EMBRY-RIDDLE
Aeronautical University

ISR-Eagle

Unmanned Aerial Systems Competition Report

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5/23/2011

This report discusses the approach taken to compete in the Association for Unmanned Vehicle Systems International (AUVSI) Student Unmanned Aerial Systems (SUAS) competition. From the outset of the project the team maintained a systems-engineering approach focused on mission requirements and the overall concept of operations. The team adopted proven system components from previous years, including the use of the Multiplex EasyStar powered glider and the Ardupilot Autopilot. To improve reliability and to meet the current competition requirements, the team developed a new imagining system that includes a modified five megapixel GoPro HD Hero camera transmitting images to the ground station over a 5.8 GHz Ubiquiti Bullet radio link. Images are examined for targets of interest by both a human operator and using digital image processing tools. New autopilot code and a custom-developed ground-station user interface make the system reliable and easy to set up and operate. The system has numerous safety features, including a fail-safe manual override control operating at 2.4 GHz and an on-board flight termination procedure in case of a lost radio link. The entire system is powered by three Lithium Polymer batteries that provide a 45 minute mission window. Extensive software simulation, hardware-in-the-loop simulation and test flights under competition conditions ensure a reliable system that should provide critical intelligence, surveillance and reconnaissance information to warfighters in the field.

DJI-1013
IPR2023-01107

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Certification of Flight

This certifies that Embry-Riddle Aeronautical University's Intelligence Surveillance Reconnaissance Eagle (ISR-Eagle) has seen 30 hours of autonomous test flight to prove its ability to accomplish the mission in this year's SUAS competition. In addition, ISR-Eagle has completed 50 hours of hardware-in-the-loop simulation. This will help us to ensure that the system is effective, safe, and maintains a standard of technological integrity to mitigate any risk to the user, operators, or spectators.

Figure 1 - ISR-Eagle Landing

Introduction

For the Association for Unmanned Vehicle Systems International (AUVSI) Student Unmanned Aerial Systems (SUAS) competition, Embry-Riddle presents Intelligence Surveillance Reconnaissance Eagle (ISR-Eagle). The competition requires that the Unmanned Aerial System (UAS) perform an autonomous take-off, demonstrate waypoint tracking, search an area of interest, and autonomously return and land. While the aircraft is in flight, it must identify targets placed on the ground, and relay this information back to the ground in real time. The targets are four to eight feet in size and can be of any shape. The vehicle must identify the background color and shape, alphanumeric symbol and color, the Global Positioning System (GPS) location, and the magnetic orientation of the target. The UAS must also be capable of altering the flight path in air, as waypoints are entered by the user through the ground station. Each part of the system was chosen based on the

Table 1 - Reasons for the selection of each component

Component	Reasons for use
Airframe	• Stable flight characteristics • Commercial Off the Shelf (COTS) • Foam body • Lightweight
Autopilot	• Cost-effective • Open Source
Ground Station	• Compliance with the ConOps • Ability to adapt to any autopilot system
Imagery System	• All components are Commercial Off the Shelf (COTS) products • Reliability • Cost-effective

criteria shown in Table 1. Overall, the ISR-Eagle team at Embry-Riddle approached the problem by designing and building the most cost effective and reliable system possible. The design implements the Ardupilot Mega autopilot board for autonomous navigation on board the Multiplex EasyStar powered glider (EasyStar) frame. The imagery system is based upon the Eye-Fi wireless SDHC cards, and the GoPro HD HERO 960 camera.

Mission Analysis

Figure 2 - ISR-Eagle on Takeoff

The SUAS competition ConOps calls for a vehicle that can provide support to a Marine patrol as it performs an intelligence sweep of the area. The UAV must be focused on both autonomy and simple user interaction with the systems interface. From this ConOps, the team defined individual goals to achieve the requirements of the overall competition. The decision to use the proven EasyStar airframe was due to its stability, superb flight characteristics, reliability and cost effectiveness. These characteristics were demonstrated in test flights leading up to the 2010 SUAS competition. The team chose to focus on an improved imaging system, higher bandwidth, more robust communications, an upgraded Ardupilot-based autopilot system and supporting software. One critical improvement was the ability to reliably update waypoints from the ground.

A customized ground station was developed to enable the user to update waypoints and provide a more informative user interface. The user now has greater control over the autopilot system than in any previous design. The ISR-Eagle team determined that a complete redesign of the previous year's vision system was necessary, including a more sophisticated software package and initial in-flight image processing to assist a human observer in identifying targets in the competition. This allowed for the vehicle to be intelligent in application and simple in its design.

Mission Requirements

The aerial vehicle must comply with all of the specified criteria for take-off and landing procedures, which are as follows:

- Take-off
  - Fully autonomous
  - After takeoff the vehicle must maintain an altitude between 100 and 750 ft. MSL
- Landing
  - Fully autonomous
  - Controlled
  - Vehicle motion ceases and the engine is shutdown

The UAS also must operate within the restricted airspace, while recognizing and recording data with respect to targets positioned on the ground. The system is required to record the alphanumeric character and color, target color and shape, target orientation, and the GPS waypoint of targets of interest. This data then must be displayed to the user through the ground station. Upon request, the vehicle autopilot must be reprogrammable from the ground station to allow in-flight retasking.

