Avalanche Mitigation Mission Operations

AERO 658: UAS Operations

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Overview

- Mission Synopsis
- Location
- Environment
- Safety
- Personnel
- Logistics
  - Communications, transportation, UAS systems, tools/supplies
- Flight Plans
- Data Analysis

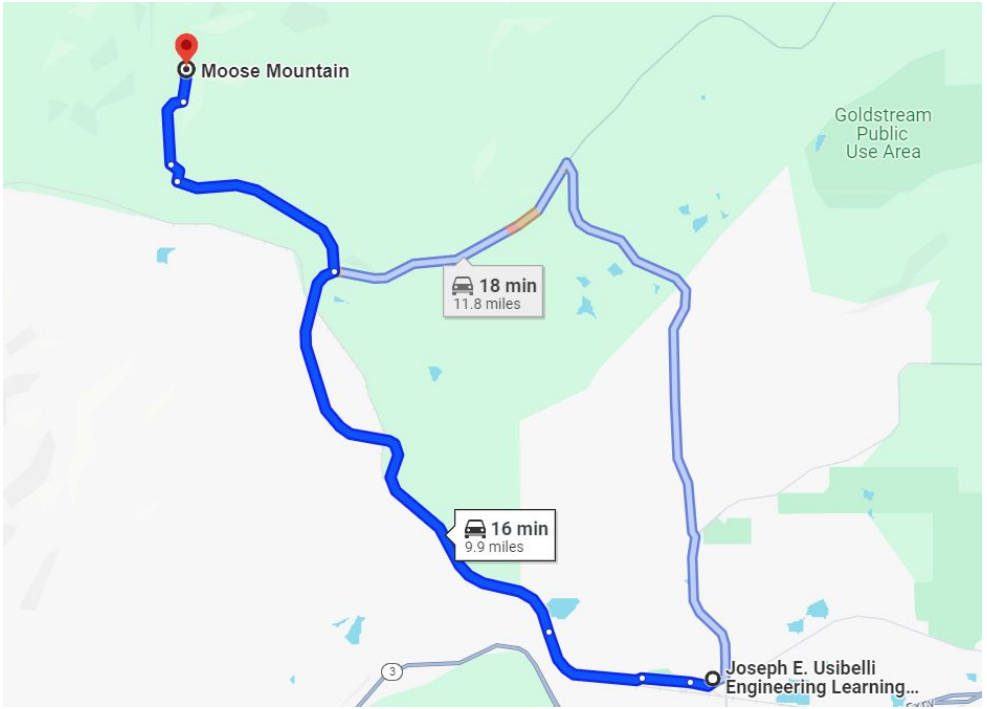
Mission Synopsis

Mission Goal: Gather data to predict avalanche risk and choosing locations to potentially trigger a controlled avalanche.

- Phase 1 - Data collection and analysis
  - Gather data to predict avalanche risk and optimize/map payload drop location
- Phase 2 - Trigger controlled avalanche
  - Deliver an explosive payload to trigger the avalanche

Location

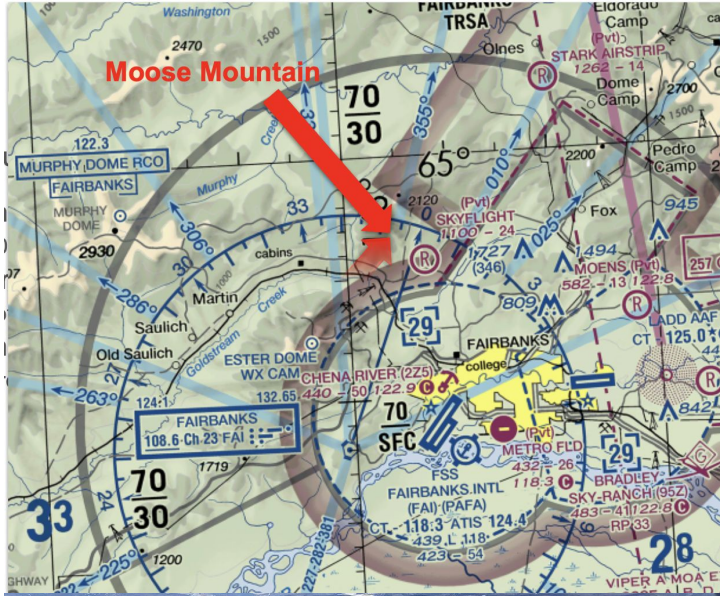
- 16 minute drive from rendezvous point at UAF
- See logistics
- Onsite transportation will include using the truck to go from lower to upper parking lots and walking from there
- Excessive equipment hauling will not be necessary as we will be operating very close to the parking lot
- Moose mountain is now closed for the season

