Team XXX

Some Assembly Required

Explorer Post 1010

Flight Readiness Review Briefing

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Flight Readiness Review Briefing

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Visesh

Introductions and Flight Mission Roles

Visesh	Primary Pilot in Command
Nick	Mission Planner Specialist / Alternate Pilot
Gunvir	Scoring Captain
Lucas	Aircraft Specialist / Safety Specialist
Timothy	Strategic Technician

Introductions and Flight Mission Roles

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Lucas	Aircraft Specialist / Safety Specialist
Timothy	Strategic Technician

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System Overview - Flight Method Strategy and Tasks

1. Fly autonomous objectives
2. Manually search for scoring items
3. Autonomously fly to scoring items
    a. Record coordinates
    b. Drop balloons
    c. Land
4. Autonomous takeoff and landing

System Overview - Flight Method Strategy

We considered two methods of flying and scoring points:

1. Fly autonomously, then manually search for scoring items (targets, debris, etc.)
2. Fly autonomously for found scoring items (while carrying balloons), locate accurate coordinates and drop balloons, then land to perform autonomous takeoff and landing

System Overview - Expected Performance

- 3 packages (balloons) on-target
- All 16 waypoints captured
- At least 6 of 8 SAR targets located and classified
- Mission completed within 25-28 minutes flight time
- Autonomous takeoff and landing

System Overview - Expected Performance

Flight Tasks

- Execute autonomous tasks first, mapping any targets seen on the way
- Use map to guide our pilot to the approximate locations of the targets to obtain precise GPS coordinates
- Use coordinates to drop balloons on designated targets using autonomous mission

Expected Performance

- All 5 SAR targets located and classified
- All 10 waypoints captured
- Mission completed within 25-28 minutes flight time
- Autonomous takeoff and landing
- At least one package (balloon) delivered successfully

System Overview - Risk Evaluation

Decision	Risk	Reward
Autonomous search	GPS malfunctions, unable to pause/resume mission to write down coordinates	Consistent/reliable searching for scoring objects
Manual search	Loss of orientation, inconsistent altitude, drift while recording coordinates	Able to recover from GPS issues, potentially faster speed

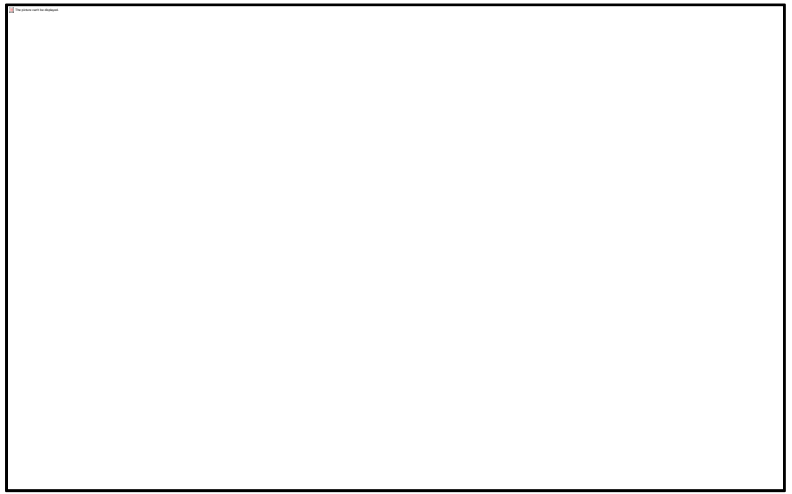
System Overview - Flight Method Risk Evaluation

Decision	Risk	Reward
Autonomous search pattern	GPS malfunctions, unable to pause/resume mission to write down coordinates	Consistent/reliable searching for scoring objects
Manual searching	Loss of orientation, inconsistent altitude, drift while recording coordinates	Able to recover from GPS issues, potentially faster speed

We decided to employ a hybrid approach: manually following a search pattern using loiter mode provides the benefits of both strategies - consistent search pattern with the ability to make manual adjustments as needed. This works by the Mission Planner specialist giving the Pilot heading directions to move the right stick, and when something is found, the Monitor Observer guides the pilot.

