Team 138

Some Assembly Required

Explorer Post 1010

Flight Readiness Review Briefing

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*

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 - 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 - Plan and 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 - 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

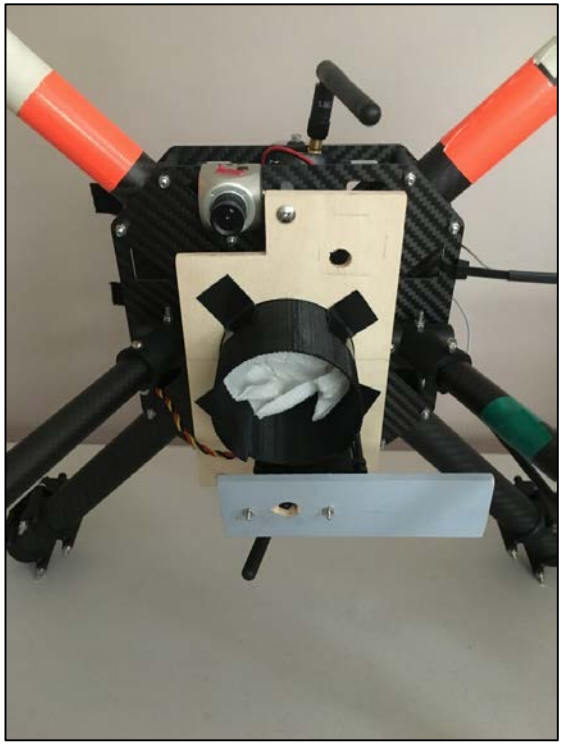
With our monitor we track the following:

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

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

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
- 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
- NO flights conducted over people or buildings

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

- 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

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!

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

- 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 - 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

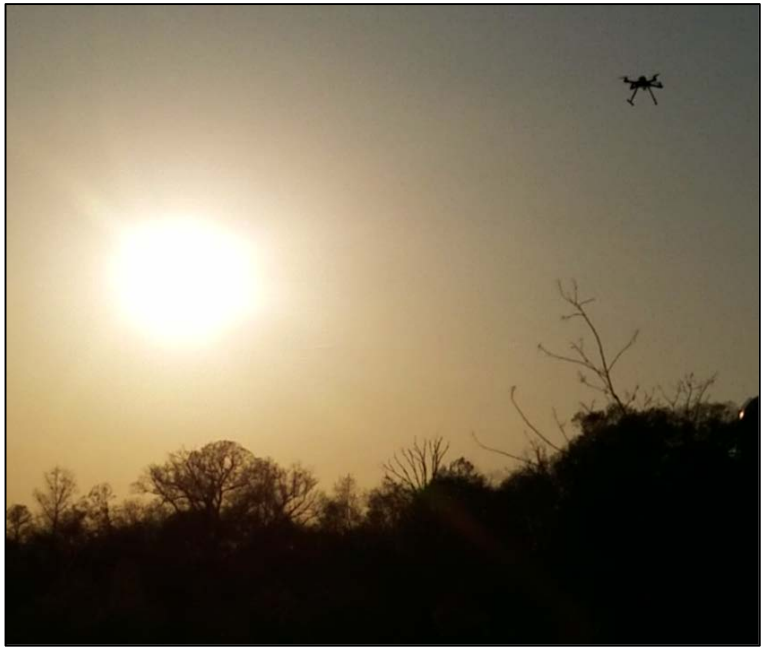
- Return to Land Immediately
- Reschedule flight or travel to other fields
- Make necessary plans to repair and inspect Quad thoroughly

What we learned!

- Compass Calibrations (“Drone Dance”)
- 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

- Analyzing quality of competition performance
- 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



Thank you for your time!

Questions?