules.⁴

- Physical Constrains- Aircraft must have a total weight of less than 55lbs. Aircraft should be able to operate in winds up to 15 knots, gusts up to 20 knots and temperatures up to 100 degrees Fahrenheit
- Takeoff and Landing- Aircraft should be able to conduct autonomous takeoff and landing within designated takeoff and landing area
- Navigation- Aircraft must be capable of autonomous navigation. Aircraft must be able to navigate using GPS coordinates. Aircraft must fly at a designated altitude. Aircraft must be able to conduct autonomous search and identify targets on land
- Communication- 2.4 GHz radio will be used for all communication with the aircraft. Aircraft must be able to transmit its position and altitude to the ground team in real time.
- Airdrop- The aircraft must be able to autonomously drop a projectile capable of landing within 100ft of a target.
- Mission Time- The aircraft must complete the mission in 60 minutes or less.
- Safety- The aircraft must follow all safety regulations as defined in section 9 of the *2015 Rules for AUVSI Seafarer Chapter 13th Annual SUAS Competition*.⁴
- Deadline- The aircraft must be completed and ready for the June 17, 2015 competition.
- Cost- The project has an available budget of \$1500

2.5 Methodology

Design Stage

- Selection of vehicle design (old fixed wing or new rotary)
- Research on theory behind flight (fixed or rotary), research into wiring, research on controls, research on autonomous mode programming, research into hardware/software integration
- Research into available parts and designs
- Prototyping using hand and CAD drawings
- Analysis of prototype
- Begin initial coding

Build Stage

- Purchase materials and parts
- Build vehicle
- Test vehicle
- Optimize vehicle

- Ensure vehicle completes primary objectives
- Develop vehicle for secondary objectives
- Final test trials before competition

2.6 Expected Results

The expected results can be broken up into different section of the project and are listed below.

Before Competition:

- The UAV will have proof of flight before the deadline or within five days after the deadline.
- Team must give a Flight Readiness Review (FRR) to the judges to prove that the vehicle is safe and to explain what is planned to be achieved during the mission flight.⁴
- A fact sheet and journal paper will be on time and we will pass the FRR and safety inspection so that the vehicle is able to compete in the competition.⁴

Vehicle:

- The vehicle for the completion must be capable of flight while being heavier than air, i.e. not hot air balloons/blimps
- The competition rules strictly state that the vehicle should stay between 100-750ft through the entirety of the completion except for takeoff and landing.⁴
- The plane must be able to fly autonomously in a safe manner that meet all the competitions safety regulations.⁴

Competition:

- Ability to identify targets in a defined area while flying autonomously
- Capture pictures of targets and relay back to a computer for further analysis
- Pictures of targets should include locations (GPS coordinates) of the targets
- Teams must be able to make a hard copy of pictures of the targets to complete the competition report sheet
- Vehicles must be able to drop a canister onto a target that is placed vertically below the vehicles flight path⁴

Ground Station:

- A map displaying the UAV current position and the “no-fly zone” should be provided for the duration of the flight using google earth. (Failure to do so will result in a disapproval to flying)⁴

- Ground station will provide feedback about the UAV such as the altitude and air speed while also being able to show and change the UAV’s search area and waypoint. If able to change search area then the new boundaries should be shown to the operator.
- Target Data providing location and characteristics of the target should be sent back to the ground station

2.7 Schedule

The deadlines for each part of the competition can be found below.⁴ These are all the deadlines that have been set by AUVSI for the SUAS competition.

Table 1: Schedule for Competition

Activity	Date	Notes
Notice of Intent	September 15, 2014	Notice Posted on Seafarer Website
Draft Rules Posted	September 22, 2014	Draft Rules posted
Teams Written Comments	October 6, 2014	Deadline 11:59 PM
University Day	October 9, 2014	Conference Call In
Final Rules Posted and Registration Opens	October 23, 2014	Final Rules Posted, 8 week registration period begins
Registration Closes	December 18, 2014	Deadline 11:59 PM
Refund for Registration	March 31, 2015	Last Day for withdrawal to receive a refund
Team Composition Table	March 31, 2015	Deadline 11:59 PM
Fact Sheet/Flight Plan	May 11, 2015	Deadline 11:59 PM
Base Access and Information Journal Paper Submission	May 11, 2015	Deadline 11:59 PM
Proof of Flight Video	June 3, 2015	Deadline 11:59 PM
Student Interviews	June 17, 2015	College Juniors and Seniors
Competition	June 17, 2015 June 18, 2015 June 19-20, 2015 June 20, 2015 June 21, 2015	Check in/ Orientation Safety Inspections Flight Mission Demo Awards Banquet Rain Day for Flying

3.0 Conclusion

As it stands now, the team does not have the ability to access last year's UAV. Once the team has access to the UAV, a decision can be made in regards to modifying the previous year's aircraft or to design and build one from scratch. If the decision is made to use the previous year's UAV, it is assumed the team will need to make some major and minor modifications to make the UAV competition ready. These modifications will define the work that needs to be done during the next two semesters. If the team decides to replace the UAV, Team 8 must immediately begin to design, build, modify, and program the new UAV as soon as possible to ensure that all deadlines are met. By the end of the semester, the team should have a flying prototype with a majority of the systems ready for calibration and programming. Functioning components by the end of fall semester should include the manual flight system, IR sensor, vision system, RF-transmitter, and GPS. Having all of this done by the end of our first semester would set the team up for success at the 2015 AUVSI SUAS competition.

4.0 References

- 1) "Senior Telemaster Plus (OVERSIZE)." From Hobby Express. N.p., 24 Sept. 2014. Web. 26 Sept. 2014.
- 2) The UAV. "The UAV - The Future of the Sky." *The UAV*. N.p., n.d. Web. 25 Sept. 2014
- 3) Garamone, Jim. "United States Department of Defense." Defense.gov News Article: From U.S. Civil War to Afghanistan: A Short History of UAVs. United States Government, 16 Apr. 2002. Web. 26 Sept. 2014.
- 4) "Auvsi Seafarer Chapter's Proprietary Information." 2015 Rules for AUVSI Competition." *DRAFT 2015 Rules for AUVSI Seafarer Ch* (n.d.): n. pag. AUVSI, 22 Sept. 2014. Web. 22 Sept. 2014.