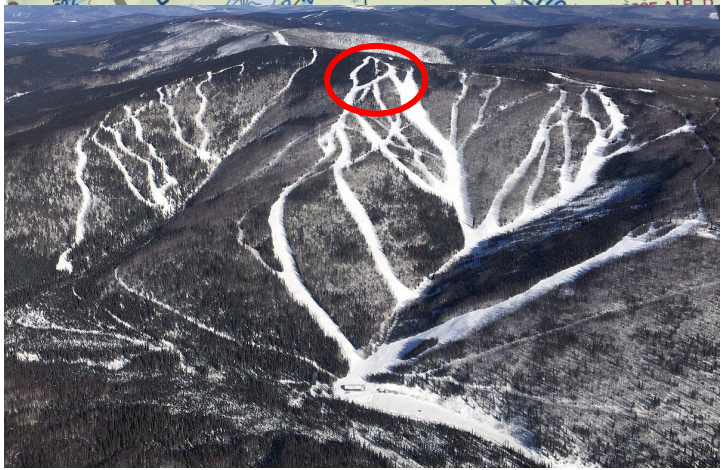


Environment

Moose Mountain:

- Uncontrolled airspace
  - 10 mi NW of PAFA airport
- Has areas without trees for photographing
  - Total area of approximately 1 square mile
- Weather Conditions
  - Around freezing temperatures and possibly windy
  - Areas of snow, slush and ice to be expected
  - Possibility of mud and exposed grass
- Wildlife
  - Lynx, bears, wolves, coyotes, moose, fox, marten, porcupine, marmot, snowshoe hares, squirrels, various birds and insects are all inhabitants of the area
- Equipment
  - This environment necessitates appropriate hiking boots and outerwear, wildlife safety including radio communication and bear spray, and bug spray
  - Safety briefing to go over bear safety as well as wolve/coyote/lynx awareness is crucial
  - Bears will have recently come out of hibernation





Summary

April 1, 2023 - April 30, 2023

	High	Low	Average
Temperature	49.2 °F	-4.0 °F	20.5 °F
Dew Point	34.8 °F	-11.2 °F	9.5 °F
Humidity	94 %	32 %	63 %
Precipitation	0.29 in	–	–

	High	Low	Average
Wind Speed	15.8 mph	0.0 mph	1.5 mph
Wind Gust	19.0 mph	--	1.6 mph
Wind Direction	–	–	South
Pressure	30.77 in	29.73 in	–

Safety

- Flight safety - conduct careful preflight, flight, and post flight inspections
- Injury to ground personnel- Site safety plan, JHA (job hazard analysis) for each role
- Equipment damage - backup equipment, tools, replacement parts, person who knows how to repair drone
- Weather - Make sure personnel have adequate clothing and footwear
- Natural dangers - mosquitos, uneven ground, bears, wolves, lynx, moose
- Communications - Radios (charged, same channel), mobile phones
- Survival gear - bug spray, coats, water, food
- First aid/buddy care - first aid, CPR certified individual
- Rescue/evacuation plans - Call for an ambulance
- Make sure everyone knows how to use all of the safety equipment
- Monitor different radio frequencies for incoming air traffic
- Everyone have whistles for emergency landing signal