Systems Engineering Approach

Table 2 - Task Chart for ISR-Eagle

Task	Start Date	Completed By
Flight Test: autopilot throttle control/ autonomous take off	26-Feb	26-Feb
Decision about camera to use	26-Feb	12-Mar
Preliminary vision code written: capable of taking image from camera and storing on computer	1-Mar	24-Mar
Flight Test: full vision system	1-Mar	28-May
Flight Test: autonomous landing	5-Mar	5-Mar
Flight Test: full autopilot capabilities/ airspeed sensor and GPS	19-Mar	19-Mar
Airframe box printed	28-Mar	1-Apr
Vision code: color identification and cropping of target	1-Apr	19-Apr
Flight Test: take images in flight/ remote trigger	2-Apr	2-Apr
Box wiring and connections completed	4-Apr	14-Apr
Flight Test: take images/ manual processing on ground	16-Apr	16-Apr
Airframe built	20-Apr	26-Apr
Airframe Ready	22-Apr	1-May
Flight Test: take images in flight/ manual processing on the ground	23-Apr	23-Apr
Vision code: Alpha numeric processing and target orientation	28-Apr	14-May
Flight Test: trim new airframe	30-Apr	30-Apr
Flight Test: target position and color identification	7-May	7-May
Flight Test: on board image processing	21-May	21-May
Flight Test: final systems check	4-Jun	4-Jun
Flight Test: final test flight procedure practice and full systems check	11-Jun	11-Jun
Journal paper due		23-May
PLANE READY FOR COMPETITION		**12-Jun**
Competition check in		14-Jun
Flight day 1		15-Jun

The competition demands that the aerial vehicle be autonomous, and while user interaction is permissible, should be limited. This required the further development and testing of the Ardupilot Mega system so that its performance is consistent and reliable. In previous years, the team spent a significant portion of our time and effort on the development of our autopilot system.

With a systems engineering approach, the team divided the group into several sub teams in order to more effectively manage the workload and goals of the competition. General group meetings occurred once a week. In these meetings, team leaders outlined the tasks completed to date and set goals to be accomplished for the following week. This kept the work attitude dynamic, and it allowed active participation in the project by all members. The focus was kept strong by a very specific and manageable task list, shown in Table 2. These meetings were vital to the success of the team in accomplishing the goals of the mission.

System Overview

The airframe platform of the ISR-Eagle for the 2011 SUAS competition is based upon the EasyStar, a platform that has proven to be easy to fly and effective in previous years. Made of Elapor Foam, the EasyStar provides a lightweight, portable and highly durable solution compared to the previously used airframes. The wings and body of the plane have been reinforced to compensate for the increased wing loading of the onboard avionics and imagery payload. The payload bay has also been widened and an additional access hatch, shown in Figure 3, has been added. As a result of extensive testing, it was found that the autopilot preformed much better in both level and turning flight with the addition of ailerons.

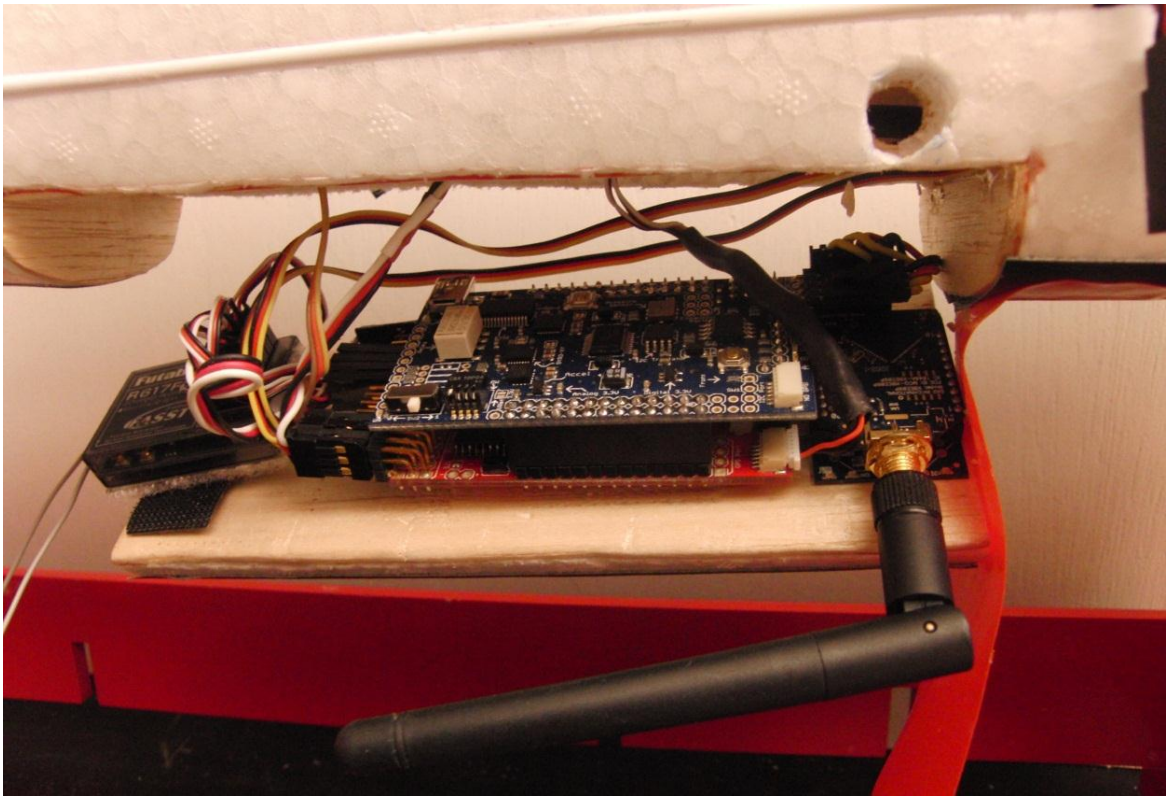


Figure 3 - The payload bay of the EasyStar

The unmanned aerial system (UAS) consists of four main subsystems, namely, Mechanical, Autopilot, Imagery and Ground Station. The Mechanical subsystem consists of the airframe, the propulsion motor, Electronic Speed Controller (ESC) and the servos, which move the control surfaces. The autopilot subsystem consists of the Ardupilot Mega with the Inertial Measurement Unit (IMU) shield, the GPS unit, Xbee 900Mhz radio, airspeed sensor, and magnetometer. The imagery system consists of a GoPro HD HERO 960 containing an Eye-fi SDHC card instead of a standard SD card, a Planex Mini Router, and a Ubiquity Bullet 5.8 GHz Radio. The ground station includes a notebook computer with custom-developed software and communication links. A diagram showing the avionics and imagery systems is provided in Figure 4.

