Autonomous Aerial Vehicle
Midterm Presentation I

Team 6 2/13/14

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Discussion Topics

- Updated Objectives
- Fall 2013 Accomplishments
- Recent Work
  - Repairs to Inherited Test Airplane
  - Completion of Air Drop System
  - Calculations and Simulation for Projectile Targeting
  - Updated Image Processing
  - Electronics and Software Package
- Future Work
  - Autopilot and Competition Airplane Testing
  - Software Development
  - Updated Budget

Updated Objectives

"Designing for the Future"

- ASME competition showcasing the capstone projects of undergraduate students
- 30-Slide technical PDF
- Finalists featured at the International Design Engineering Technical Conference (IDTEC)

Manual for Future Seniors

- Progress toward competition goals
- Items available in Team 6 portable
- Challenges faced and means of avoidance

Continue Designing and Testing for AUVSI Competition as Originally Planned

- Image Analysis
- Autonomous Flight
- Air-Drop Mechanism
- Target Detection

Fall 2013 Accomplishments

Choice of Competition Objectives

- Autonomous flight (required), takeoff, and landing
- Autonomous target detection (required) and identification
- Autonomous air drop

Selection of Competition Vehicle and Components

- Senior Telemaster Plus Airplane
- Battery powered electric motor
- Fixed-mount GoPro camera system

Selection of Electronics and Software

- ArduMega 2.5 autopilot system
- Inherited communications components
- Software development plans:
  - Autopilot scripting using Mission Planner
  - Custom image processing software using OpenCV

Fall 2013 Accomplishments

Purchase of All Necessary Components

- Flight-ready Senior Telemaster Plus with electric motor
- GoPro Camera
- Video Transmitter
- Batteries

Completion of Inherited Senior Telemaster Video Test Flight

- Use of fixed mount GoPro system validated by onboard video
- Crash landing caused by failure of nitro power motor
  - Caused damages to wing structure, landing gear, and underside of fuselage

Repairs to Inherited Test Airplane

- Replaced wooden structure components of fuselage and covered with Monokote

Design and Partial Implementation of Air Drop System

- Modeled and simulated using ProEngineer and Autodesk ForceEffect Motion
- Servo-controlled trapdoor system added to fuselage

Completed Work – Spring 2014

Structural Repairs to Wing

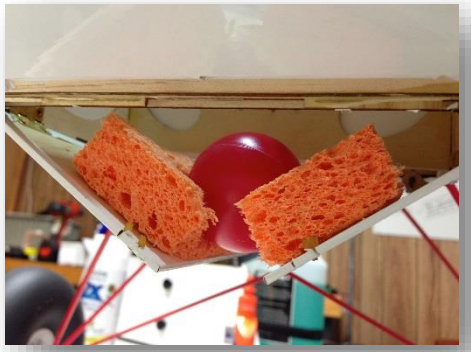
- Removal and replacement of damaged wooden supports

Aerodynamic Coating Repair to Wing and Fuselage

- Preparation and placement of Monokote film
- Heat and pressure application to seal

Finalization of Air Drop Mechanism

- Addition of foam supports for projectile
- Successful land testing of drop system with model projectile
- Air drop calculations for projectile accuracy



Air Drop Simulation

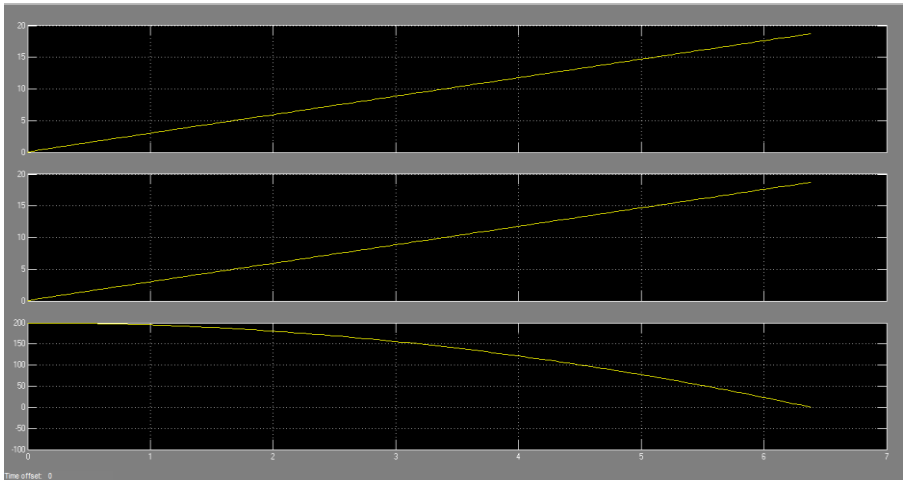
Analysis of care package dropped under given wind conditions performed using Simulink