Personnel

- **1 Pilot** - Operates the DJI Inspire 1 (Seth)
  - Transports the UAS between flight locations
- **2 Observers** - Both observers will watch the Inspire 1 from different locations along the flight path. One observer will be at the landing location. (Josh and Lawrence)
  - Transports spare tools, supplies, and batteries

Logistics

- Transportation
- UAS Systems
- Tools/Supplies
- Communications

Transportation

- 2007 Ford F-150
  - 6.5 ft bed to carry UAS and supplies
  - 5 Seats
- Sufficient space to carry
  - UAS
  - 3 Personnel
  - Tools and Equipment
- Sufficient gas mileage for a round trip from UAF to Moose Mountain

UAS Payloads

DJI inspire 1: Small multi-rotor UAS

- Weight with battery: 2.935 kg
- Flight time: 18 minutes per battery
- 4 batteries total
- Operating temperature:14°F to 104°F (-10 to 40 C)
- Easy to operate
- Minimal payload attachment points
- 22mph max wind speed resistance

UAS Sensors - Visual

DJI Inspire 1 Zenmuse X3

- 12MP Camera
- FOV 94°
- Operating Temperature 32°F - 104°F (0°C - 40°C)

For best results of image quality

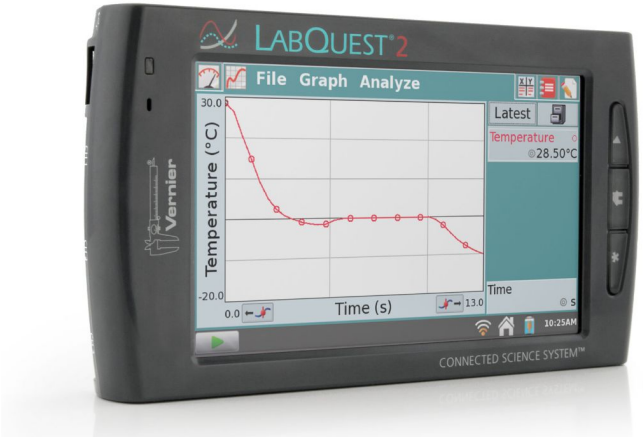
- 60% - 70% forward overlap
- Flight Altitude 150 ft : 322.56 ft image width

UAS Sensors - Thermal

Vernier Infrared Thermometer

- FOV: 65 mm diameter circle at 1 meter range
- Temperature Range: -4°F - 752°F (-20°C - 400°C)
- Operating Temperature 32°F - 122°F (0°C - 50°C)

- Required Equipment
  - Cable to connect to data-collection interface
  - 4 AAA batteries



DJI S1000 - Advanced stability octocopter

- Total weight: 4.2kg
- 15 min hover time at 9.5kg
- Easy assembly and transportation
- Adequate room for payload attachment
- Max takeoff weight of 11kg
- Expensive and difficult to fly, requires trained pilot
- Operating temperature: 14°F to 104°F (-10 to 40 C)
- Max Speed 16m/s
- High Wind resistance

Tools/Supplies Packing List

- Toolkit and hand tools for basic repairs of gear
- Cleaning Cloths/Solution for UAS and Sensors
- Binoculars for UAS Observers
- High Visibility Vests
- First Aid Kit
- Radios
- Caution Tape
- Whistles
- Trash Bags
- Safety Glasses
- Laptop

Full Complete Packing List:
https://1drv.ms/x/c/ca3bd59a4fc399ff/EbR4ky8oDq5CvKTJk2uAaokB7AtXQgh8CYGs_dDb6ne2nA?e=Yhjgfn

UAS and Sensors Packing List

- DJI Inspire 1 and DJI S1000
  - Batteries
  - Storage Box
  - Backup Equipment (ex. Propellers)
  - Multiple SSDs
  - Cables and Charger
- Sensors
  - Visual Camera
  - IR Thermometer and LabQuest System
  - Battery and AAA Batteries
  - Cables and Charger
- Payload
  - Sample Explosive Payload
  - Payload Deployment Device

