

Project Proposal and Statement of Work

Team Six: Autonomous Unmanned Aerial Vehicle

FAMU-FSU College of Engineering, Tallahassee, FL

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Mechanical Engineering

Bernardo Raposo

Ernandes Nascimento

Greg Buker

Jennifer Gavin

Mark Parish

Electrical and Computer Engineering

Jason Randall

Stephen Kwon

Steven Cutchins



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Abstract

The main objective of this project is to design and build an Autonomous Aerial Vehicle capable of performing specific tasks. The aircraft will be submitted to the 2014 Undergraduate Students Unmanned Aerial Systems Competition and will be evaluated on the quality of the performed tasks as well as the consistency of its technical design and report.

Project Overview

Unmanned Aerial Vehicles (UAVs) are pilotless aircrafts, controlled either by onboard computers or through the use of a remote control on the ground. They have become widely used in a variety of civilian, industrial, and military applications. One of the more public (and perhaps controversial) uses of the drone technology is to provide aerial reconnaissance for military commanders and ground troops in forward deployed locations. On the other end of the spectrum, this technology can be used by local law enforcement for search and rescue operations.

These drones, programmed with complex imagery systems, can be extremely effective in scanning oceans for stranded vessels, national parks for lost hikers, or neighborhoods for abducted children (think AMBER alert). Why stop there? It is hard to argue against a swarm of autonomous helicopters bombarding a wildfire with flame retardant, routing to a defined refill zones, and repeating until the fire is neutralized. Many of these applications would typically put an onboard pilot in danger, making the UAV even more appealing. These difficult and pivotal missions have led to a rising demand for more advanced autonomous aerial technology.

Most of these applications require substantial research, testing, and development of complex autonomous systems. Luckily, much of the ground work is already done. There are autopilot systems that require only slightly more work than planning a trip using Google Maps. Computer vision systems that can recognize faces have been researched for decades. This project will work to combine these advanced autonomous systems with fundamental mechanics of flight, while incorporating cooperation between the FAMU/FSU College of Engineering and UNIFEI in Brazil, in order to produce a competition-ready UAV.

The aircraft built by previous Senior Design teams will be used for flight training and to test new electrical equipment and programming, while a new aircraft is simultaneously being designed and built. The aircraft will be tested according to a list of tasks resembling a reconnaissance mission. Upon successful completion of the tasks, Team Six will take this aircraft to the Association for Unmanned Vehicle Systems International (AUVSI) Competition to be held in the summer of 2014.

Justification

The Unmanned Aerial Vehicle (UAV) was first introduced in the 1960's by the United States Air Force to perform aerial missions without risking the pilot's life. The UAVs provide a number of additional advantages:

- Greater maneuverability and stealth capabilities due to its small size;
- Greater design flexibility as pilot's physiological constraints are removed ;
- Greater endurance: physical durability and increased flight time.

With such advantages, interest in UAVs has grown consistently over time as technological advancements have made its use more reliable and feasible. However, due to the still high accident rate (crashing and civilian casualties in military operations) the technologies involved in the UAVs are also a growing field of research and improvement.

Furthermore, the increase of non-military use of UAVs in the recent years has brought more significance to the development. UAV's non-military applications include remote sensing and surveillance, domestic policing, exploration and scientific research, search and rescue, and transportation to name a few. With the growing popularity and growing number of functions, design projects such as this will contribute to the development of a great engineering field.

Project Objectives

The goal of this senior design project is to design and build an autonomous search and rescue remote control plane. The team plans to use their design to compete in the annual Student Unmanned Aerial Systems (SUAS) competition in the June 2014. The competition is scored on a set of primary and secondary tasks. The former goals are minimum requirements to compete while the later provide opportunities for bonus points. Primary tasks require that the plane autonomously fly along a set of waypoints while searching the ground targets using onboard cameras. Targets are correctly identified by determining the following criteria:

- GPS coordinates (longitude/latitude)
- Background color
- Orientation (NE, W, etc.)
- Alphanumeric character on the target
- Color of the alphanumeric character
- Shape of the target

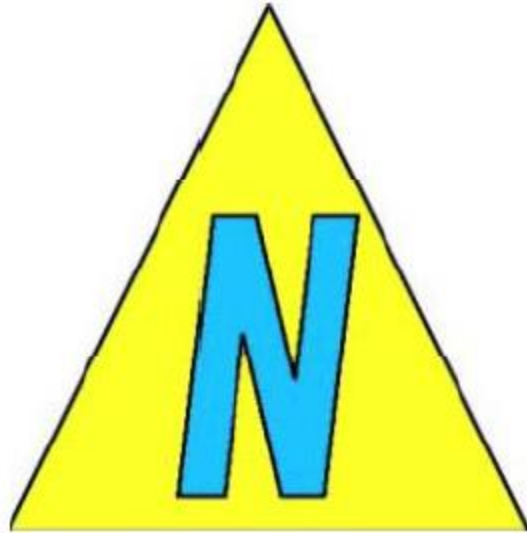


Figure 1 Example Target

There are many secondary tasks which award bonus points. Due to time constraints, our team will not be able to accomplish all of them. The following tables show the secondary tasks which the team is planning on implementing.