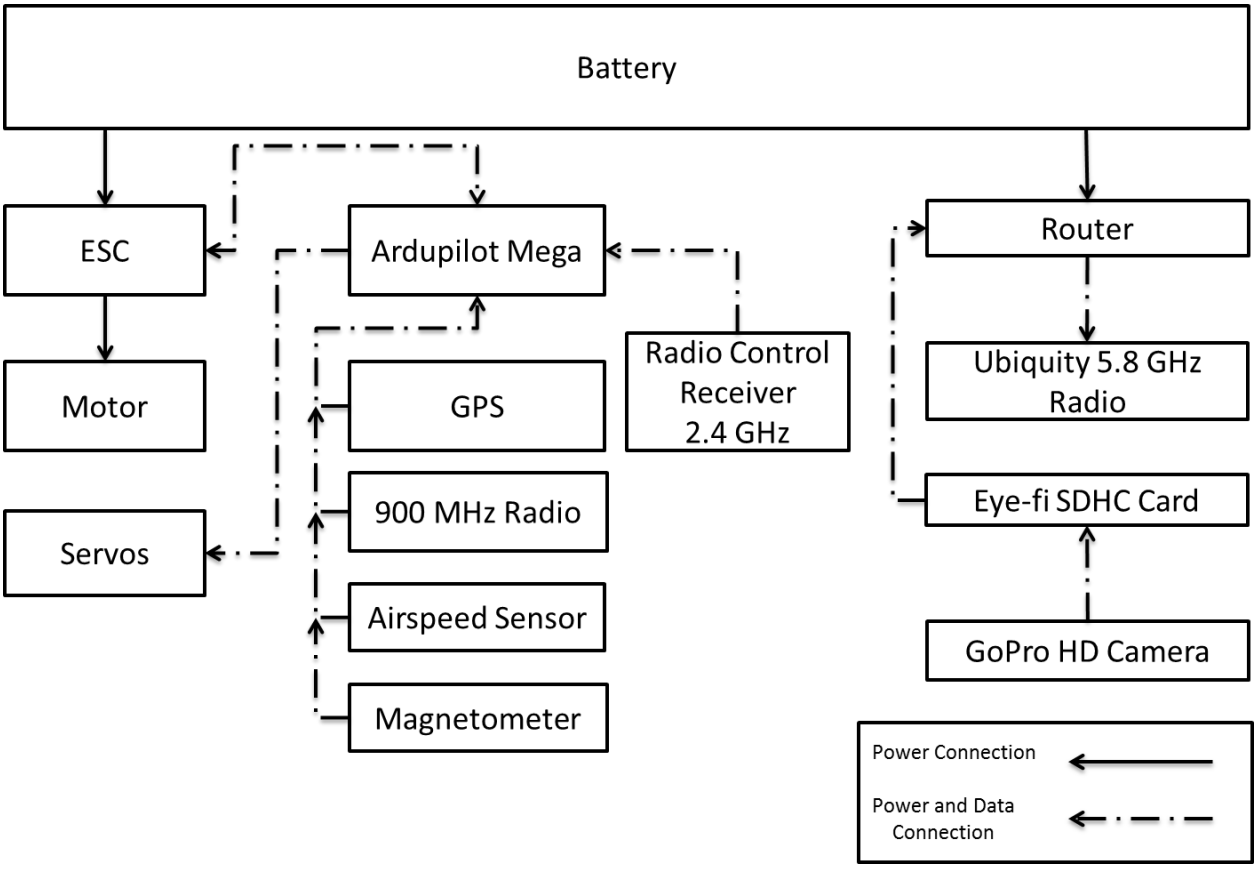


Figure 4 - Airborne Systems Diagram

The autopilot system that was chosen for the competition is the Ardupilot Mega with the Inertial Measurement Unit (IMU) Shield attached. This autopilot was chosen because it is effective, inexpensive, non-ITAR controlled, and most importantly, it has an open source architecture. With the 2.0 software update, the Ardupilot Mega is capable of meeting all mission requirements, including the dynamic upload of waypoints and the ability to change the search area while in flight. The Ardupilot Mega also communicates with a standardized protocol, similar to the Joint Architecture for Unmanned Systems (JAUS) protocol (OpenJAUS, LLC, 2011), called MAVlink. This creates a reliable systems interface. The team implemented the MAVLink communication protocol to use a standardized and open communication system, which enabled greater control over the UAS during flight (Meier, et al., 2011).

The imagery system used on ISR-Eagle has been chosen to be as reliable and as cost effective as possible. The design of the imagery system is centered on the use of a high-resolution digital camera and an Eye-Fi wireless SDHC card (Eye-Fi , 2010). This card allowed us to select from a variety of off-the-shelf point-and-shoot cameras and establish a communication protocol between the aerial system and ground station processing software. The GoPro HD HERO 960 camera was chosen for the mission due to its small size and durability (GoPro, 2010). This characteristic made it a good choice for flight. To transmit the images over the great distances required, there is an onboard router. This proved to be the most reliable and effective solution for transmitting the data between the vehicle and ground. The onboard router is connected to the Eye-fi card through a wireless connection and to a Ubiquity Bullet 5.8 GHz radio through an Ethernet connection. The radio then transmits the images to the ground, where the images are processed. This system is shown in Figure 5.