Full Complete Packing List: https://1drv.ms/x/c/ca3bd59a4fc399ff/EbR4ky8oDq5CvKTJk2uAaokB7AtXQgh8CYGs_dDb6ne2nA?e=Yhjgfn

Personal Packing List

- Food and Water
- Cell Phones
- Warm Clothing for Late Winter/Early Spring conditions
- Waterproof Boots

Full Complete Packing List:
https://1drv.ms/x/c/ca3bd59a4fc399ff/EbR4ky8oDq5CvKTJk2uAaokB7AtXQgh8CYGs_dDb6ne2nA?e=Yhjgfn

Communications

- Cellphones
  - Main form of communications
  - Right next to Fairbanks, so coverage will be fine (from first hand experience)
- Spare radios
  - Backup communications: Walkie-Talkies will be kept on person at all times

Mission Operations Preparations

- Prepare Equipment
  - Clean, prepare, and charge UAS for quick preflight setup
    - Ensure software is up to date and maps are downloaded
    - Ensure sensors are set up properly and interface with the UAS
  - Charge laptop and ensure data analysis software is up to date for quick inspection of data collected before leaving the site
- Pack and prepare all personal items
- Pack all equipment and personal items into vehicles

Photogrammetry Operations Schedule

Monday April 15th

8am - Meet at UAF Engineering building and assemble packing list including the Inspire 1

9am - Mobilize to Moose Mountain

9:16am - Arrive onsite

9:30am - Safety meeting, go over flight schedules/site safety plan. Set up safety delineators, caution tape to mark off takeoff/landing zones according to SSP

10am - Assemble and carefully inspect UAS, sensors, communications and data reduction equipment. Test everything to ensure proper operation.

11am - Begin Flight Operations. We will perform 3 flights total at roughly 15 minutes per flight with a 15 minute break in between each flight.

12:30pm End Flight Operations. Use DJIAfterflight to perform a quick data analysis to ensure quality photogrammetric data. One person walk down the flight path, taking temperature/GPS readings every 2 minutes. Every time a temperature reading is made, this person will drop a pin on their phone that we can later use as position data.

1:00PM Inspect, maintain, and pack up all equipment for demobilization. Document the condition of all equipment.