Automatic Detection, Localization, and Classification – Find and describe the target’s characteristics automatically using imagery analysis		
Parameter	Threshold	Objective
Automatic localization of each target	N/A	Identify target position with 100ft
Automatic classification of each target	N/A	Identify at least three of five target characteristics
False alarm rate	N/A	Demonstrate less than 50% false alarm rate

Airborne Actionable Intelligence - Provide complete and accurate target characteristics while airborne		
Parameter	Threshold	Objective
Actionable Intelligence	N/A	Identify target location within 50ft and all 5 target characteristics while airborne

Emergent Target – Given coordinates of a last known location, find and describe an emergent target in the form of a human engaged in an activity of interest

Parameter	Threshold	Objective
In-flight re-tasking	N/A	Add last known position of the emergent target as a waypoint
Autonomous Search	Searching for emergent target	Autonomously search for the emergent target
Target Identification	Provide an image of the emergent target	Provide an image of the emergent target, location within 50ft, and an adequate description of the target'

Airborne Actionable Intelligence - Provide complete and accurate target characteristics while airborne

Parameter	Threshold	Objective
Actionable Intelligence	N/A	Identify target location within 50ft and all 5 target characteristics while airborne

Off-Axis Target – Provide target characteristics of an off-axis target within the search area

Parameter	Threshold	Objective
Imagery	N/A	Provide an image of the off-axis target
Classification	Identify any two target characteristics	Identify all five target characteristics
Tracking	N/A	Automatic tracking of the off-axis target

Air-Drop – Drop a simulated emergency rescue canister within a target location while airborne		
Parameter	Threshold	Objective
Release	Manual release within the target area from a specified direction, no greater than 200ft away from the target, airspeed above 25 knots, and altitude between 300-400ft	Autonomous release within the target area from a specified direction, no greater than 200ft away from the target, airspeed above 25 knots, and altitude between 300-400ft
Accuracy	Less than 100ft from the bulls-eye	Less than 50ft from the bulls-eye

In addition to the tasks for competition, the plan for this project includes improvements on some parts of last year’s similar project. The Gimbal video system will be improved to receive less vibration from the motor and therefore read the targets more effectively. Team Six also plans to improve the camera system programming so that the objectives can be read and deciphered accurately by the system. The last objective of this project is to communicate and work efficiently internationally. One member of Team Six is currently working from Brazil, and he will be returning to America at the midpoint of the project. At this time, another team member will leave for Brazil. To complete this project at its highest potential, Team Six must communicate effectively and work together between the two countries.

Constraints

Several constraints are involved in developing a system capable of functioning as required by 2014 Undergraduate Students Unmanned Aerial Systems Competition. In order to present the constraints, the following list is given with brief description about the topics stated by the Seafarer Chapter (AUVSI; International).

Preflight Constraints

- 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 (Team 6 enrolled in Senior Design 2014 inherited a compatible radio).

Inflight Constraints

- Takeoff - Takeoff shall take place within one of two designated Takeoff/Landing areas, depending on wind direction during competition.
- Waypoint Navigation - Air vehicles must autonomously navigate to selected waypoints, and will be restricted to assigned airspace and avoid no-fly zones.
- Waypoints - GPS coordinates (ddd.mm.ssss) and altitudes will be announced the day prior to the flight competition.
- Enroute Search – Air vehicles will be required to fly specific altitudes while identifying several targets along the predefined entry route.
- Targets - Targets will be constructed of plywood of a given size, basic geometric shape, and color. Each target will be a different shape and a unique color.
- Area Search - Once transitioning into the predefined search area via the entry/exit route, the air vehicle shall autonomously search for specific targets of interest.
- Landing - Landing shall be performed completely within the designated takeoff/landing area.
- Total Mission Time - Total mission time is the time from declaration of mission start (from the judges) until the vehicle has safely landed, transmitters are shut off, and target data sheet (or spread sheet) is handed to the judges.
- Real Time Actionable Intelligence - Extra credit will be given for providing complete and accurate information (actionable intelligence) during flight within the search area: once that information is provided, it cannot be modified later.

Miscellaneous Constraints

- Budget: a budget of \$1500 is available to develop the entire project.
- Time: As the project involves routinely testing, the given amount of time might be short.

Design and Analysis

Given that unmanned aerial vehicles have become common not only in industrial and military applications, but as projects for hobbyists around the world, much research and product development has been done on the topic. To succeed in this competition, Team Six must become familiar with these developments and choose the most effective options to incorporate or modify into the design of a competing vehicle. Considering both the requirements of flight and the previously stated competition objectives, three imperative mechanical components of this

project are the vehicle body, motor, and camera mounting system. The requirements and specifications of these aspects will first be discussed, followed by evaluation of available options.

