Avalanche Mitigation With UAS

AERO 658: UAS Operations

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Mission Description

Phase 1 - Data collection and analysis

- Gather data to predict avalanche risk and optimize/map payload drop location

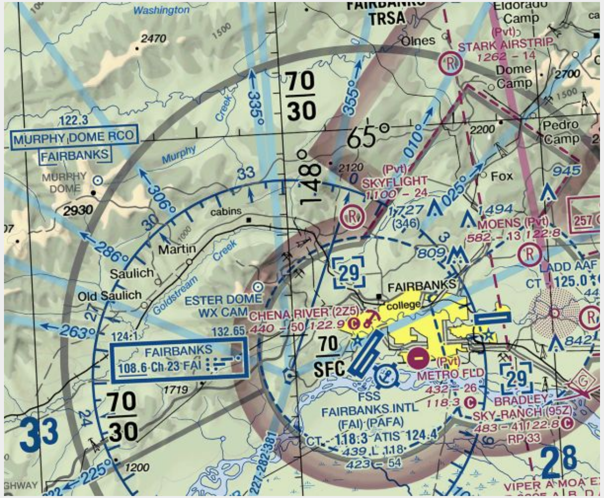
Phase 2 - Trigger controlled avalanche

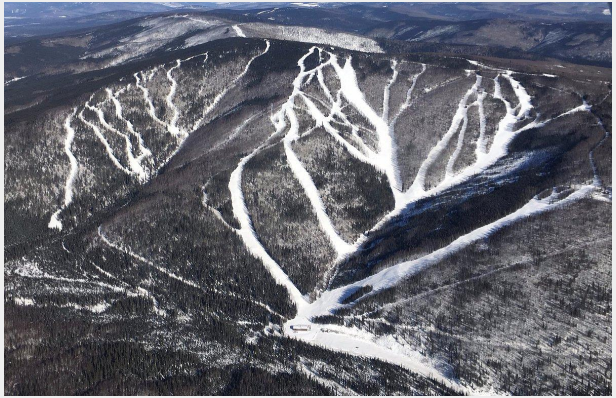
- Deliver an explosive payload to trigger the avalanche

Flight Location and Airspace

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
  - Likely cold and possibly windy





Possible UAS: Payload Deployment

DJI S900 or S1000

- Total weight: 4.2kg
- 15 min hover time at 9.5kg
- Easy assembly and transportation
- Adequate room for payload attachment

Possible UAS: Sensing

DJI inspire 1: Small multi-rotor UAS

- Weight with battery: 2.935 kg
- Flight time: 18 minutes per battery
- 4 batteries total
- Operating temperature: -10 to 40 C

Possible UAS: Sensing

Holy Stone HS700D:

- 4K Adjustable Camera
- 22 min max flight time
- Simple control
- Easy Transportation

Avalanche Factors

- Dry or Wet Snow
- Slope angle
- Cracks forming in snow leading to spontaneous release
- Recent heavy snowfall or rain
- Significant warming or rapidly increasing temperatures (refreezing cycles)

Snow Layering

- Unstable Snow
  - Strength of snowpack varies from layer to layer
  - Stronger layers on top of weaker layers

Snow Layer Strength

- Depends on the shape of the ice crystals
  - Snowfall in varying weather conditions
  - Ice crystals become rounded after melting and refreezing and don't stick together forming weak layers in the snow

Loose snow avalanche

- Doesn’t carry much snow
- Release at a point
- Looks like large snowballs
- Dry Snow: Slope angle >40°
- Wet Snow: Slope angle <40°

Slab Avalanche

- 98% of all avalanche accidents
- Masses of snow slide as a cohesive plate caused by layering
- Slope angle 30-38°
- Triggered when subject to an additional load
    - Typically triggered by the first person to set foot on the slope
    - Underlying weaker snow slab collapses

Sensor Payloads

GPR - Ground Penetrating Radar

- Gives raw data that when processed will allow us to identify weak layers of snow
- Requires programmable, controlled flight at a constant altitude

Photogrammetry (camera)

- Map the pitch of varying slopes to identify high risk areas within 30-38 degrees

Infrared Thermometer

- Map surface areas that have been heated by the sun and pose higher risk

Explosive Deployment Payload Considerations

- Special approval from FAA required to have explosives onboard UAS
- Must be capable of holding 2-5 kg of explosives, as well as storage, release and detonation device
- We will need constant reliable communication and control over the drone, release mechanism and detonation device
- Ideally for safety reasons, we’d like to be able to remotely detonate the explosive, or arm the explosive onboard when it is above the specified drop location and detonate on impact

Benefactors and Collaborators

The FAA issued its first ever approval for Alaska DOT & PF and ARRC to carry explosives on board UAS for avalanche mitigation (Glasset, 2023).

- Potential collaborators - DOT, ARRC
- Collaborate with DOT to expand the applicability of UAS for avalanche mitigation
- Expand to other customers including Alaska Parks and Outdoor Recreation, Alyeska Resort, Arctic Valley, Skeetawk, Tordrillo Mountain Lodge, Chugach Powder guides, ect.

References

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