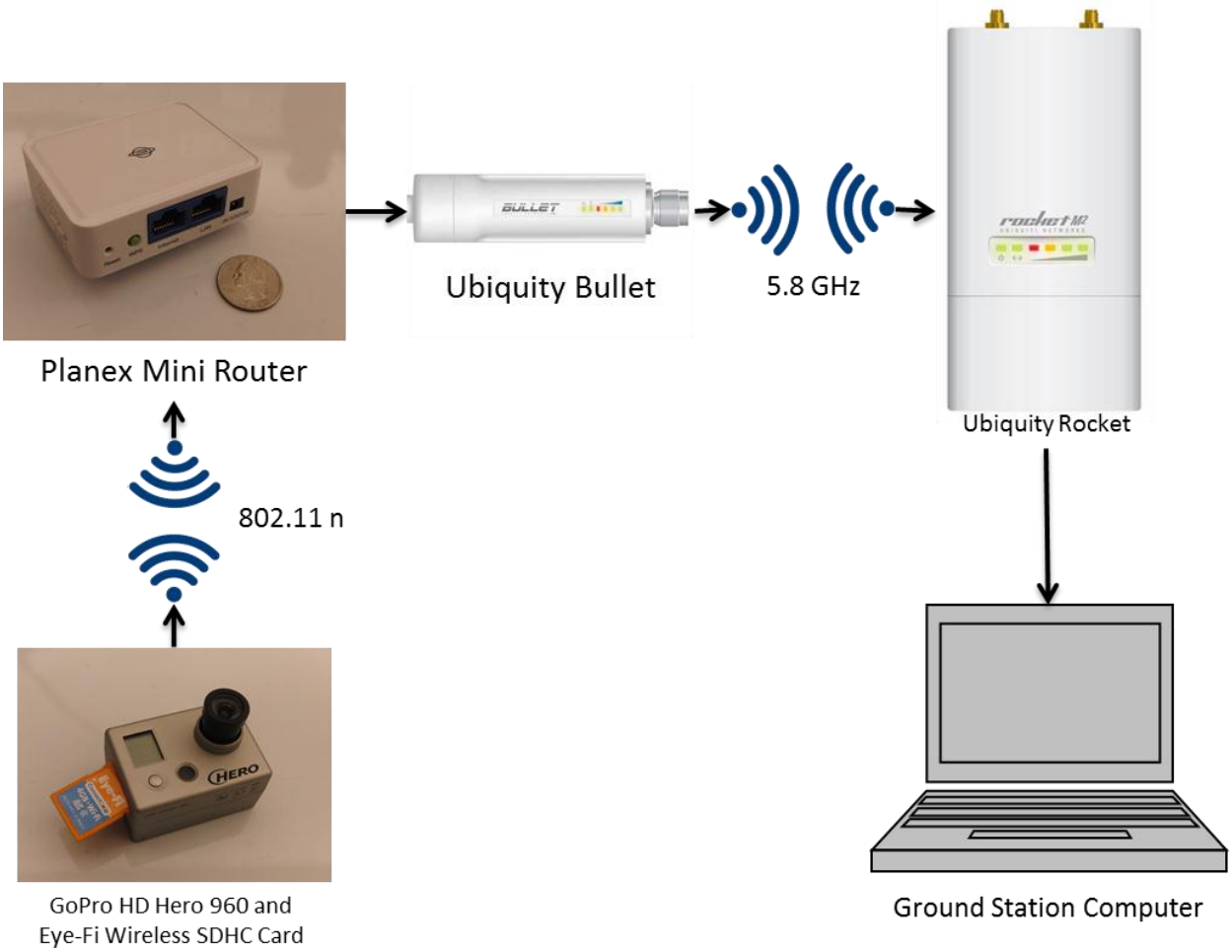


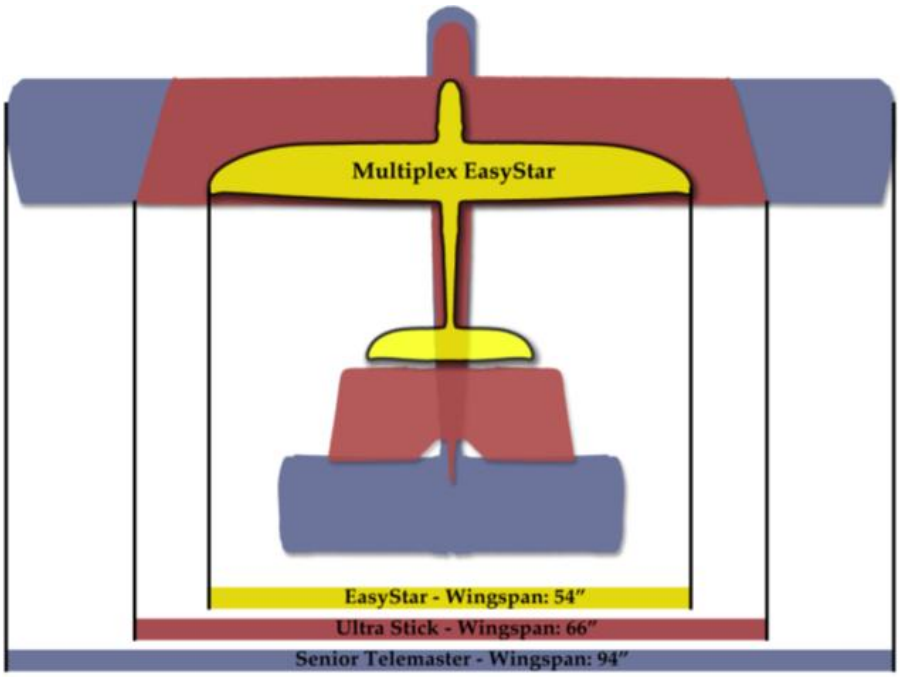
Figure 5 - Imagery System Overview

In addressing the ConOps defined by the competition, safety was also a defining factor in the design and construction of our UAS. The system was designed with multiple manual overrides that directly take back control of the aircraft should something go wrong with the autopilot. The ground station operator has the ability to manually override the waypoints from the ground while the plane is in air. In addition the operator has the ability to disable the autopilot operation and switch to radio control at any time.

As a further precaution, the system may be shut down as well. This initiates a standard flight termination procedure. The airborne system is designed to be small and lightweight to lessen the energy in the event of an impact. In addition, the foam body of the EasyStar allows the energy to be dissipated by breaking apart in the event of a crash. This also minimizes damage to the internal components. To ensure safety of operators and spectators while the vehicle is in operation and testing, a clear flight checklist was developed and is consistently obeyed prior to any test flight. This consisted of a range check of the signals, clear communication between the operator and ground station monitor of the vehicle, and the obvious clearance of the vehicle to any person or object. These operators are well trained and have large amounts of remote controller flight experience that range from flight simulator hours to actual flight experience. All new members are well trained using trainer flights, while tethered to an experienced pilot to familiarize them with the system and their ability to take command of the vehicle in the event of an error.