The three major electrical components include the autopilot system, communications system, and the camera system. After initial testing of the last year's hardware, we found out that not only are the major components in working order but they are relatively new with relatively high specs. Therefore a decision has been made to inherit most of the electrical components. This will not only help with the budget but it will also allow for some of the designs from last year to be reused if applicable.

Vehicle Body

Function Analysis:

The first aspect to consider is, of course, the vehicle. Since the goal of this project is to have a working autonomous aircraft ready to compete by the spring of 2014, designing and building a novel vehicle is outside the scope of this project. Instead, Team Six will focus on modifying an existing vehicle to operate autonomously. The primary specifications for this vehicle involve:

- Ability to support approximately fifty five (55) pounds in weight, including the weight of the vehicle's body
- Availability of space inside body of vehicle to house chosen camera system and egg-drop system
- Structural integrity to allow for modifications to body
- Flight stability to facilitate coding for autonomous flight, takeoff, and landing

Taking these requirements into consideration, the clear choice for a vehicle body is an airplane with a large aspect ratio to increase stability and support added loads. After consultation with a local hobbyist, the Senior Telemaster airplane was chosen for modification. Specifications for this model include:

- Wingspan: 73in
- Body Length: 53½ in
- Wing Area: 838 in²
- Flying Weight: 6 lb
- Available Controls: Ailerons, Elevator, Rudder, Flaps, Throttle

Design Concepts:

Team Six has the option of refurbishing and modifying an inherited Senior Telemaster, or purchasing a newer model (Figure 2) to modify from its original condition. The inherited Senior Telemaster is in working condition, but removing or altering the modifications made by the previous design group would require extensive repairs to the structure, and could result in structural weakness.



Figure 2 Senior Telemaster Airplane

Purchasing a new airplane would allow for the selection of a model with wing flaps, which would be pivotal in the implementation of autonomous takeoff and landing due to the increased lift and lower stall speed. The newer model also comes equipped with an electric motor, as opposed to the nitro-powered motor of the inherited airplane. This would give Team Six the option of testing and using either motor.

Another major benefit of purchasing a second plane is that Team Six would be able to use the inherited plane to test new equipment and code, as well as learn how to fly. This removes the high risk involved with testing new modifications on the airplane intended for competition.

These positive and negative aspects are represented in tabular form below.

Table 1 Modification of Inherited Senior Telemaster Airplane

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Zero initial cost • Available immediately 	<ul style="list-style-type: none"> • Repairs must be made to body • No wing flaps for added control during autonomous takeoff/landing • If electric motor is chosen, it would need to be purchased separately • No chance to practice flight or test coding and equipment – high risk

Table 2 Purchase of New Senior Telemaster Airplane

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Wing flaps for added control during autonomous takeoff/landing • Electric and nitro motor options • Inherited airplane may be used for testing • No repairs need to be made – intact body 	<ul style="list-style-type: none"> • High cost

Motor

Function Analysis:

In order for the UAV to fly, it must have a motor. Requirements of the motor include:

- Ability to support weight of airplane
- RPM
- Power
- Ability to run for a maximum of 40 minutes

The Senior Telemaster airplane can fly with either an electric or nitro-powered motor. The nitro-powered option is inherited from a previous design team, and has the following specifications:

- Model: Magnum XL .91RFS
- Stroke: 24.8mm
- RPM: 2,000-11,000
- Weight: 1.4 lb
- Propeller Size: 14x6

The electric motor option has the following specifications:

- Model: .46 Brushless Outrunner
- RPM/Voltage: 600 RPM/V
- Battery Range: 4-6 Lithium Polymer
- Weight: 0.474 lb

Design Concepts:

Since there is a precedent set by the previous design team, implementing the nitro-power motor would be relatively simple. This is an inherited motor, so using it would come at zero monetary cost. However, as the previous design team experienced, the vibrations caused by a nitro-power motor can cause high levels of distortion in the images captured by the onboard camera. Since target detection and area scanning are a major component in the competition, this is highly undesirable.

Implementing an electric motor would eliminate most of the vibrations experienced by the camera, however, the batteries needed to power the electric motor are bulky and heavy. If the weight or required space of additional batteries becomes too great, the maximum flight time of the AUV will be reduced.

These aspects are compared in the tables below.

Table 3 Nitro-Powered Magnum XL .91RFS

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Zero initial cost • Ease of implementation • Proven ability to complete flight time 	<ul style="list-style-type: none"> • Produces high levels of vibration – very undesirable for captured image quality • Relatively high weight: 1.4 lbs

Table 4 Electric .46 Brushless Outrunner

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Minimal Vibrations – highly desirable for captured image quality • Relatively low weight: 0.474 lb 	<ul style="list-style-type: none"> • Will have to be purchased if new Senior Telemaster (already equipped with electric motor) is not purchased • Batteries will add considerable weight • Flight time may be diminished if additional batteries become too heavy or require too much space

Camera Mounting System

Function Analysis:

Many objectives in the AUVSI competition require the aircraft to be equipped with a camera capable of scanning the area both beneath and adjacent to the flight path for specified targets.

