Team SAR

Some Assembly Required

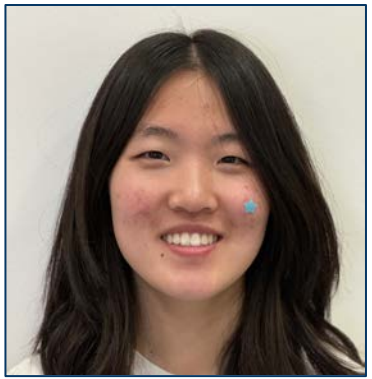
Explorer Post 1010

Flight Readiness Review Briefing

29 April 2024

Introductions and Flight Mission Roles

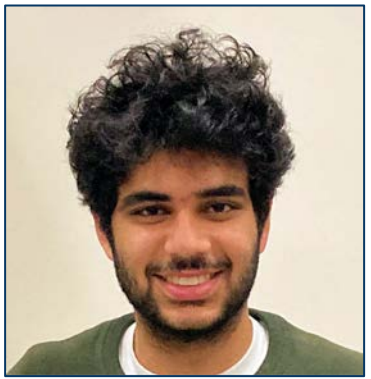
Nathan	Scoring Captain
Jasmine	Team Captain / Air Boss
Bobby	Pilot in Command / Payload Specialist
Veronica	Mission Planner Specialist

Introductions and Flight Mission Roles (cont'd)

Sam	Safety Specialist
Lindsay	Strategic Technician
Jane	Visual Observer / Secondary Backup Pilot / Video Lead
Jason	Aircraft Specialist/ Backup Pilot



Meet JEFF!

Joint Engineered and Fabricated Flyer

New Team Support/Training Video

System Overview - Flight Tasks Planned

1. Accomplish autonomous objectives
    - Map locations of scoring items while completing autonomous objectives
2. Recon mission - fly to targets w/ as few batteries as possible
    - Record coordinates
    - Decode QR Codes for drop-off targets
3. Fly to pick-up targets (waypoint navigation)
    - Pilot “nudges” quad to center over target
4. Drop-off autonomously (waypoint navigation/autonomous drop)
    - Prioritize unmoving targets; do moving target last w/ chocolate bar (fly to moving target’s path)
5. Autonomous takeoff and landing

System Overview - Expected Performance

Successfully execute Flight Mission

- Mission completed within <30 minutes flight time
- 3 payloads transferred
  - Deliver 1 payload to moving target
- AI-assisted autonomous pick-up and drop-off
- Autonomous takeoff and landing

System Overview - Risk Evaluation

Risk	Mitigation
Material Failure	Use highest quality 3D printed parts with appropriate layer height, infill, and orientation
Inaccurate Coordinates for MP mission	Pilot "bumps" quad or AI is used to automatically center quad for pick-up/delivery
Automatic QR Decoding Failure	Manually use phone to decode QR code from monitor
Early Battery Depletion	Using old batteries for autonomous mission, newer batteries for pick-up/drop-off; voltage call-outs
Early payload drop	New modifications and additional testing for grabber system to adjust to Hershey bar
Wind Interference	Pilot practice in windy conditions; for AI, coordinate transformation for camera tilt
Flight Beyond Visual Line Of Sight (BVLOS)	Confirmed with flight directors that a visual observer will monitor the quad and communicate w/ PIC, team visual observer

System Safety - Operational Strategies/General

ALL flights conducted:

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

NO flights conducted:

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

System Safety - Operational Strategies/Mission Planner Usage

- Monitor aircraft telemetry data
- Safety dashboard (arm/disarm, GPS status, flight mode)
- Program autonomous missions
- Control payload mechanism servo
- Interface with AI system
- Simulate missions
- Autonomously navigate to targets

