Introductions and Flight Mission Roles

Muhammed   Safety Pilot/Pilot in Command

Nathan   Scoring Captain

Ethan   A.I. Developer

Jasmine   Mission Planner Specialist / Team Captain

Introductions and Flight Mission Roles (cont'd)

Bobby   Aircraft Specialist/ Visual Observer

Sam   Safety Specialist

Julian   Airboss

Veronica   Strategic Technician

Lindsay   Co-Strategic Technician

New Team Support/Training Video

System Overview - **Flight Tasks Planned**

1. Accomplish autonomous objectives
   a. Map locations of scoring items while completing autonomous objectives
2. Hybrid search for further scoring items
3. Fly to drop-off targets
   a. Record coordinates of targets
4. Fly to pick-up targets (waypoint navigation)
   a. AI assisted pick-up
5. Drop-off fully <u>autonomously</u> (waypoint navigation/auto drop)
6. Autonomous takeoff and landing

System Overview - Expected Performance

- Successfully execute Flight Mission
- All 6 target coordinates recorded
- 3 payloads transferred
- <u>Autonomous assisted pick-up</u>
- <u>Autonomous drop-off</u>
- Mission completed within <30 minutes flight time
- Autonomous takeoff and landing

System Overview - Mission Planner Usage

- Monitor aircraft telemetry data
- Safety dashboard (arm/disarm, GPS status, flight mode)
- Program autonomous missions
- Control payload grabber servo
- Simulate missions
- Use flight log to diagnose problems
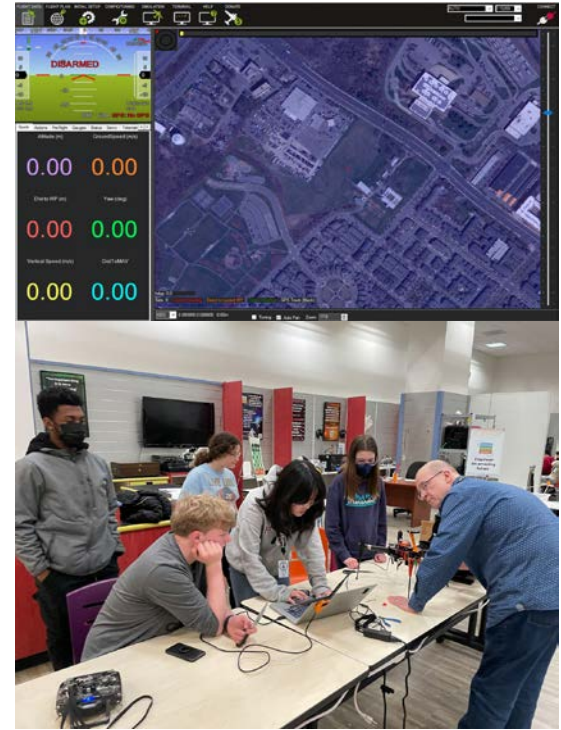
System Overview - Risk Evaluation

Risk	Risk Type	Mitigation
Autonomous payload procedure ● GPS coordinate margin of error	Safety / Scoring	Release the payload while airborne, possible location adjustment
Payload system failure	Scoring	Attached mechanism to all four legs for additional stability Extensive testing, higher quality mechanical parts
Payload falls unexpectedly during flight	Scoring	Pick-up immediately or return later (may be worthwhile to complete other mission objectives first)
A.I. Failure	Safety / Scoring	Switch to manual flying or use waypoint mission
Flight Beyond Visual Line Of Sight (BVLOS)	Safety	Confirmed with flight directors that a visual observer will monitor the quad and communicate w/ PIC

System Overview - A.I. Based Autonomy

1) Hybrid approach to leverage strengths of each type of AI
    a) MP for coarse navigation to target
    b) Vision based DNN/SSD to maintain target lock through delivery
2) Automated payload drop for delivery
3) Draw a bounding box around the target
4) Calculate if the vertices of the square match the supposed coordinates of the target
5) Utilize Closed Loop software control to guide the Quad over the target and release the payload

System Overview - Risk Evaluation – A.I.

- False Positives
  - Misidentify targets
  - Can result in harm or damage
- False negatives
  - Miss real targets, miss points in the competition
- Reliability
  - May not be reliable in complex environments
  - Malfunctions result in false negatives/positives
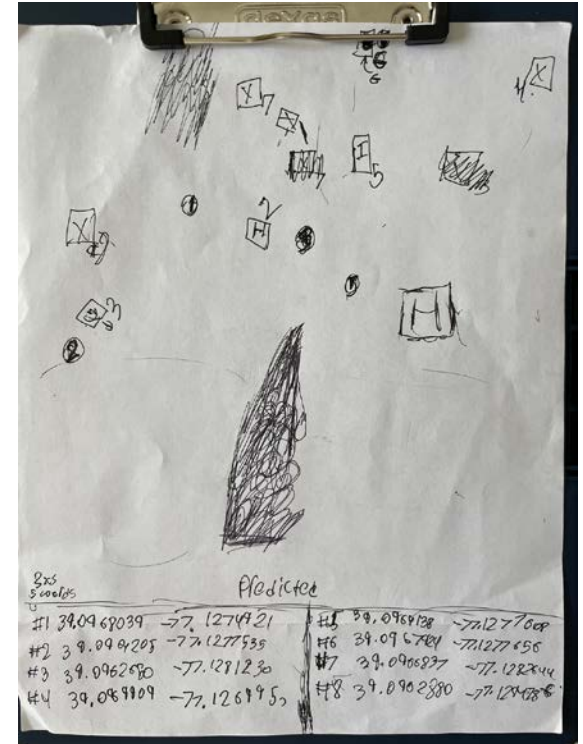
System Overview - Monitor Usage