With this consideration, the camera mounting system should:

- Provide clearance in front of the camera lens for effective image capture
- Allow for various angles of scanning outside flight path
- Minimize disruption of air flow over vehicle
- Resist tendency to vibrate during flight

Design Concepts:

The typical approach used to control the angle of a mounted camera is a gimbal system (Figure 3), or a system that allows the rotation of an object about a single axis. This allows for the camera to self-stabilize during flight and rotate to view targets outside the flight path. However, the gimbal system is very sensitive to vibrations caused by the nitro-power motor, its complexity leads to heightened risk of failure, and it is expensive. Additionally, the gimbal system mounted outside the body of the airplane will disrupt the flow of air over the body.



Figure 3 Gimbal System

A new approach considered by Team Six involves using a solid-mounted camera inside the body of the airplane, with a glass door through which the camera can capture images. While this eliminates many of the complexities and risks of the gimbal system, this would require the airplane to remain completely level to acquire useful images under the flight path. The entire airplane must also autonomously rotate to view images outside the flight path.

The positive and negative aspects of these options are listed below.

Table 5 Gimbal System

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Ability to self-stabilize • Rotation to scan area not directly under flight path • No barriers between camera lens and desired view 	<ul style="list-style-type: none"> • Sensitive to vibration • Added complexity • High cost • Potential risk of failure • Disrupts airflow over body

Table 6 "Glass Door" Approach

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Mechanically simple • Inexpensive • No disruption of airflow • More resilient to vibration 	<ul style="list-style-type: none"> • Airplane must remain level to avoid distorted images in flight path • Airplane must rotate to view objects outside flight path • Glass could potentially reflect light or become cloudy

Autopilot System and Communications System

Functional Analysis:

A functional autonomous flight can be easily achieved with the Ardupilot Mega 2.5 autopilot system (Figure 4). While it does not provide fine controls for high precision flight out of the box, it is a powerful system capable of being configured and customized for achieving the necessary stability and precision for succeeding in the competition. The main autopilot module along with all of the peripherals such as the GPS module and sensors used in last year's project have been tested to be fully functional and sound in hardware integrity. Some of APM 2.5's features include:

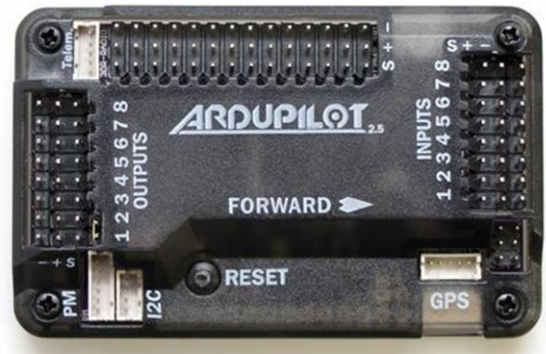


Figure 4 Ardupilot Mega 2.5

- Open-source firmware (ArduPlane), GUI software (Mission Planner), and embedded developer toolkit (Arduino)
- 3-axis gyroscope, 3-axis accelerometer, 3-axis magnetometer, 2-way wireless telemetry
- Support for external GPS module and various sensors
- Support for full "hardware-in-the-loop" testing with flight simulators
- Support for autonomous takeoff and landing
- Waypoint-based navigation

The communications system including the transmitter, receiver, and the controller will be directly inherited as the hardware is fully functional and meet all of the competition requirements such as frequency management.

Design Concept:

The included Mission Planner is a very versatile software. It not only includes support for simple 3D navigation waypoints but it also includes mission planning, in-air parameter setting, on-board video display, voice synthesis, and full datalogging with replay. The autopilot module is fully customizable with the included developer toolkit, which allows for fine tuning necessary for accomplishing complex objectives such as autonomous landing. The old autopilot system and communications systems provide all of the necessary controls for accomplishing a vast majority of the competition objectives.

Camera System

Functional Analysis:

The competition requirements do not list many technical specifications for the imaging system. Therefore the inherited KT&C KPC-E700NUB camera will be sufficient for achieving the minimum goals. However, as the imaging system was the weak point of last year's project, (camera system from last year suffered greatly from vibration) purchasing and implementing higher quality camera will greatly improve various aspects of the project and may be necessary. A main candidate for a new camera is a GoPro system.