Airframe

The almost-ready-to-fly Multiplex EasyStar provides a lightweight, portable and highly durable solution compared to the more conventional balsa and monokote airframes and more expensive composite solutions. Figure 6 shows the top view of the EasyStar in comparison with two similarly capable airframes, the Hanger 9 Ultra Stick and Senior Telemaster, combined with the specifications of each airframe.



	Multiplex EasyStar	Hanger 9 Ultra Stick	Senior Telemaster
Airframe Weight (lb)	1.5	7	10.5
Fuselage Length (in)	35	55	64
Wingspan (in)	54	66	94
Wing Area (sq. in)	372	913	1330
Power Source	Electric	Electric	Gasoline
Manufactured Material	Foam	Balsa/Plywood	Plywood

Figure 6 - Airframe Comparison Chart

The body of the EasyStar has been modified to compensate for the increased weight of the avionics and to improve system reliability. The first modification was to increase the strength of the wings, to increase the life of the vehicle. This was needed due to the increased wing loading on the aircraft due to the added mass of the system. The payload bay on the EasyStar has also been widened to allow room for all the mission essential equipment. Another modification made to the basic aircraft, was the addition of ailerons to the wings. The autopilot maintained better flight stability with the addition of these control surfaces. The EasyStar remains in the hand launch and belly landing configuration. This configuration increases the operational areas of the platform by eliminating the necessity of a paved runway and requires only a small area to take off and land. Another benefit to the EasyStar design is that it is a Commercial off the Shelf (COTS) product and is sold in a ready-to-fly configuration, so in the event of an accident, the airframe can easily be replaced. The foam build allows for small repairs to be made allowing the user to solve the minor damage that occurs with routine use. Overall, the vehicle design is robust and manageable for both transport and flight.

Motor

ISR-Eagle's UAS is powered by the E-flite Six-Series Brushless 2700Kv Motor. The electric motor was selected over an internal combustion engine for the following reasons.

- The electric motor causes less vibration in the airframe, producing superior image quality and mitigating the possibility of damage to internal components and wiring connections.
- The electric motor causes less stress on the airframe due to vibration
- The electric motor is more compact
- The vehicle is easier to control under electric power
- Electric motors do not produce emissions that can fog camera lenses.

The possibility of electromagnetic interference due to motor noise was minimized by keeping sensitive electronics away from the motor. To complete the system, the E-flite Six-Series Motor is connected to a Castle Creations Phoenix 54 Electronic Speed Controller (ESC), which also contains a three Amp Battery Eliminator Circuit (BEC). This circuit also supplies the power from the battery to the autopilot. The motor and ESC are also both COTS products making them reliable and cost effective.

Battery

The UAS is powered by a COTS 11.1 Volt, 5300 mAh Lithium Polymer battery. This battery provides power to all components of the aircraft. This specific battery was chosen based upon the needs of the electric motor and the range required by the mission. Battery voltage is monitored by the autopilot in flight and relayed to the user through the ground station.

In the event that the battery voltage drops below a safe threshold of operation, the operator will regain radio control of the vehicle and safely land it as soon as possible. To mitigate this problem, the batteries are carefully monitored for overall safety, and the voltage was checked and recorded prior to each test flight. The batteries are clearly labeled and charged following any testing. All flights are recorded with the number of the battery to keep careful logs of all equipment to ensure that it is not only safe but reliable for flight.

Autopilot

ISR-Eagle's use of the Ardupilot Mega with the IMU shield as the integral part of our autopilot system is based upon many design considerations. The primary reason is the cost effectiveness of the Ardupilot Mega. When compared with other autopilots it is easy to see the price difference, the Ardupilot Mega costs only $350, while the other option that was explored, the Cloudcap Piccolo Plus, costs $6000 (Cloud Cap Technology Inc, n.d.). In addition to being more cost effective, the Ardupilot Mega is also much smaller in size and weight, Figure 7. The Ardupilot Mega provides a very stable foundation for the autopilot system, which was rigorously tested. Each week a flight test would focus on an integral component of the code and refine the software to ensure that it would operate effectively in competition. This allowed the team to not only become very familiar with the software, but more importantly, it gained a strong confidence in the design overall. Every alteration to the code was thoroughly checked in simulation and flight testing to prove its effectiveness in the system.