Flight decisions made based on:

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

System Overview - Maps

Consolidation of Data:

- Target location relative to surface features

- Type of Target

- Latitude/Longitude

- Possible Obstacles

- Review after flight

System Safety - Operational Strategies

ALL flights conducted:

- With supervising adult
- In visual line of sight or Visual Observer
- 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 - Design and Operational Strategies

- High quality payload components (sufficient infill, appropriate layer height, high quality aluminum connecting components)
- Verified failsafe RTL action
- We use checklists to enforce safety
  - Pre-flight
  - Post-flight
- Maintain safe altitude when crossing over obstacles
- Repairs made w/ consent from all members

Developmental Test - Test Planning

1. Prototype Completion
2. Independent System Test (off quad)
3. Integrated Ground Test (on quad)
4. Basic Flight Test (airworthiness)
5. Aerial System Test in open field
6. Mission Performance Test

Developmental Test - Ground and Mission Performance

- Plan to simulate competition flight experience:
  - Find scoring items (autonomous map method followed by manual search)
  - Transfer payloads
  - Complete autonomous objectives

Developmental Test - Corrective Actions Taken

- Built new quad
  - Planning on:
    - Replacing faulty motors and ESCs
    - Testing new propellers to correspond with new motors
  - Antenna mounting
    - Diversity system
    - Optimized antenna placement to reduce interference

Developmental Test - Corrective Actions Taken (cont'd)

- Designed new "grabber"
  - Belt driven system for smooth catching of payloads
    - Focus on reducing weight while maximizing margin of error
      - (Inverted Tablecloth Pulling Mechanism) design
  - Concept → CAD Model → Low cost prototype
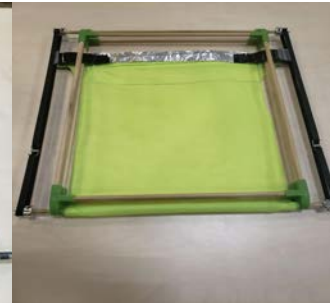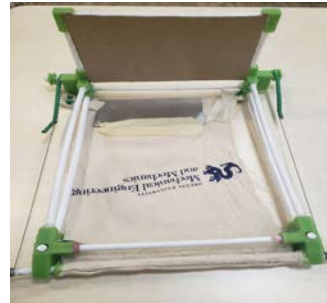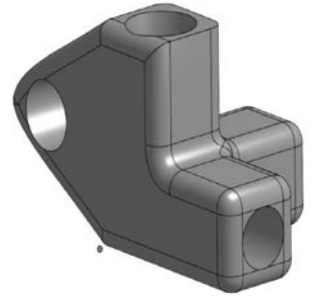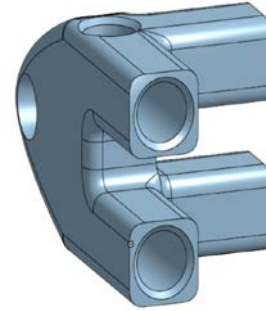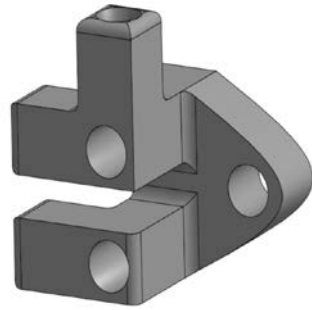
Evidence of Mission Accomplishments

- Payload grabber prototype that has picked up all 3 payloads in testing
- Trained A.I. to recognize a target
- Safety protocols effectively ensured no damage to persons or property
- Team members effectively executed assigned roles
- Successful pick-up of water bottles last year

Pre-Mission Briefing - Personnel Resourcing

- Defined responsibilities based on roles
- Roles assigned based on skills and interests
- Allocated positions and tasks based on flight vehicle condition
  - Grounded-preflight
  - Flying
  - Grounded-post flight

Pre-Mission Briefing - Team Comms

Maintaining communication with team roles:

- All non-essential activities are forbidden (sterile cockpit)
- Share essential information
- Each role has specific call outs
- Maintain records of each flight

Pre-Mission Briefing - Go/No-Go Criteria

Discussions and briefings include:

Before Flight
- Weather
- Airspace Activity
- Presence of people
- Condition of Quad

During Flight
- Aircraft Performance
- Wind Speed
- Battery Condition
- Airspace Activity

Thank you for your time!

Questions?