Some of the specifications of the old camera include:

- Color NTSC spec (analog, standard definition)
- Effective pixels: 976(H) x 494(V)
- Shutter speed: 1/60 – 1/100,000S
- SNR: over 50db

Specifications of a popular GoPro Silver system:

- Fully digital, HD capable
- Built-in WiFi and included GoPro app for remote control
- Video: 1080p at 60fps, 960p at 60fps, 720p at 120fps
- Photo: 10MP and 10fps burst

Design Concept:

The imaging system from last year's project suffered greatly from mechanical vibration and electrical noise in the analog data. However, depending on some of the mechanical design concepts such as the camera mounting system and choice of motor, vibration may or may not be a constraint on this year's imaging system. In the event that the mechanical designs do not reduce

enough vibrations, newer and higher spec hardware that is operational under such conditions will be necessary for proper imaging. A digital system with a built-in data communications capability will provide a much greater quality image over an analog system as digital signals are less susceptible to noise. Higher quality images will help reduce errors in the image processing software and make implementation of auto target detection easier as well.

The positive and negative aspects of these options are listed below.

Table 7 KT&C camera

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Zero initial cost • Meets competition specs 	<ul style="list-style-type: none"> • Hardware susceptible to vibration • Analog data susceptible to high noise • Low resolution • More complex and more difficult image processing

Table 8 GoPro Camera

Positive Aspects	Negative Aspects
<ul style="list-style-type: none"> • Overall high spec • Digital, HD resolution • Built-in WiFi • More resilient to vibration • Less complex and less difficult image processing 	<ul style="list-style-type: none"> • Cost • May require redesign as the hardware was never implemented before

Evaluation of Designs

Because not all positive and negative aspects are equally important to the project goals, it is useful to rate different qualities of each option on a weighted scale to determine the optimum choices. Below is a decision matrix showing the different options discussed above, rated with respect to competition priority, cost, difficulty of implementation, required time for completion, and risk. Rows highlighted in the same color are in competition with each other, and the option with the highest point value was chosen.

Also shown in this decision matrix are optional secondary objectives of the competition. Since it would not be feasible to attempt every secondary objective, only objectives scoring thirty or more points will be initially attempted. If time and resources allow, additional secondary objectives will be attempted in order of point values. Design concepts for these options have not yet been developed, given that the list of secondary objectives became available only very recently.

Table 9 Decision Matrix

Objective	Competition Priorities	Cost	Difficulty	Required Time	Risk	Totals
Autonomous Flight	10	10	8	9	5	42
Buy New Plane	6	4	9	9	10	38
Modify Old Plane	4	8	6	6	4	28
Nitro-Powered Motor	4	10	4	7	3	28
Electric Motor	8	5	6	7	7	33
Retractable Landing Gear	2	6	6	5	6	25
Glass Camera Door	3	9	8	9	9	38
Retractable Camera Door/Gimbal System	9	5	5	3	6	28
Infrared Camera	7	0	5	7	0	19
Modular Design	3	7	4	4	5	23
Autonomous Takeoff/Landing	7	9	5	6	3	30
Autopilot System Training	2	7	3	3	8	23
Autonomous Target Recognition	7	9	3	3	8	30
Air Drop System	7	6	6	7	8	34

Implementation of the electric motor and the glass camera door will take place as soon as possible, since although the potential benefits are high, both involve considerable risk of being ineffective for completing the objectives.

Programming

The successful completion of the primary goals in this competition will require the extensive use of Image Processing Software (IPS). For this, the group has chosen to utilize Intel's OpenCV library. OpenCV is an open-source software written in C/C++ that is focused on real-time application use. Considering that one of the basic requirements for this competition is to display, in real-time, the current location, altitude and speed of the aircraft, this software is ideal because it allows that required information to be displayed on the screen in real-time.

With as many secondary objectives that exist in this competition, the team will consider adding a microprocessor to handle all the simultaneous functions and calculations that would be required for a successful competition. The microprocessor that will be considered to handle this task is Texas Instruments (TI) MSP430. This microprocessor was chosen due to its very low cost (MSP430 costs \$4.30), low power consumption, and memory capability. The processor has to have the ability to transmit continuous streams of data, such as location, speed and altitude facilitated with standard transmitters and receivers. It also needs the ability to receive data such as "secret messages" from the judges, decipher/read the message and finally, implement the message. Another task the processor must handle is the Air Drop System. The processor must be able to know where its physical location is with respect to the "target" area and execute the Air Drop System at the appropriate location.

The final competition rules were scheduled to be posted on 24 October, however at time that this report is due the rules have not yet been published. Because of the relatively late posting of the rules and vast differences from last year's competition, the team has not had adequate time to complete an in-depth analysis of all programming requirements. Nonetheless, the MSP430 will satisfy the requirements for several of the secondary objectives and potentially aid in the reliability of the system.

Procurement

The team 6 AUVSI project was given an initial budget of \$1500. Since our project involves flying RC planes it was necessary that we have team members who can fly planes and for this reason we decided to spend the first part of our budget on a small, easy to fly, and durable practice RC plane. After researching around for the best possible options for something like this, we decided to purchase the FMS Dragonfly, for \$160, or 11% of our total budget.