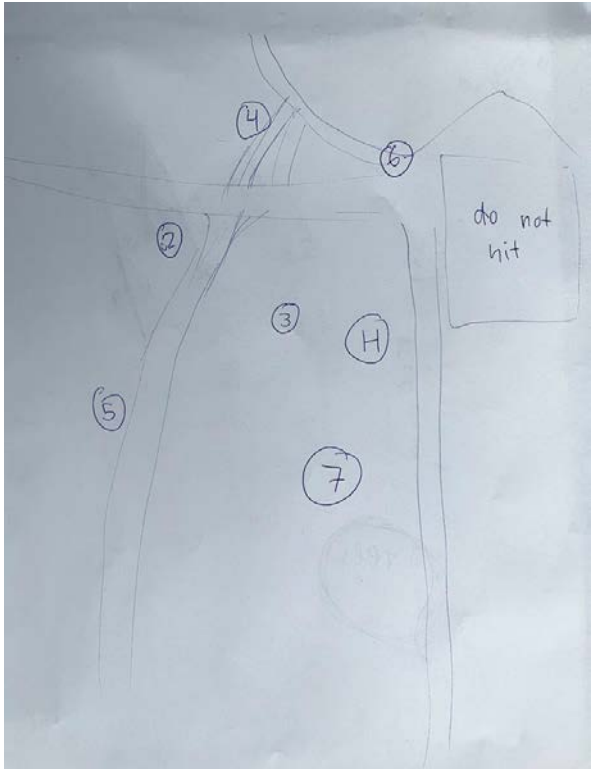
System Safety - Operational Strategies/Monitor Usage

- Digital camera + receiver
- Payload capture assistance
- Flight decisions made based on:
  - Camera and receiver battery voltages
  - Temperature
  - Signal quality
  - Distance
  - Quad location

System Safety - Operational Strategies/Map Usage

Consolidation of Data

- Target location relative to surface features
- Type of Target
- Latitude/Longitude
- Possible Obstacles
- Moving Target Locations
- Review after flight



System Safety - Operational and Design Strategies

- Verified failsafe RTL action
- Use checklists to enforce safety
- Maintain safe altitude when crossing over obstacles
- Clear call-outs made so all members are aware of important updates during operations
- Repairs made w/ consent from all members
- High quality components (sufficient infill, appropriate layer height, high quality carbon fiber connecting components)

System Safety - Design Strategies/ AI Based Autonomy

- Working on a hybrid approach to leverage the strengths of AI
- Mission Planner to autonomously navigate to target
- Successfully trained an CNN to recognize targets and draw a bounding box
  - Accuracy >80%
- Precision Landing to autonomously use AI to center quad on top of payload for a fully autonomous pick-up
  - May use AI to also center quad for drop-off

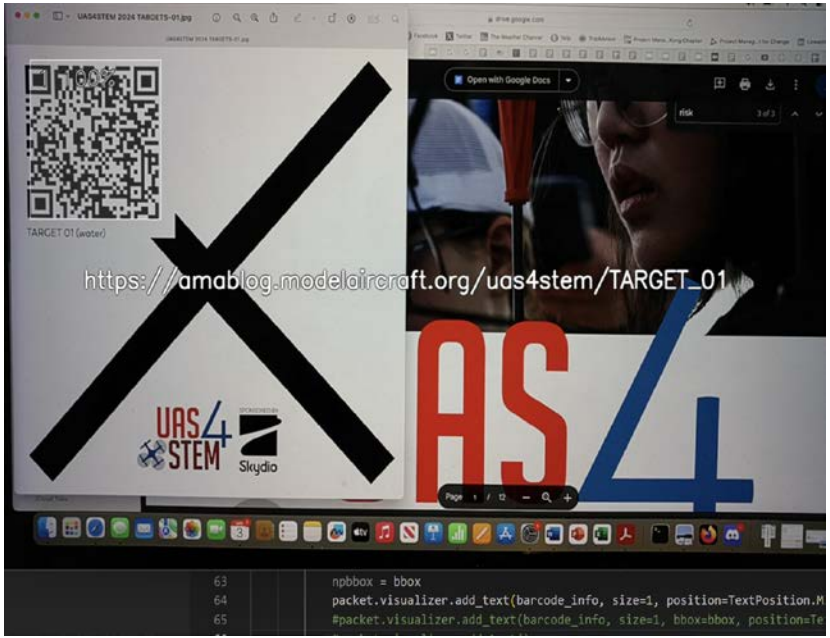
Developmental Test Results - Test Planning