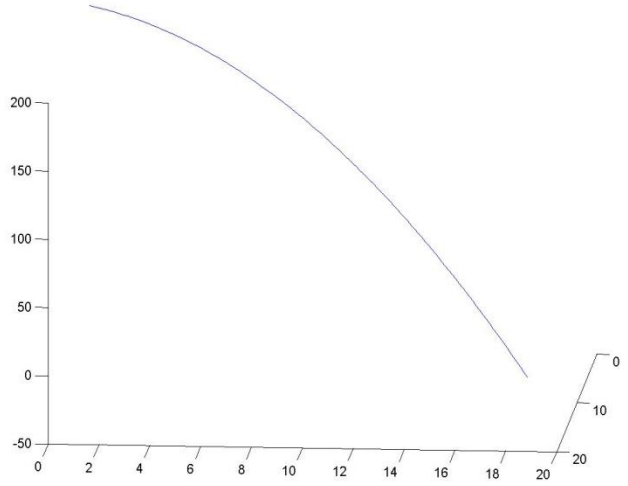
Factors Considered:

- Plane velocity (initial condition)
- Wind speed under free fall
- Projectile mass and geometry

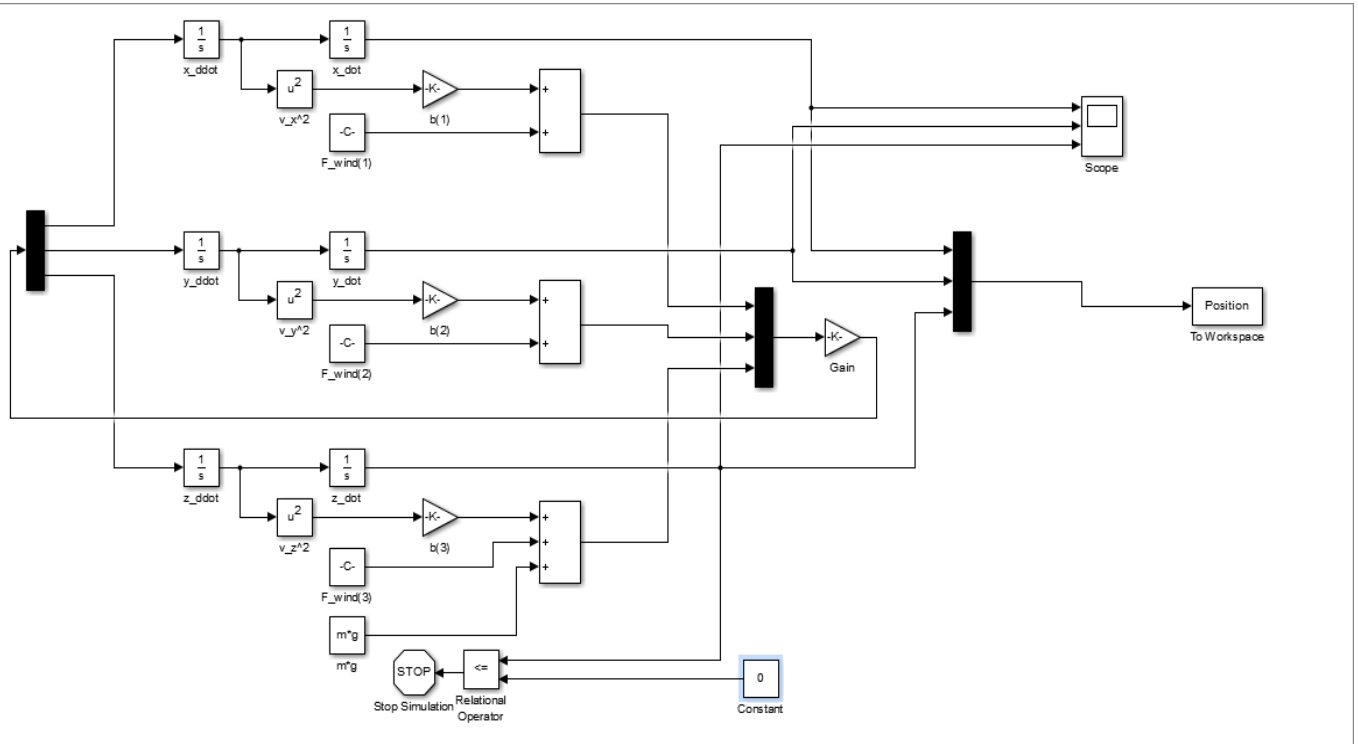
Determination of impact coordinates

- Used to create offset from drop position





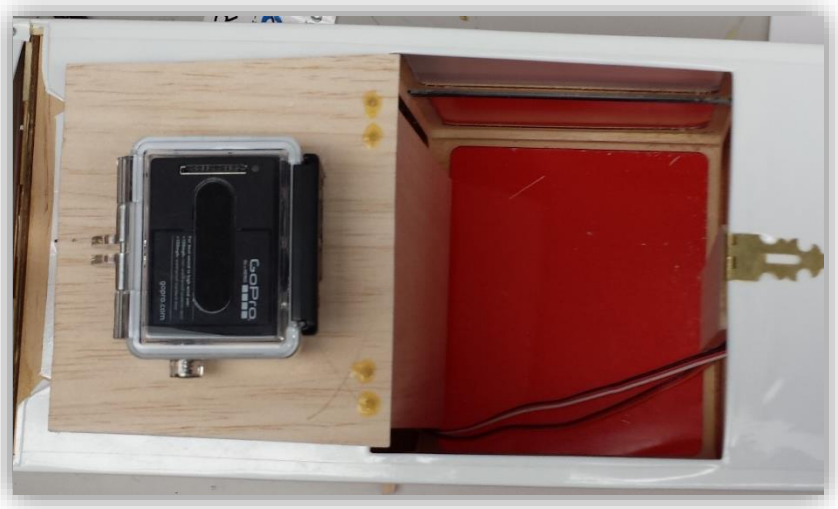
Air Drop Simulation



Completed Work – Spring 2014

Implementation of Camera Mounting System

- Removal of fuselage section and Monokote film repair
- Fabrication of camera mounting door
  - Allows access to camera from vehicle exterior
- Installation of door using double hinge and latch