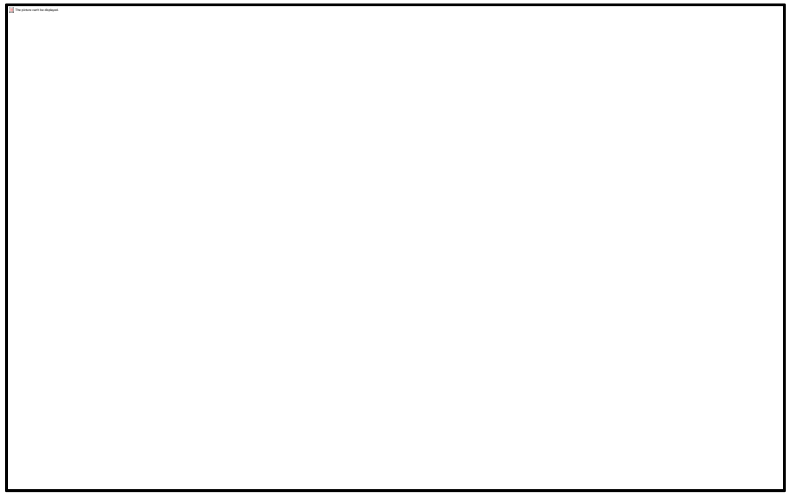
System Overview - Mission Planner Usage

- Monitor aircraft telemetry data
- Program autonomous missions
- Control Balloon Mechanism Servo
- Safety dashboard (arm/disarm, GPS status, flight mode)
- Use flight log
  - Diagnose Problems
  - Assess aircraft performance



System Overview - Mission Planner Usage

- Get telemetry data from the aircraft
- Use the flight log to understand aircraft performance
  - Diagnose Problems
  - Compare Data
- Program autonomous missions
- Monitor relevant aircraft telemetry data
- Use Mission Planner to Control Servo on Balloon Mechanism (Camera Shutter approach)
- Check for safety (arm/disarm, GPS lock, GPS satellite count, flight mode check)



System Overview - Monitor Usage

Team decisions made based on:

- Latitude/Longitude
- Altitude
- Battery Voltage
- GPS Lock
- GPS Satellite Count
- Flight Mode

System Overview - Monitor Usage

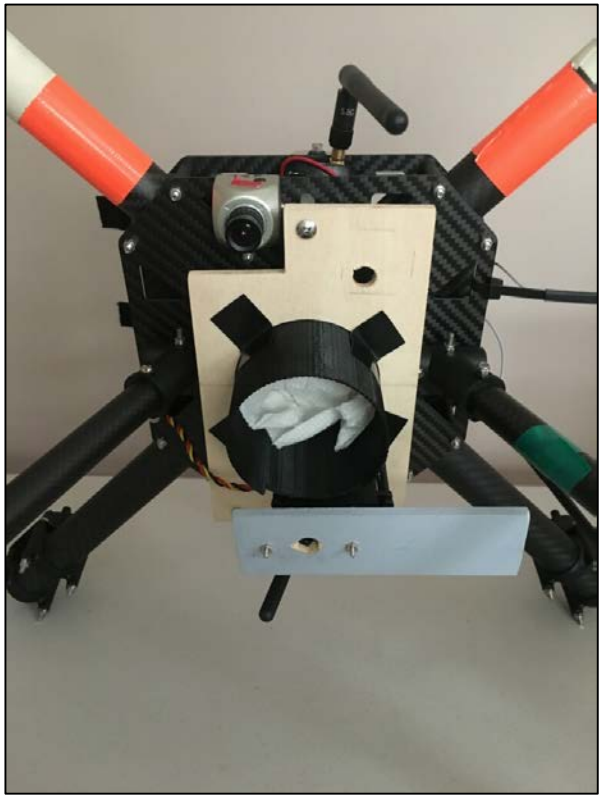
With our monitor we track the following:

- Latitude/Longitude
- Altitude
- Battery Voltage
- GPS Lock
- GPS Count
- Flight Mode

Most of our decisions pertaining to safety and scoring are made by our whole team using this information.