When testing the AI and grabber, we follow these steps:

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

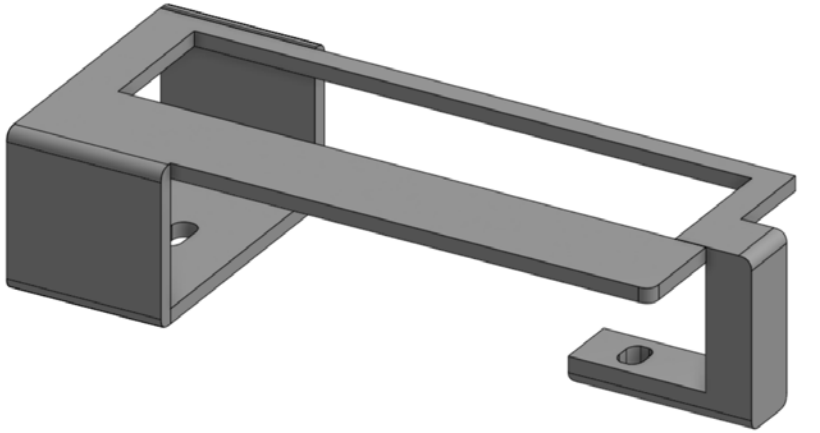
Developmental Test Results - Ground and Mission Performance

- Confirmed groundbot can be used to practice delivery to moving target
- Successfully tested Mavlink software to decode telemetry data from Pixhawk Cube for interfacing AI based QR decoding
- Successfully tested QR decoding prototype on Oak-D AI camera using Python Library (pyzbar)
- Tested grabber with Hershey bar and identified corrective actions needed