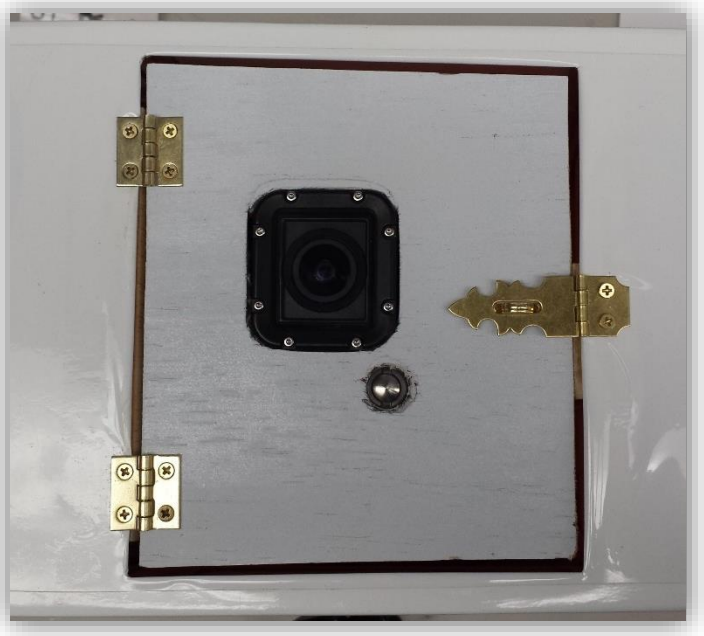


Image Processing

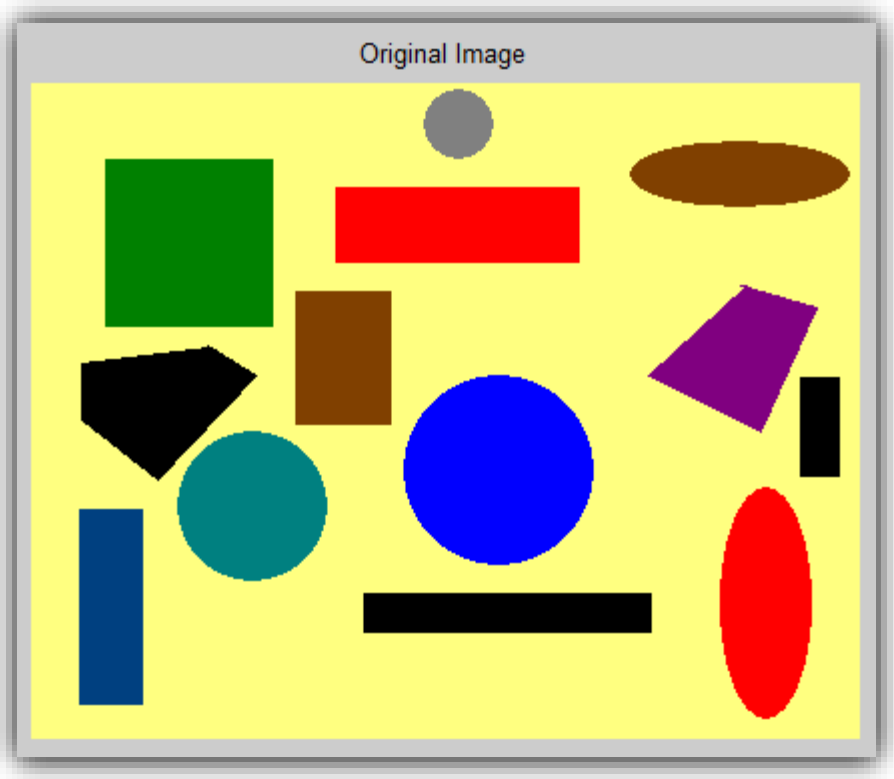


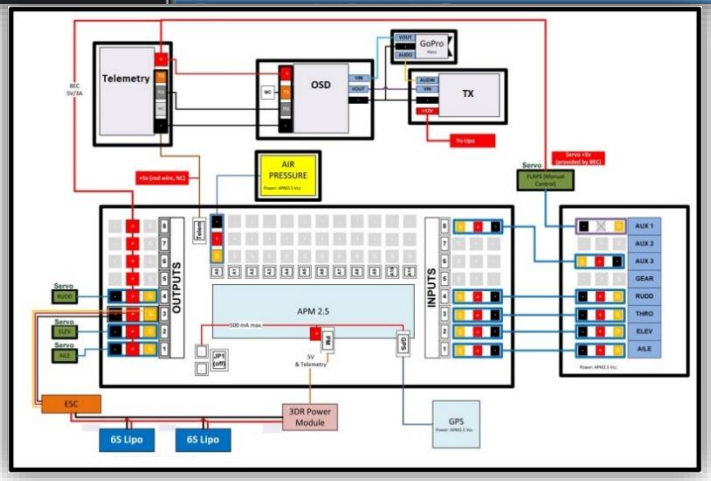
Image recognition partially completed over winter break

- Using OpenCV (wrapped in EmguCV)
- Latent Support Vector Machine pattern recognition training
- Training parameters and training time
  - Training time proportional to quality of classifier
  - Initial training took up to 12 hours
- Inadequate detection of some stock images

Matlab vs. OpenCV

- Various image proc. and pattern recognition Toolboxes available
- Much higher detection rate with Matlab

Electronics and Software Package



Successful test with video transmitter and receiver

- XBOX 360 video output streamed to Mission Planner
- Bench-top PSU in place of the batteries in shipment

Video stream fed through Mission Planner

- Custom GUI can be integrated
- Same software design features to be implemented
- Image processing, telemetry, and autopilot scripting can **ALL** be handled

Autopilot Hardware-in-the-Loop simulation testing with Xplane 10

- Use of flight simulator to test autopilot scripts
- Safe testing and debugging environment

Future Work

Autopilot Testing

- Hardware in the loop testing with a flight simulator
- To be completed upon arrival of batteries

Flight Testing of Autopilot Using Test Airplane

- To be completed upon successful HIL testing of autopilot system

Test Flight of Competition Airplane

- First flight: manual flight, controlled by experienced RC airplane pilot
  - Will include testing and evaluation of air drop system and video stream
- Autopilot test flight to occur after successful first flight
- All flights include risk of collision, and time will be allotted for repairs