For our next expenditure, we decided to buy a new RC competition plane, the Senior Telemaster Plus. As mentioned in an earlier section, with this new plane we would be able to test all of our electronic/autopilot systems on the old plane without having to worry about destroying our competition plane. Also, this plane comes with flaps already designed into the wings, which will allow for a much safer autonomous landing and takeoff. The total cost of this new RC plane came

out to roughly \$625, or 41% of our budget. Obviously this is a large chunk of our budget, however, since it is the main component of our project we felt justified in spending the money. Since we inherited a plane and many components from last year’s project we are able to save a lot of money in that we do not need to buy an autopilot system, gas motor, servos, a remote control, or any other necessary items for autonomous flight. Because of this, we have the option of improving the camera system that will be used on the plane for the image detection.

Again as mentioned earlier, we might decide to purchase the very popular GoPro camera for our plane. If we do decide to purchase the GoPro, we could acquire one for roughly \$300, or 20% of our total budget. In the event that we decide to design a new gimbal system for our plane, we also conservatively estimate that it will cost approximately \$125 (8%) for all of the equipment necessary to build it. In addition to our actual hardware purchases, we also need AMA certified pilots in order to fly at the airfield where testing would take place. Ideally, our project would have 2 certified pilots, which would cost \$50 per year/per pilot, so \$100 (7% of total). The airdrop mechanism is something completely new this year, so a conservative estimate for the necessary parts to create the mechanism is \$75 (5%). The rest of our budget will be left open for unforeseen purchases and repair costs. In the event that we need something unforeseen and it extends over our budget, we are allowed to purchase it if we get approval from our sponsor, Dr. Shih.