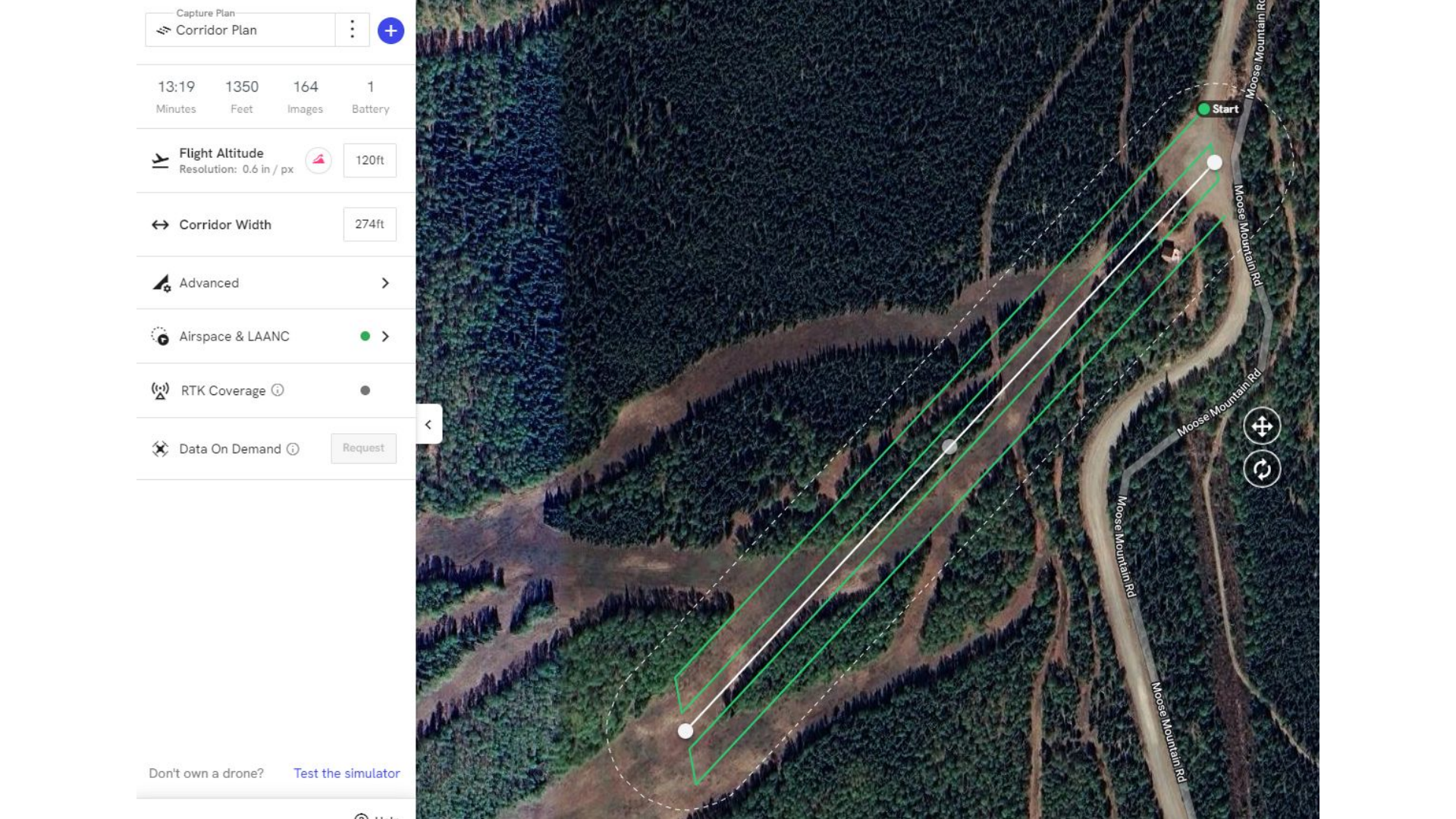
2:00PM Demobilize, head to Ivory Jack’s for lunch