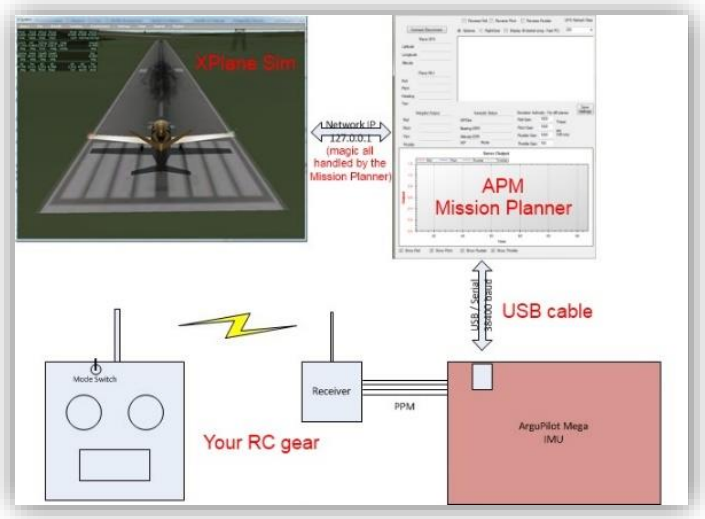
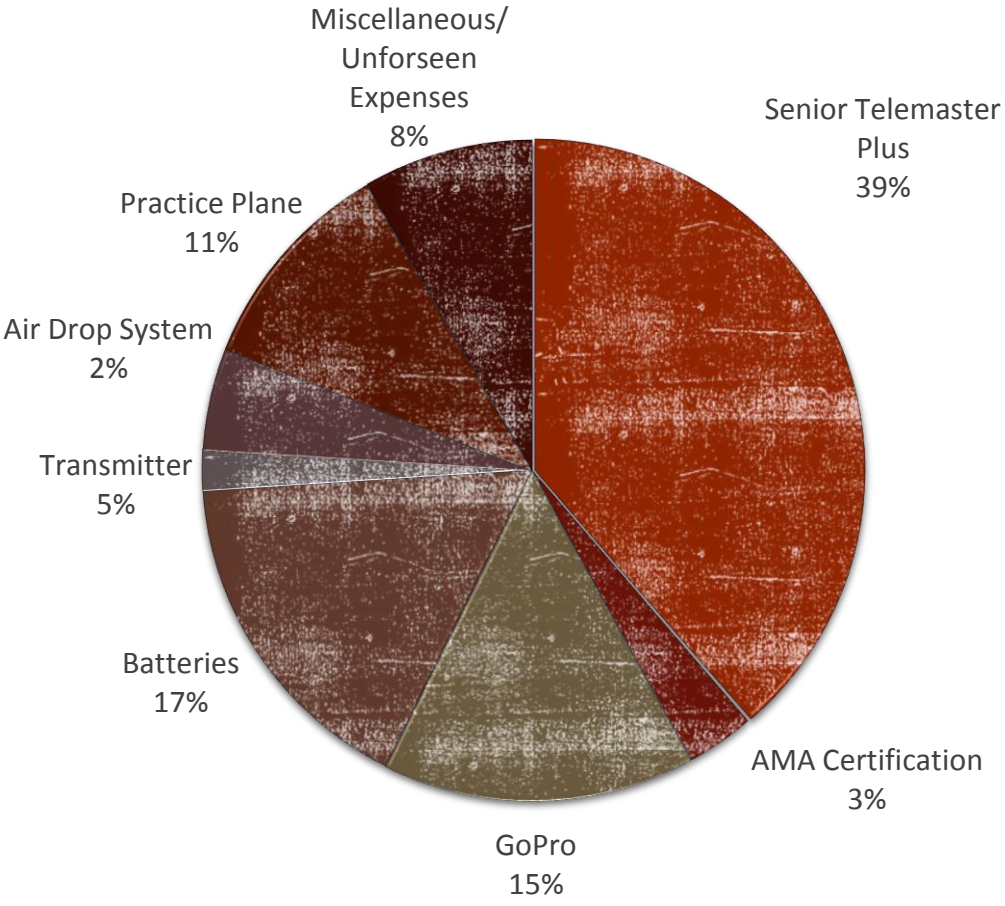