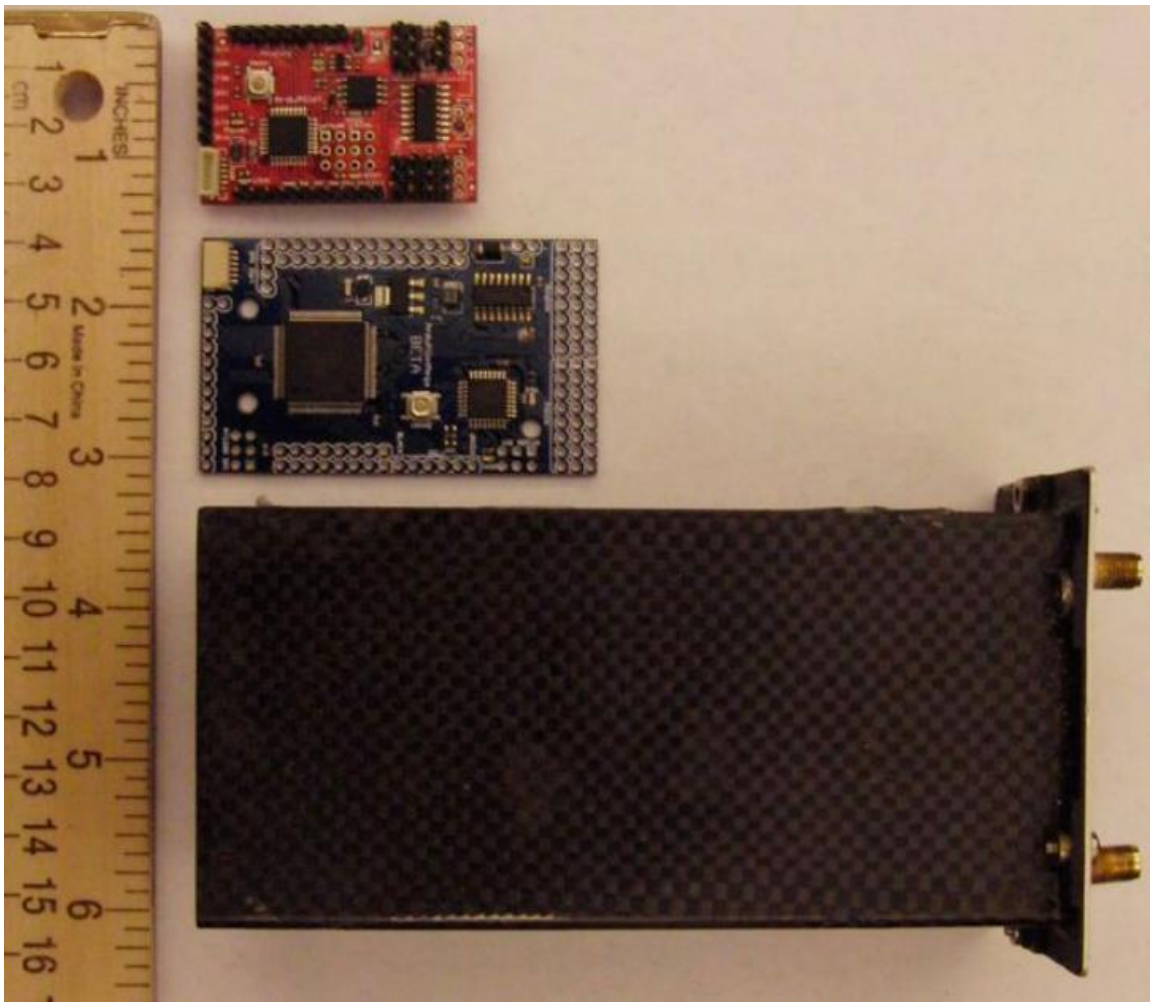


Figure 7 - From Top to Bottom: Ardupilot, Ardupilot Mega, Piccolo Plus Autopilot System

Sensors

Part of the incentive to using the Ardupilot Mega autopilot was the ability to use the IMU shield as a way to integrate a variety of sensors into the system. With this, the vehicle can consult the data supplied by

three-axis gyros, three-axis accelerometers, and a barometric pressure and temperature sensor. In conjunction, these sensors contribute data to coordinate the correct level of throttle to maintain a steady and level flight. In addition, the IMU shield has the potential to be compatible with several sensors that are employed in our autopilot system including an airspeed sensor which helps to maintain stable flight, a GPS unit which allows for the navigation of waypoints, a current and voltage sensor which monitors the battery levels, and a three-axis magnetometer which helps in the accurate identification of the target's magnetic orientation.

Communications

The Ardupilot Mega communicates with the ground through a 900 MHz radio link using the MAVLink protocol. This link transmits all the information that is requested by the ground station during flight. In standard configuration, the system will send attitude, GPS and current waypoint information to the ground station, where it is translated and displayed to the operator, in an easy to use visual display. This communication system also allows for two-way communications as required by the mission.

MAVLink is a standardized protocol that is able to communicate with multiple UASs of varying types. This allows the use of a wide range of autopilot systems without the need to switch communication standards or ground stations. This includes the support that comes along with the open source communications standard. This communication protocol is similar to the JAUS communication standard. This protocol allows waypoints to be directly set on the 3D map (Meier, et al., 2011).

Ground Station

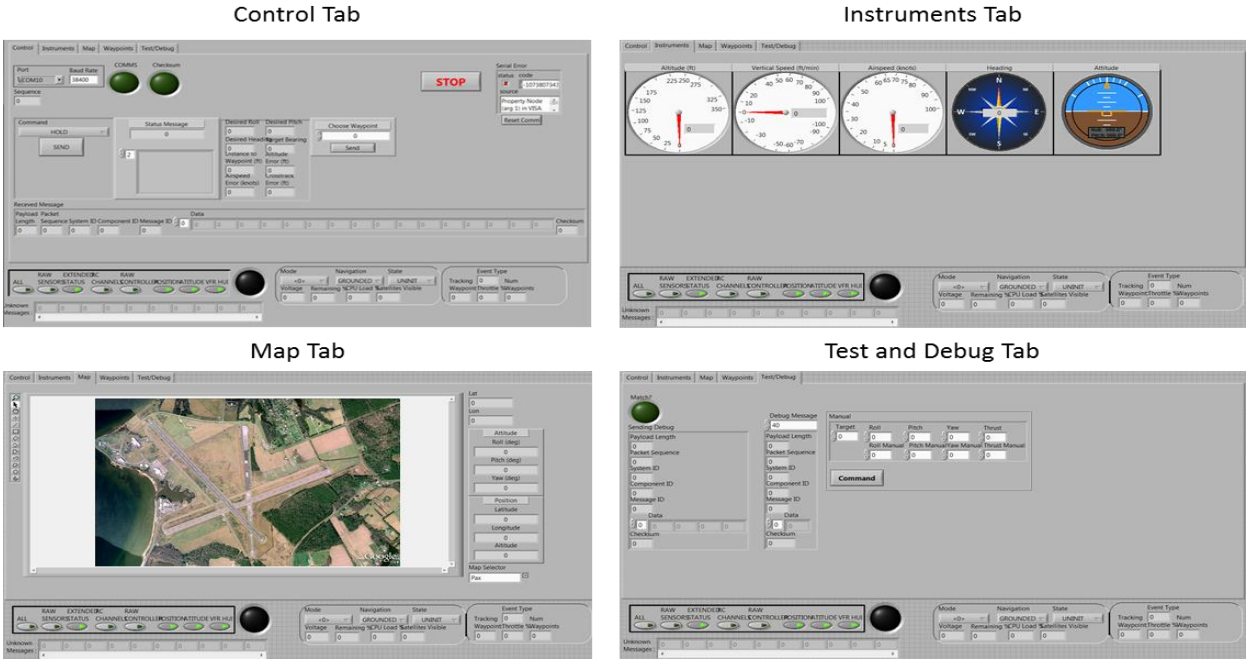


Figure 8 - JEDI Ground Control Station

One of the requirements for competition identified by the team was the ability to relay information regarding the flight in a simplistic and highly interactive user controlled environment. With regards to both safety and ease of operation, the team aimed to create a ground station that would allow the user