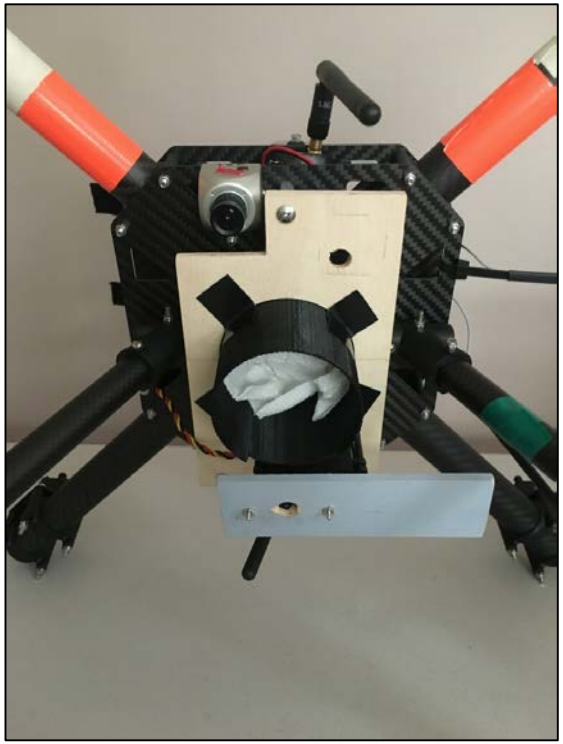
System Safety - Design Strategies

- Single balloon drop system
- Wood plate attached with 3 nylon standoffs
- 3D-printed cylinder to hold balloon
- Balloon secured by wood plate on servo
- “Camera Shutter” feature activates servo to release balloon



System Safety - Design Strategies

- Our final design is a single balloon drop system
- We used 3 nylon standoffs to firmly attach a wood plate to the aircraft
- A 3D-printed cylinder holds the balloon in place
- A single wood plate is on the servo, to secure the balloons until ready to be released
- Activating the "Camera Shutter" feature toggles the servo releasing the balloon and recording the location of the drop in mission planner!



System Safety - Operational Strategies

ALL flights conducted:

- With supervising adult
- In visual line of sight
- BELOW 400 feet and within FAA regulations

NO flights conducted:

- Without performing pre-flight inspection
- In bad weather or bad visibility
- Over people or buildings

System Safety - Operational Strategies

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- All flights conducted in visual line of sight
- All flights conducted BELOW 400 feet and within FAA regulations

- NO flights conducted without performing pre-flight inspection
- NO flights conducted in bad weather or bad visibility
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System Safety - Maintenance and Checklists

- We use checklists to enforce safety
  - Pre-flight
  - Post-flight
- We regularly inspect all aircraft parts
- Repairs are made with consent from all team members

System Safety - Maintenance and Checklists

- To enforce safety our team uses a series of checklists: pre- and post-flight.
- Checklists ensure a safer, more successful flight.
- All parts of our aircraft are regularly inspected.
- All repairs are made with consent of all the members.

Developmental Test - Ground and Mission Performance

- Ground tests after aircraft modifications
- Flight tests in open field at King Farm Park
- Consistently performed well
  - Finding scoring items (autonomous map method followed by manual search)
  - Dropping balloons on target
  - Completing autonomous objectives
- Initial issue with landing upright

Developmental Test - Ground and Mission Performance

- All of our tests were conducted at King Farm Park in an open field
- Manual flight tests using our “hybrid” strategy and autonomous flight went well
- We were consistently able to search for and locate search objectives and were also able to autonomously take off and land
- We practiced using our “Map” method to locate the general locations of targets in autonomous mode prior to the search mode

Developmental Test - System Enhancement (New Landing Gear)

- Redesigned landing gear to achieve greater stability
  - Cut down carbon fiber rods from stock landing gear
  - Used 4 custom 3D-printed pieces to attach legs to aircraft
- Performance
  - 100% upright landings!

System Enhancement - New Landing Gear

- The landing gear uses the same carbon fiber rods from the stock landing gear, but we cut them to achieve greater stability.
- The interface between the legs and the aircraft are 4 custom 3D-printed pieces
- Our new landing gear ensures that we land upright 100% of the time!

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Other Corrective Actions to Improve Mission Effectiveness

Issue:

- Double balloon drop system increased amp draw and decreased battery life
- Motor Mounts Misaligned to Frame
- Standing waves formed in balloons

Corrective action taken:

- Switched to single balloon drop system
- New motor arm design
- Shortened Balloon Holder

Corrective Actions Taken to Improve Effectiveness of Mission

Worked Well:

- Single & Balloon Drop System
  - Increased Flight Time and Improved Reliability
- New motor arm design keeping motor mounts aligned
- Shortened Balloon Holder
  - provides more balloon compression and less room for balloon movement
- In tests able to locate, identify, and drop balloons over targets autonomously

Didn't Work:

- Initial Double Balloon Drop System
  - Increased Amp Draw and Decreased Battery Life
- Motor Mounts Misaligned to Frame
  - Increased Vibrations/Caused Failsafe
- Standing Wave Formation in Balloons
  - Made Quad Unmanageable in the Air

Evidence of Mission Accomplishments

- >20 successful flights
- Accurately identified target objects
- Balloons landed <10 ft from targets
- Safety protocols effectively prevented unsafe deviations from planned mission (autonomous mode)
- Problems solved through effective team communication