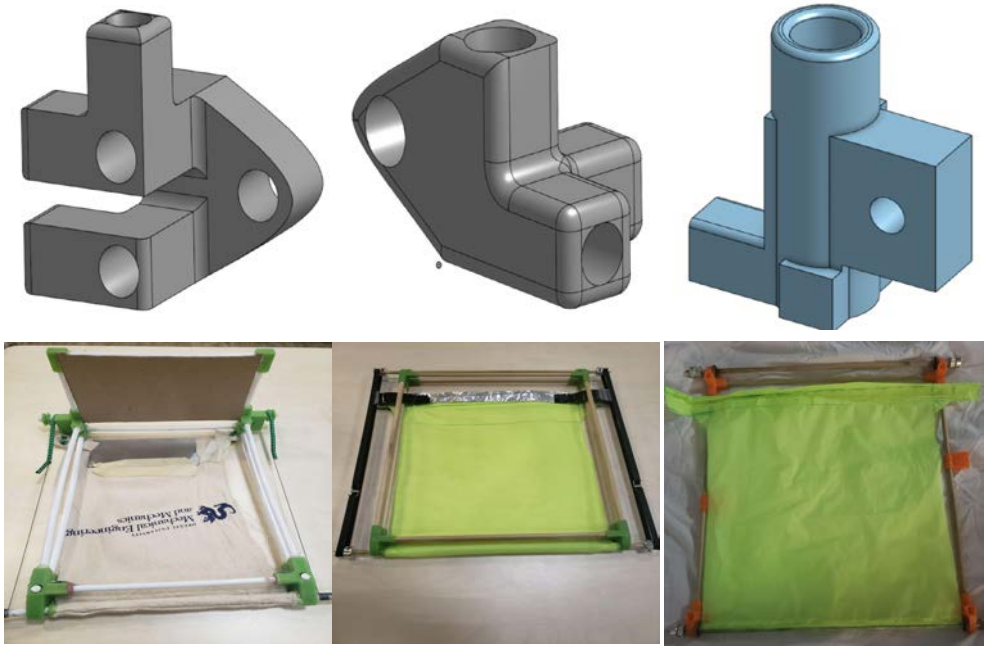
Developmental Test - Drone Enhancements

- Remote ID Module to comply with FAA regulations
- Mount redesign
  - Redesigned to improve strength-to-weight ratio
- OAK-D Camera
  - Custom 3d printed mount
  - Optimized location for AI recognition
- Plan to add battery throughput circuit



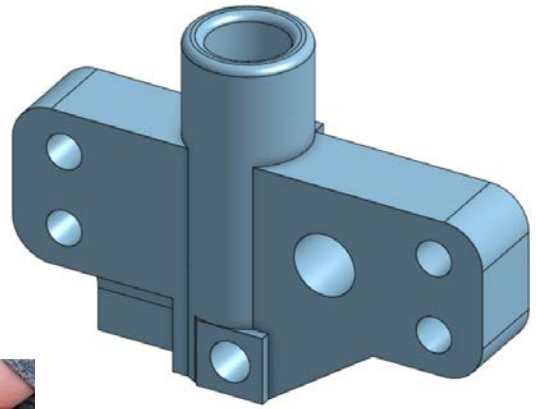
Developmental Test - Grabber System Enhancements

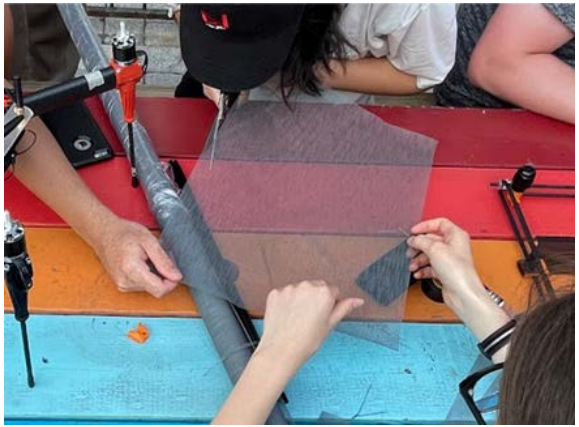
- Improving last year's reverse tablecloth magic trick (RTMT)
- Last year's device:
  - Belt driven system for smooth catching of payloads
  - Focus on reducing weight while maximizing margin of error for landing
  - Iterated design (Concept → CAD Model → Low cost prototype → Final prototype

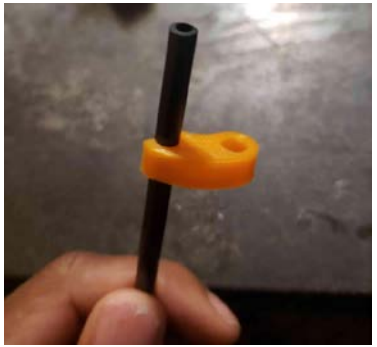


Developmental Test - Grabber System Enhancements (cont'd)

- Direct drive servo
- Sharpened leading edge
- Screen modifications
- Different belt design to even out tension
- Skirt to hold Hershey bar
- Magnets for closing







Evidence of Mission Accomplishments

- Grabber works with water bottle & med kit
- Successfully completed 7 team flying practices
  - Autonomous flying
  - Manual flying (Skydio, Quadzilla, JEFF)
  - Team members successfully worked in assigned roles
- Updated our checklists
- Safety protocols effectively followed to ensure no damage to persons or property

Pre-Mission Briefing - Personnel Resourcing

- Determined necessary responsibilities, split into individual 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 - Communication Procedures

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

Social Outreach

- Local science day event
  - Introduce community to drones/explorer post (flight simulators)
- Explorer Post picnic
  - FUNdraising event, demos for the public (Skydio drone and flight simulators)

Thank you for your time!

Questions?