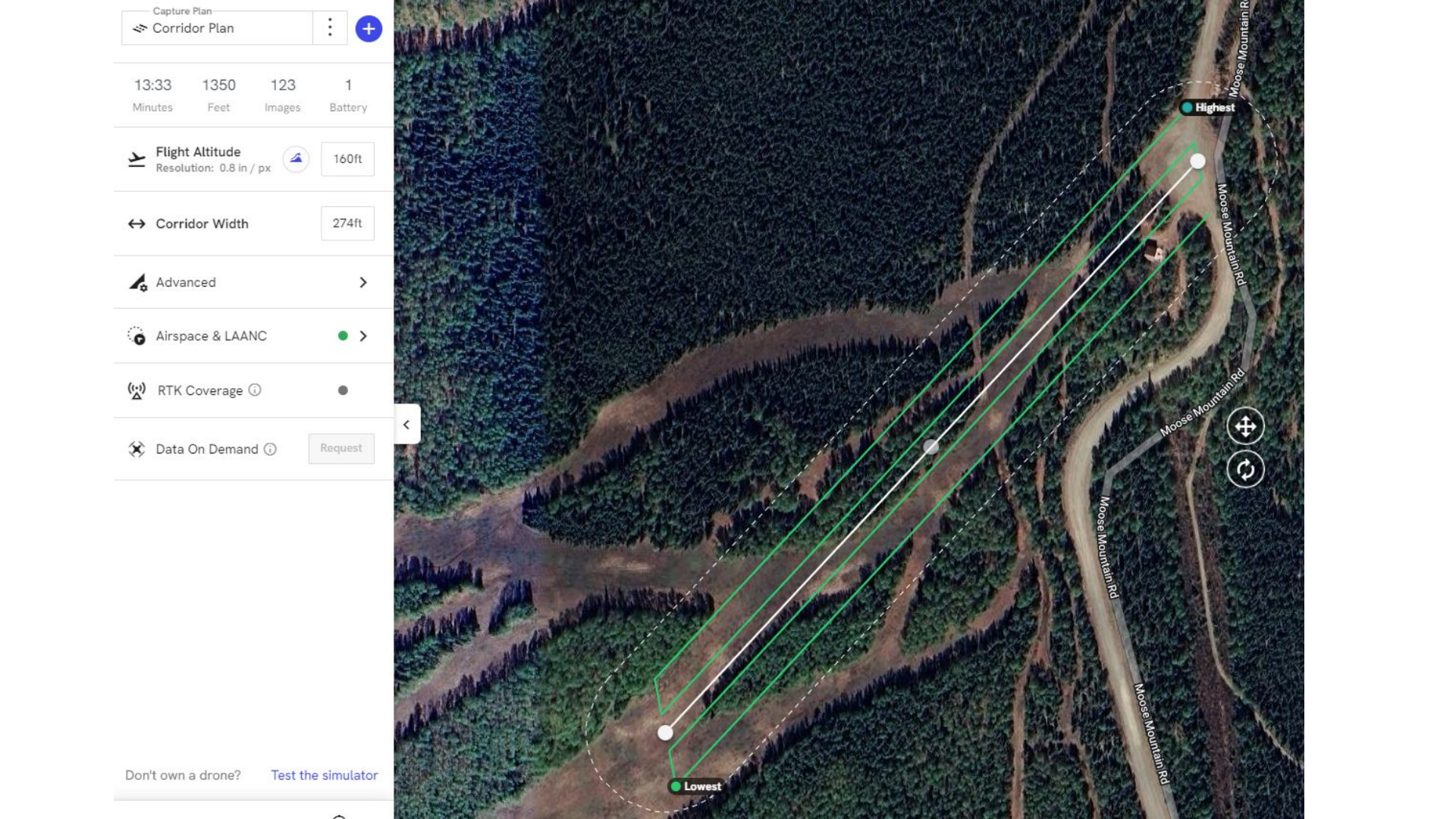
3:00PM Head back to UAF, unload, store, and document all equipment.

4:00PM Mission debrief and assign data analysis work accordingly

Photogrammetry Operations

- For a 264ft required image width, a 121 ft (37m) height is required for sufficient coverage of the area. We will also fly at 160 and 200 ft. These higher elevation flights will help to create a large overlap in the photos.
- 75% front overlap
- 65% side overlap
- 5mph flight speed
- (2) 13 minute flights, (1) 7 minute flight


Capture Plan
Corridor Plan
13:19
Minutes
1350
Feet
164
Images
1
Battery
Flight Altitude
Resolution: 0.6 in / px
120ft
Corridor Width
274ft
Advanced
Airspace & LAANC
RTK Coverage
Data On Demand
Request
Don't own a drone?
Test the simulator
Start
Moose Mountain Rd
Moose Mountain Rd
Moose Mountain Rd
Moose Mountain Rd
Moose Mountain Rd


Capture Plan
Corridor Plan
13:33
Minutes
1350
Feet
123
Images
1
Battery
Flight Altitude
Resolution: 0.8 in / px
160ft
Corridor Width
274ft
Advanced
Airspace & LAANC
RTK Coverage
Data On Demand
Request
Don't own a drone?
Test the simulator
Highest
Lowest
Moose Mountain Rd
Moose Mountain Rd
Moose Mountain Rd
Moose Mountain Rd
Moose Mountain Rd