Evidence of Mission Accomplishments

- More than 20 successful flights which included carrying balloons, autonomous missions, and use of hybrid method
- Successful identification of target objects
- Balloons landing less than 10 ft from desired targets
- Safety protocols executed effectively to prevent unsafe deviations from the planned mission when in autonomous mode
- Problems solved through effective team communication

Pre-Mission Briefing - Personnel Resourcing & Communications

Visesh	Primary Pilot in Command
Nick	Mission Planner Specialist / Alternate Pilot
Gunvir	Scoring Captain
Lucas	Aircraft Specialist / Safety Specialist
Timothy	Strategic Technician

Pre-Mission Briefing - Personnel Resourcing & Communications

Visesh	*Primary Pilot in Command*
Nick	*Mission Planner Specialist / Alternate Pilot*
Gurvir	*Scoring Captain*
Lucas	*Aircraft Specialist / Safety Specialist*
Timothy	*Strategic Technician*

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Timothy

Pre-Mission Briefing - Go/No-Go Criteria and Fall Back Plans

Before Flight

- Weather
- Airspace Activity
- Presence of people on field
- Condition of Quad

During Flight

- Aircraft stability / functionality
- Wind Speed
- Battery Condition
- Airspace Activity

When one or more conditions is seen as a hazard we may:

- Return to Land Immediately
- Reschedule flight or travel to other fields
- Make necessary plans to repair and inspect Quad thoroughly

Pre-Mission Briefing - Go/No-Go Criteria and Fall Back Plans

We use checklists to ensure safety and make Go/No-Go decisions, using criteria such as

Before Flight

- Weather
- Airspace Activity
- Whether there are people on the field
- Condition of Quad

During Flight

- Aircraft stability / functionality
- Wind Speed
- Battery Condition
- Airspace Activity

When one or more conditions is seen as a hazard we may

- Return to Land Immediately
- Reschedule flight or travel to other fields
- Make necessary plans to repair and inspect Quad thoroughly

What we learned!

- Compass calibrations (“Drone Dance”)
- More ways to use mission planner (control and drop servos)
- Basic flight safety
- Soldering and wire splicing skills
- Handling GPS interference issues
- How to apply physics to solve problems (e.g., vibrations that caused rapid descent)

What we learned!

- Compass Calibrations (“Drone Dance”)
- Learned more ways to apply mission planner
  - Control & Drop Servos
- Basic Flight Safety
- Built up soldering and wire splicing skills
- Learned to handle GPS Interference Issues
- We also learned how to apply physics to solve problems
  - Minimize Vibrations that cause rapid descent

Future Steps for Improvement

- Analyze quality of competition performance
- More practice, practice, practice!
  - Manual and autonomous flight
  - Mission Planner
- Ardupilot tuning and calibration
- Techniques to improve GPS Accuracy
- Maximize balloon drop accuracy
- Increase understanding of the Pixhawk Parameters

Future Steps for Improvement

- Analyzing quality of competition performance
- Practice, practice, practice!
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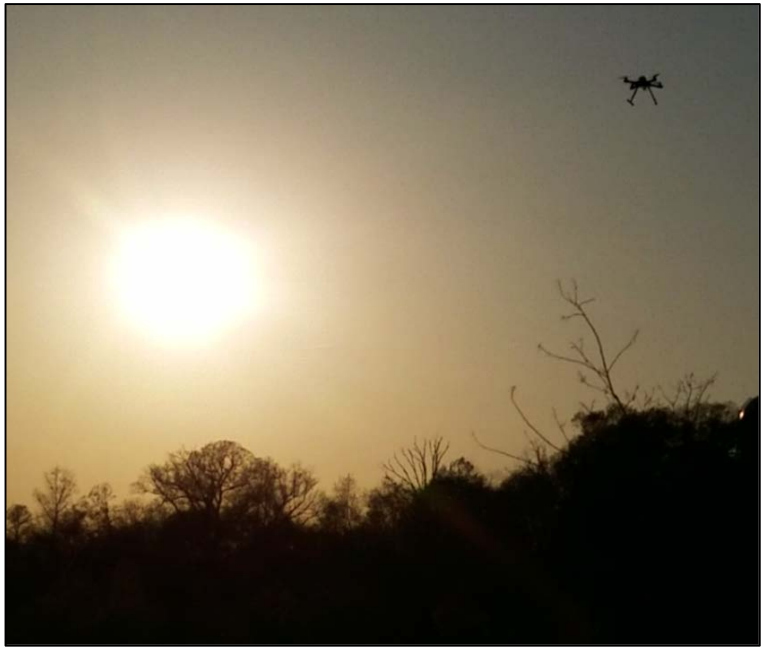

Thank you for your time!

Questions?

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