Image Processing and Ground Station Software

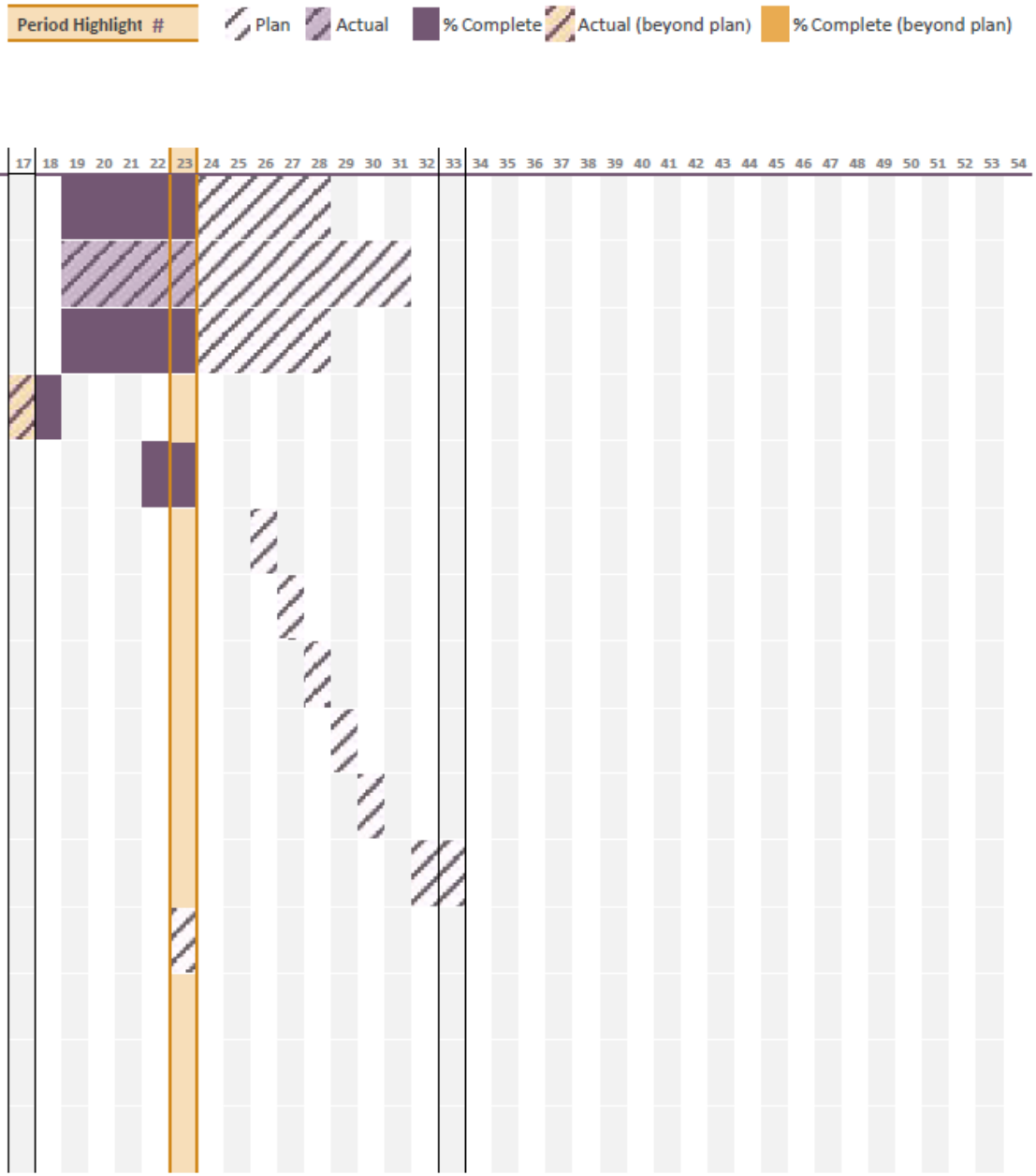
- Consultation with technical advisors for image processing
- Ground station software to be developed upon complete hardware testing

Budget



- $1500 Total Budget
- $1325 Spent
- $175 For Unforeseen Expenses

UAV Project Plan



ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION
Test Autopilot System	19	10	19	5
User Interface Development	19	13	19	5
Implement the Airdrop Code	19	10	19	5
Restated Project Scope	18	1	18	0
Midterm Presentation I	22	2	22	2
Spring Break	26	1	0	0
Proof of Flight Video	27	1	0	0
Midterm Presentation II	28	1	0	0
Operation Manual	29	1	0	0
Manufacturing/Reliability and Economics Report	30	1	0	0
Final Presentation	32	2	0	0
Competition: Intent to Participate	23	1	0	0
Competition: Submission of Materials	32+	1	0	0
Competition: Selection Finalists	32+	1	0	0
Competition: IDETC Conference	32+	1	0	0

References

1. (http://www.fas.org/sgp/crs/natsec/R42136.pdf)
2. (http://www.fas.org/sgp/crs/natsec/R42938.pdf)
3. http://www.auvsi-seafarer.org/documents/2014Documents/2014_AUVSI_SUAS_Rules_Rev_0.2a_DRAFT_13-0930-1.pdf
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Questions?