Capture Plan

Corridor Plan

7:27	1350	50	1
Minutes	Feet	Images	Battery

Flight Altitude
Resolution: 1.0 in / px

200ft

Corridor Width

274ft

Advanced

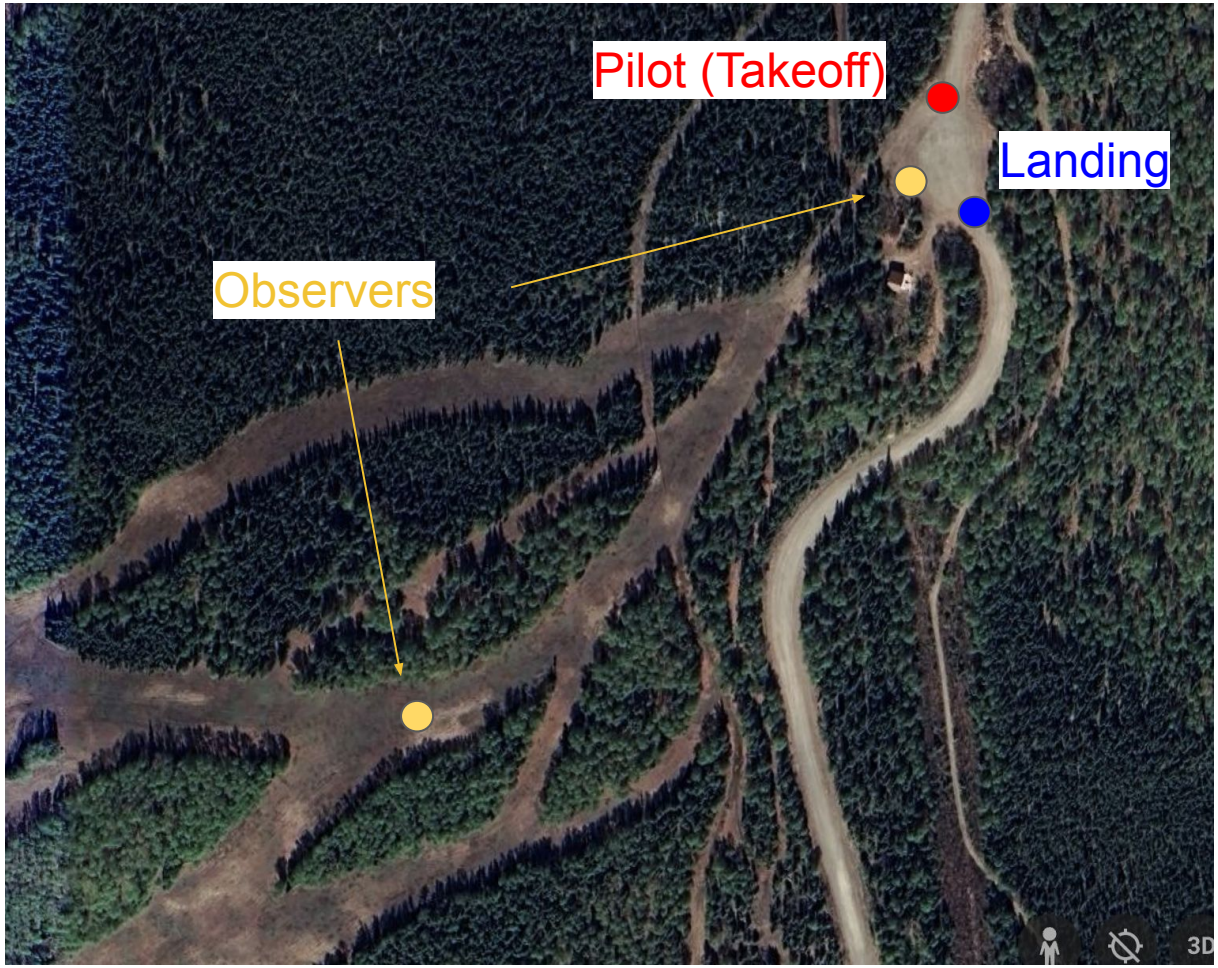
Airspace & LAANC

RTK Coverage

Data On Demand

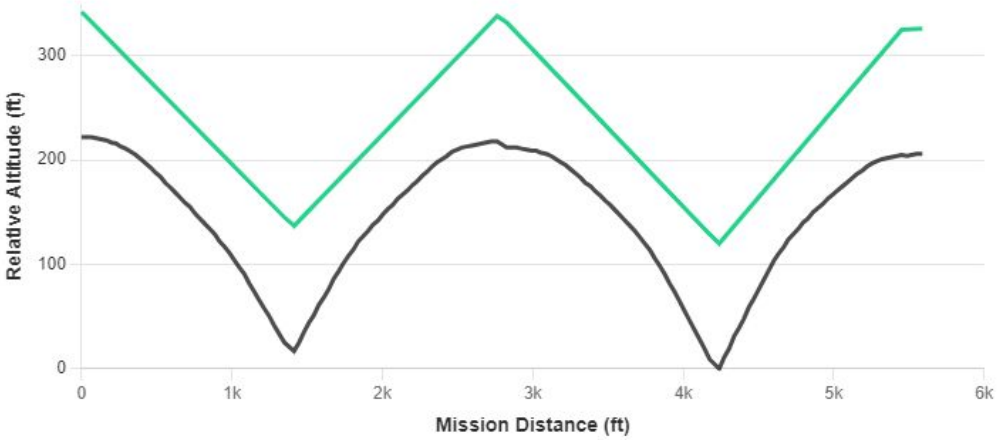
Request

Don't own a drone? Test the simulator


Pilot (Takeoff)
Landing
Observers
3D

Terrain Awareness

Enable to adjust flight altitude to compensate for varied terrain. This feature relies on data from NASA, Mapbox and other sources that may not be up-to-date.



No Authorization Required

View Airspace | Request LAANC

This briefing is for 6PM tomorrow, as LAANC Authorization is only available during daylight hours.

§107.43: 25AA, 32AK are nearby. The UAS must be operated in a manner that does not interfere with operations and traffic patterns at any airport, heliport, or seaplane base. The remote pilot in command must give way to manned aircraft and check local airport traffic patterns.
§107.41: The proposed UAS operation occurs in uncontrolled airspace. No authorization is required, however the operator must comply with Part 107 rules.

13:19	1350	164	1
Minutes	Feet	Images	Battery

Automatic Settings

Front Overlap 75%

Side Overlap 65%

Capture Flight Speed 5mph

Starting Waypoint 1

Obstacle Avoidance

Show Existing Map

Low Light

Manual Exposure in DJI app

Manual Focus in DJI app

Planning Camera

Zenmuse X3

Software / Data Analysis

- Using DJI Flight planner/Drone deploy we will create automated flight plan files which can be exported into Litchi
- Litchi will run the flight file automatically while providing a user interface for UAS and sensor controls and feedback, including control over automatic/manual flight modes