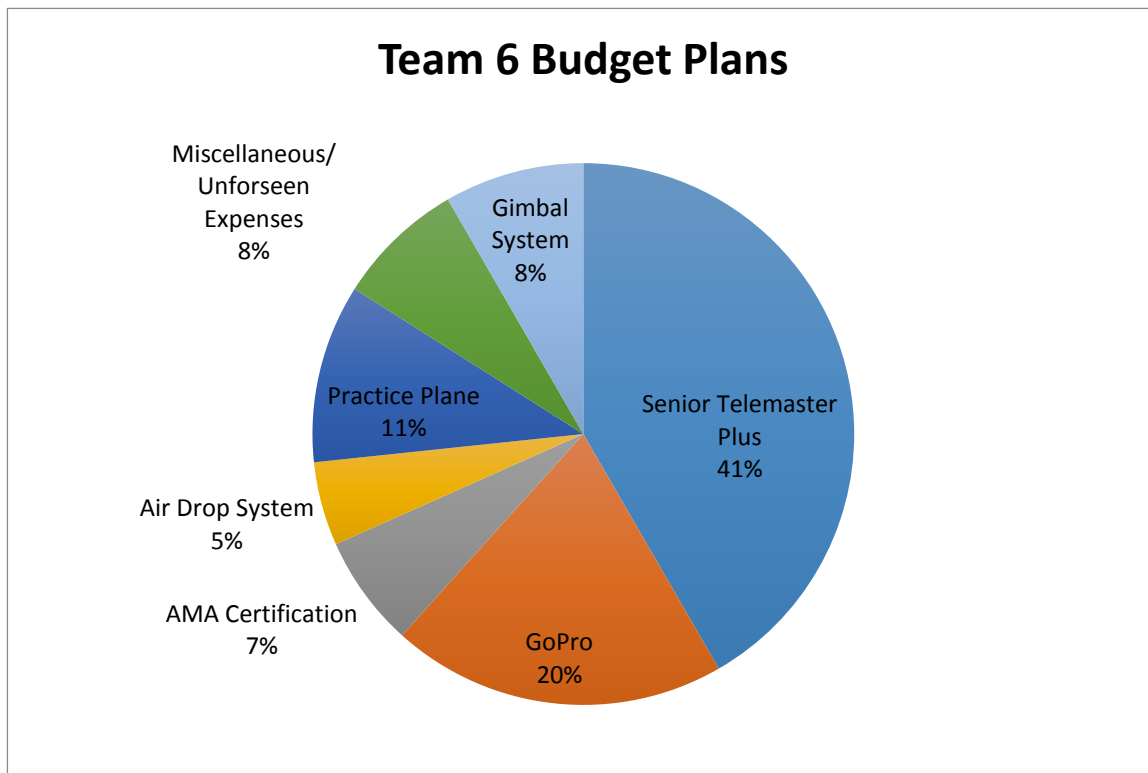


Figure 5 Budget Visual

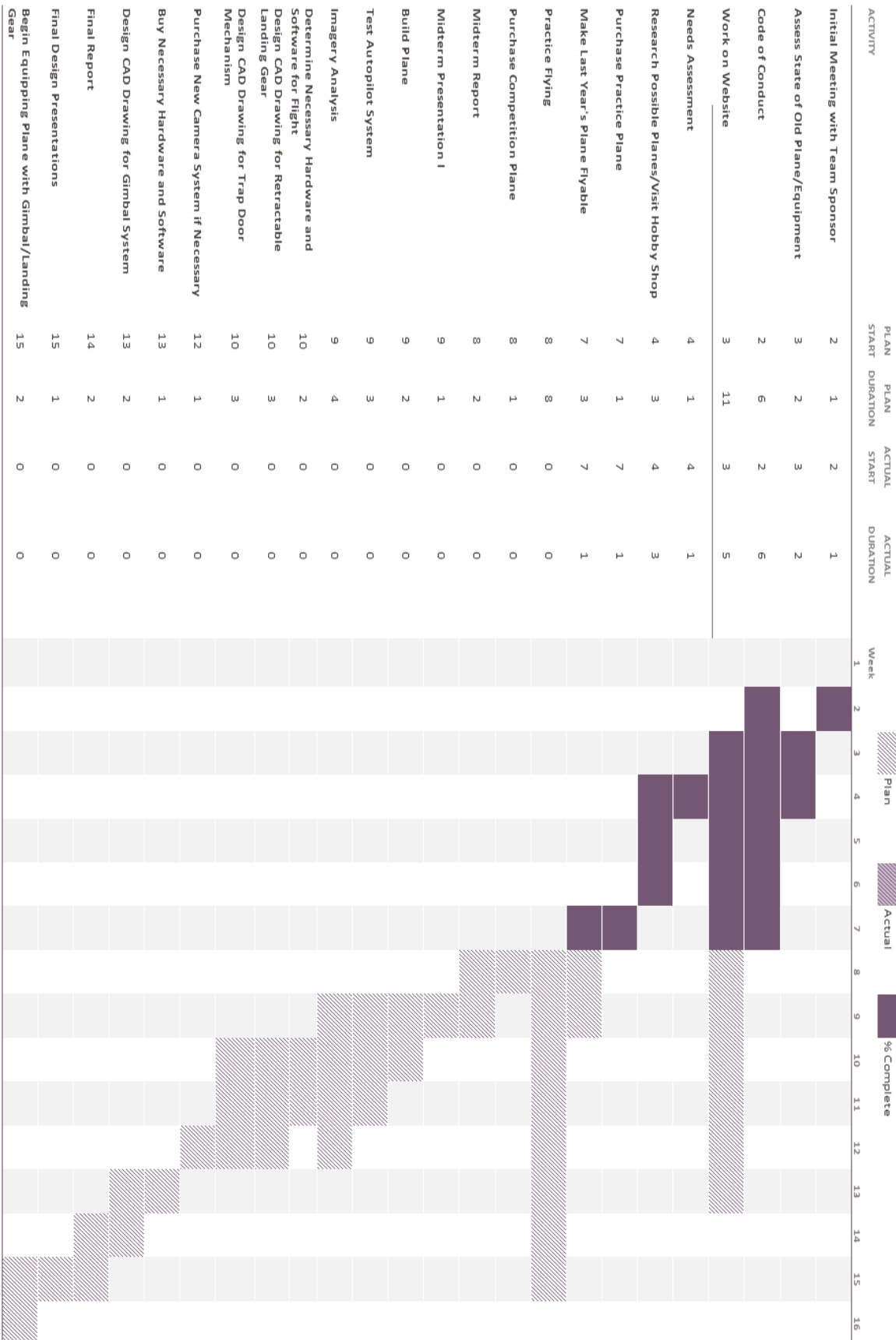
Future Plans

The first task that we plan on accomplishing is flying the old plane while operating the autopilot and current camera system. Once we get this setup in the air we will be able to determine multiple important items of information that will determine the future of our project. We will first determine how the autopilot currently works in order to decide what needs to be programmed into the system so that we can achieve autonomous takeoff and landing. Also, once in the air we will be able to test the quality of the current camera we have which will allow us to determine whether or not it is necessary to upgrade to the higher quality GoPro. In this test, we will also be able to determine the difficulty of autonomous target recognition, and the possibility of off axis target locating without a gimbal system. Once we determine all of the above parameters, we will be able to more concretely decide which way to go with regards to the gimbal/glass door approach and the autonomous/manual target recognition. In addition to the electronics testing, we will also test the two motors (gas and electric) in flight to see which one will better suit our needs (minimum vibration, max flight time, power, etc.) After all of the above testing is completed the mechanical engineers of our project plan on focusing on designing and building the air drop mechanism and a new gimbal system (if necessary). During this time, the electrical engineers will be working on the camera and autopilot systems, and their interfacing with the software that intertwines all of the systems. Meanwhile our two RC pilots will continue their flight practice until they are able to master the art of RC flying. Also, we will be working closely with our international teammate throughout this entire time span to receive input on designs and possible implementations of our mechanical systems.

Conclusion

The competition rules states several primary and secondary objectives to accomplish. The majority of the decisions were made taking into consideration the priority of the objectives, the time and budget available. Therefore it was decided to purchase a new plane (Senior Telemaster Plus) with flaps (which can make the autonomous landing and takeoff easier) and an electric motor that will allow a better image quality due to less vibrations coming from the engine. Other aspect that was taken into consideration when choosing a new plane was the camera implementation. A stationary camera inside fuselage with a glass door will be tested to determine its validity; otherwise the gimbal system will be used. The autonomous system will be Ardupilot mega 2.5 (same of the last year's team as it does not have any damage or failure). As a second objective, the "air drop" system will be built and tested by team six. The "air drop" system may be autonomous or manual (to be defined by the team members) and it will simulate a supply drop with "Egg Canister" filled with flour.