to maintain complete control of the vehicle while in flight and possess the ability to delegate that control to a remote controlled operator or allow for autonomous flight. The team also wanted to ensure that the user was presented an adequate visual representation of the aircraft's flight performance. Through the testing of already developed ground stations that support the MAVLink protocol it was determined that they would not be suited for the mission. After determining this, we began development our own GCS, in order to accomplish all the requirements of the mission. The autopilot onboard the aircraft sends data to the Ground Control Station (GCS) which displays it to the user. The Jedi Embry-Riddle Drone Interface (JEDI), as seen in Figure 8, provides the team with the functionality to monitor and control the mission during flight. As opposed to a pre-constructed ground station, the specific creation of the JEDI ground station allowed the team to address the specific aspects of the mission requirements, such as the re-tasking while in flight and the display of the flight instruments to the judges. JEDI is capable of visually displaying the aircraft location on accurate satellite imagery of the location, in-flight re-tasking and the functionality to show the loss of communication and the defined landing zone. It also had the ability to update waypoint data on the UAS while it is in flight, which is a significant portion of the competition that the team had not been able to develop in previous years. JEDI includes several safety precautions to protect the welfare of the operators and spectators during flight testing and active reconnaissance. While several fail safes exist within the code themselves, including a termination command in the event that the vehicle loses radio link while in flight, it is important that the ground station operator possess complete control over the vehicle at all times and can determine the decision to terminate the flight in the event that an operator, official, or spectator deems the flight plan unsafe or potentially destruction to the vehicle or environment in any way. JEDI allows the GCS operator to override the autopilot, and restore the UAS into manual control. As even further precaution to failsafe coding already in place, the GCS operator can also send a terminate flight command in the event that the Remote Control (RC) link is lost and the built in termination fails to activate.

Imagery System

The imagery system onboard the UAS consist of a GoPro HD HERO 960 containing an Eye-fi SDHC card, a Planex Mini Router, and a Ubiquity Bullet 5.8Ghz Radio. Rather than a standard SD card, the Eye-fi SDHC card integrates the camera with the network system, allowing a data transfer through a wireless router, between the target images and the processing computer. These components were chosen on the basis of cost effectiveness, durability and reliability. In addition, the GoPro offered the additional benefit of its lightweight design and separate four hour battery, making it not only suitable but manageable for the vehicle's payload.

Camera and Eye-fi Card

The Eye-fi card allows for any camera with an SDHC card slot to be utilized on board the UAS. The card wirelessly transmits the images that are taken by the camera to the designated computer. This was determined to be the most cost effective and versatile system available. This design decisions is particularly unique for the versatility it offered to the system. This design choice is modular in that sense that it allows for the contingency that a new camera could be necessary at some point in the testing through the use of the Eye-Fi SDHC Card. The GoPro HD HERO 960 is lightweight and rugged,

while also remaining a cost-effective decision overall. The only modification to the standard GoPro was the swapping of the standard 170° field of view lens with a 70° lens. This was changed due to the fact that the wide angel lens gave a distorted image of the ground requiring extensive correction and also lower the altitude required to achieve the desired pixel density. The camera along with the Eye-fi card are contained within the camera's water and crash resistant removable polycarbonate housing. This isolates the visions systems, mitigating the potential of damage to the components in the event of a serious crash during testing. Further mitigating this risk the use of a wireless network eliminated the necessity for a physical link between all of the components.

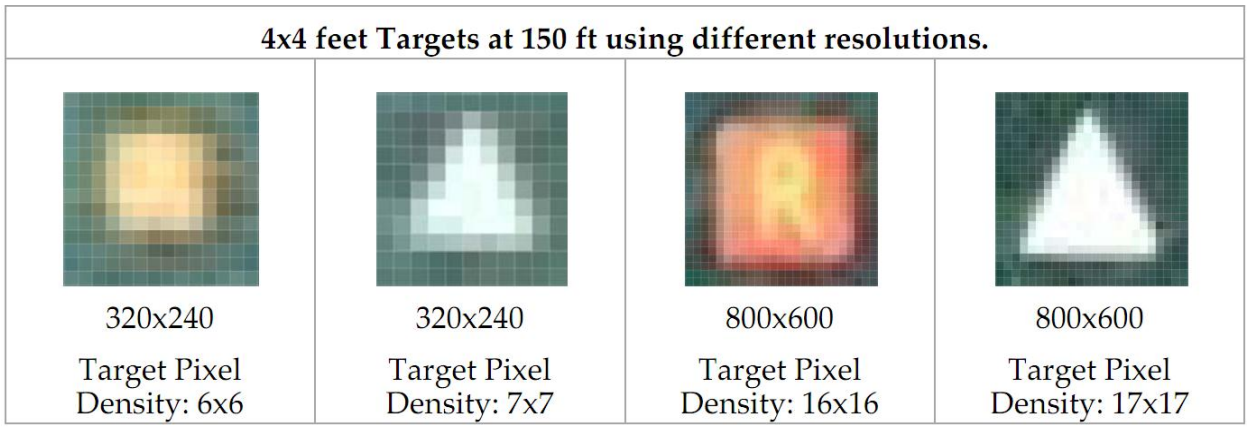


Figure 9- Pictures of test targets to determine minimum required pixel density

The GoPro HD HERO 960 takes a 1280 X 960 pixel image every two seconds. The 1280 X 960 pixel image was specifically chosen as the best compromise between the rate of data transfer and the required pixel count needed in order for the targets to be identified accurately. In order to effectively process the target image and determine the identifying characteristics, especially the alphanumeric character, it was determined that a grid of 16 by 16 pixels over a four foot target would be required. The team arrived at this decision through the results of testing, the results of which are shown in Figure 9. This system also has the ability to buffer the pictures that are being taken on to the Eye-fi SDHC card in the event that communication with the vehicle is lost, after the communication is reestablished the pictures will continue to transfer the ground computer.