- DJI After Flight will allow us to perform a quick data analysis to ensure quality photogrammetric data
- Using photogrammetric mapping software such as iWitness Pro V4 we will import the photogrammetric data and use it to create a 2D orthomosaic and 3D surface model
- Using the temperature/position data from our LabQuest Pro we will use MATLAB or R to overlay each map with our recorded temperature data

Payload Deployment

Although this is no longer a core part of our mission, we would still like to provide a conceptual mission flow for payload deployment.

- Following the results of our data analysis, we would reference a digital elevation map (DEM) of the area without snow coverage to identify ground anchors, and then select an optimized drop location.
- We would then return to the sight with the S1000, deployment device, and sample payload, and set up according to the same SSP from the previous mission
- With the area properly delineated and flight preparations complete, we would complete a demonstration of sample payload deployment to the target location using the S1000

References

"Moose Mountain Maps." Moose Mountain Ski and Snowboard Area, Fairbanks, Alaska. Available at: https://shredthemoose.com/moose-mountain-maps/.

"Top Five Mammals to View in the Interior." Explore Fairbanks, Alaska. Available at: https://www.explorefairbanks.com/blog/post/wild-and-furry/.

"Wildlife Viewing at Smith Lake and UAF Trails - Interior Alaska." Alaska Department of Fish and Game. Available at: https://www.adfg.alaska.gov/index.cfm?adfg=viewinglocations.uaftrails.

"Choosing Flight Altitude | Drone Data Processing." Aerotas. Available at: https://www.aerotas.com/choosing-flight-altitude.