AUVSI Project Plan



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Appendix I – Manufacturer’s Specifications

Model Plane:

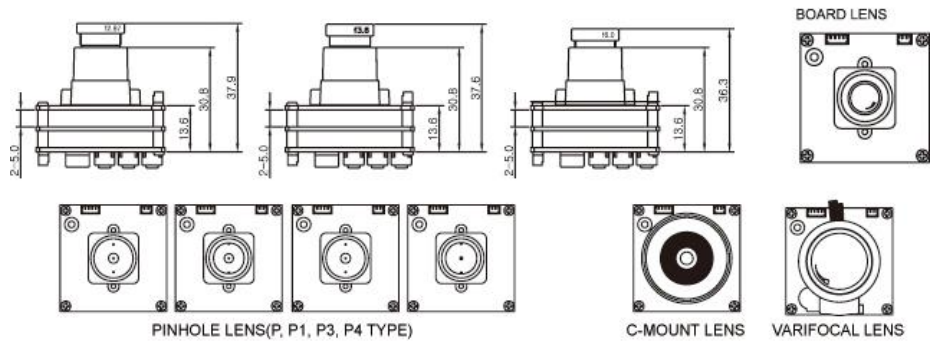
Senior Telemaster Plus



Weight	Wingspan	Length	Wing Area
9 lb	94 in	64 in	1330 sq-in

Camera:

KT&C KPC-E700NUB



Power	Operating Temperature F (C)	Total Pixels	Scanning System
DC 12V - 70mA(Max 110mA)	14 - 110 (-10 - 50)	1020 x 508	2:1 Interlace

Motor:

Magnum XL .91CI 4-Stroke



Displacement	Weight - w/o(w)	Prop Shaft Dia.	Practical RPM
0.91 ci (14.95 cc)	21.7 oz (22.4 oz)	5/15 - 24	2k - 11k

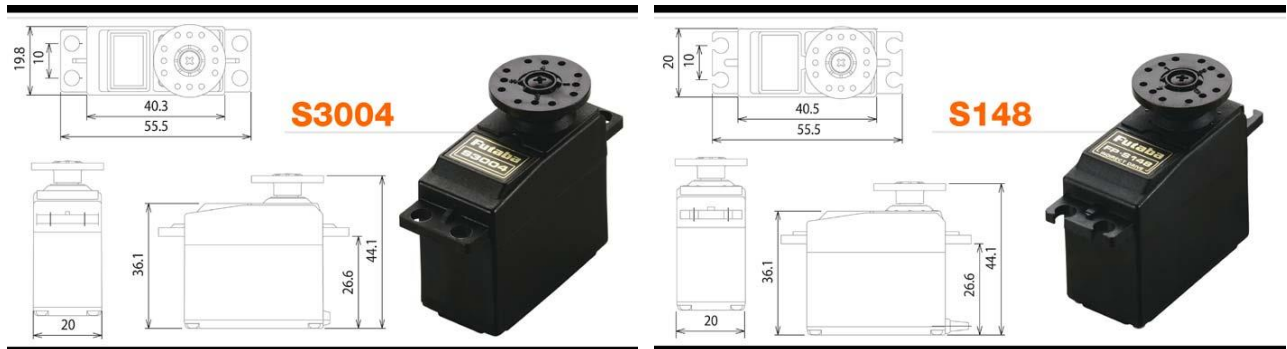
Servos:

Futaba S3004

Power	Torque	Speed	Weight
4.8V	44 oz-in (3.2 kg-cm)	.23 sec/60°	1.3 oz(37 g)
6.0V	57 oz-in (4.1 kg-cm)	.19 sec/60°	

Futaba FP-S148(Precision)

Power	Torque	Speed	Weight
4.8V	33 oz-in (2.4 kg-cm)	.28 sec/60°	1.6 oz (44 g)
6.0V	42 oz-in (3.0 kg-cm)	.22 sec/60°	



Radio Control:

Futaba 6J 2.4 GHz



Type	Power	Freamerate	Requires
2-stick; 6 Channel; FHSS/S-FHSS	4.8 - 7.4 V(170 mA)	6.8 ms	AA x 4 + Reciever

Battery Packs:

Tenergy Li-PO 11.1V

Voltage (Capacity)	Weight	Cont. Discharge	Dimensions
11.1 V (2200mAh)	185 g	25C/55 ^a	110x35x25mm

Tenergy Ni-Mh 4.8V

Voltage (Capacity)	Weight	Type	Dimensions
4.8 V (2000mAh)	108 g	Flat	58x15x52 mm