Router and Radio Link

In order to transmit the images captured by the camera to the ground, we are using the Planex Mini Router, and a Ubiquity Bullet 5.8 GHz radio. The Planex Mini Router is the world's smallest 802.11n wireless router, and can be seen in Figure 10, which allows it to be easily fit on the UAS (Layer Four Solutions, n.d.). The router is then wired to the Ubiquity Bullet 5.8 GHz radio through an Ethernet connection. This is then connected via a wireless link to the ground where a Ubiquity Rocket 5.8 GHz radio is set up attached to another router and the ground station computers. A diagram of this system can be seen in Figure 10.

Figure 10 - Planex Mini Router

Imagery Ground Station

In the current imagery ground station the targets are identified by the user as they appear from the communications link. If a target is identified in the photo the image is saved for post processing. Once the images are all received, they are analyzed and the user identifies the six characteristics as is required by the competition requirements. The pop up target is also identified by the user.

Testing

Testing is a vital component of the vehicles development. The team worked to identify each of the mission requirements and focus on each one specifically. By ensuring that the team successfully and effectively met the mission requirement during a flight test before progressing to another requirement, the vehicle developed logically and in a timely manner. The testing proved to be valuable because it allowed for the proper trimming of the aircraft. In Figure 11, it is easy to see that the autopilots ability to track waypoints is drastically better when the aircraft and autopilot are properly trimmed.

Figure 11 - Untuned Autopilot (Left), Waypoint Tracking after Tuning (Right)

The team used both static and dynamic testing to evaluation the functionality of the system. Static testing included repeated Hardware In the Loop (HIL) tests to evaluate the overall reliability of the system a screen shot of this testing can be seen in Figure 12**Error! Reference source not found.**. This further ensured our confidence in the vehicles safety before flight.

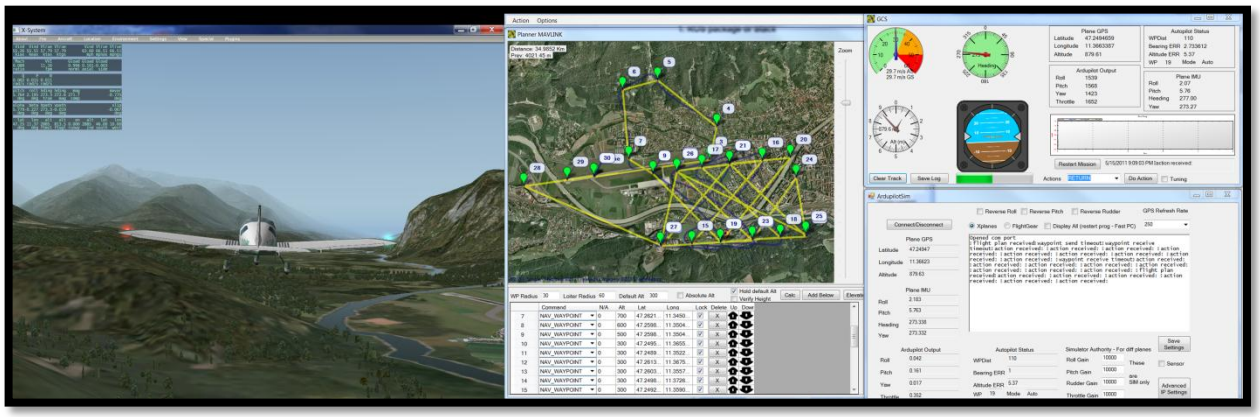


Figure 12 - Hardware In the Loop Simulation

Safety of the users and operators remained a major consideration throughout all of the testing. A consistent procedure was obeyed prior to any test flight to ensure that the conditions were safe for a test flight. Before initializing the system, the team ensured that the propeller was clear. After the system was powered on, the team performed a range check with the vehicle. This indicated the status of all of the electronic systems on the vehicle and the ability of the communications system to remain operational through the flight process. It is critical to verify that the vehicle would not lose communication with the ground station during flight. Losing radio communication would cause a flight emergency and require the team to terminate the vehicle in air. In addition, the team aimed to maintain as fully autonomous flight for the duration of most tests. This provided the best replication of actual competition conditions and practice.

Testing included allowing the vehicle to autonomously track waypoints in a way that mimicked actual competition environment. As testing progressed, the team gave the vehicle more control over the system, including autonomous take off, autonomous landing, and vision tracking in flight.

Conclusion

The system developed by the team at Embry-Riddle Aeronautical University has the ability to successfully complete the SUAS competition mission. The superb flight characteristics of the Multiplex EasyStar, along with the extensive and adaptable capability of the Ardupilot Mega, allow the UAS to accomplish all the tasks required by the mission including the tracking of waypoints and the navigation of the search area, along with the dynamic upload of waypoints. The vehicle is capable of sustained and level flight to carefully and accurately track targets positioned on the ground. The custom-developed JEDI ground control station gives the operator a simple, intuitive interface with all the information normally provided to a traditional pilot by the instruments in the aircraft. The imagery system is comprised of the GoPro HD HERO 960 camera, Eye-Fi wireless SDHC cards, Planex Mini Router and Ubiquiti Bullet radio link. The camera system is combined with the image processing system for acquisition and identification of targets as required by the competition. The combination of the Multiplex EasyStar powered glider, Ardupilot Mega autopilot, the JEDI GCS and the imagery system, create an exceptionally cost effective and reliable system that will perform successfully in the AUVSI SUAS competition.

Recommendation

I recommend that the SUAS team at Embry-Riddle Aeronautical University submit ISR-Eagle into the AUVSI foundation SUAS competition. This recommendation is based upon the superior capability of the system being used and my belief that it will be able to successfully complete all of the mission requirements of the competition.

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Acknowledgments

Dr. Charles Reinholtz

Dr. William Barrot

Michael Potash

Dr. Brian Butka

Dr. Snorri Gudmundsson

Gathan Broadus

Gene Gamble