MichiganTech Research Institute

Applications of UAV Systems for Post-Disaster Damage Assessment of Transportation Infrastructure

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2. Michigan Technological University (MTU)
3. USDOT Research and Innovative Technology Administration

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Abstract

- Advances in UAS airframes, control system technology and image processing make small unmanned systems practical and cost effective for more frequent flights
- Multiple platforms have recently become practical for remote damage assessment
  - Large to small, fixed wing, rotary wing, multi-rotor

Overview

- Damage assessment important element in recovery process post-event
- Condition of transportation infrastructure important to response and recovery process
- High resolution (6”-1’ per pixel) aerial imagery often captured after major events but not necessarily after smaller regional/local events
- Weather may limit aerial imagery collects for several days post event
- Cost may limit number of flights during recovery phase (if any after initial flights)

Rotary wing/multi rotor

Small Fixed wing

Trimble UX5

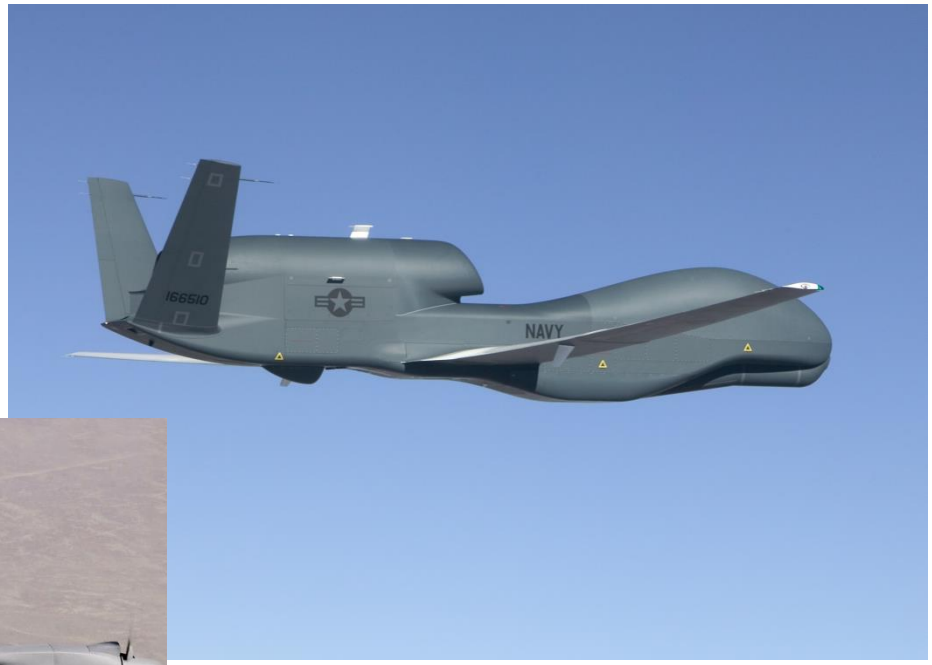
IntelliTech Microsystems Vector P

senseFly Swinglet

Trimble Gatewing X100

Small Fixed Wing

Large Fixed wing



The right system for the job

- Continuum from small fixed wing/multirotor UAVs with point and shoot cameras collecting imagery from low altitude over a small area to the manned, rotary or fixed wing aircraft and metric aerial photography cameras capturing imagery from high altitude over a large area
- Select the right sensor and airframe for the event
  - Small airframes and sensors for limited areas (inspecting transportation infrastructure – bridges)
  - Larger airframes for synoptic imagery of larger events (hurricanes, flooding, volcanic events)

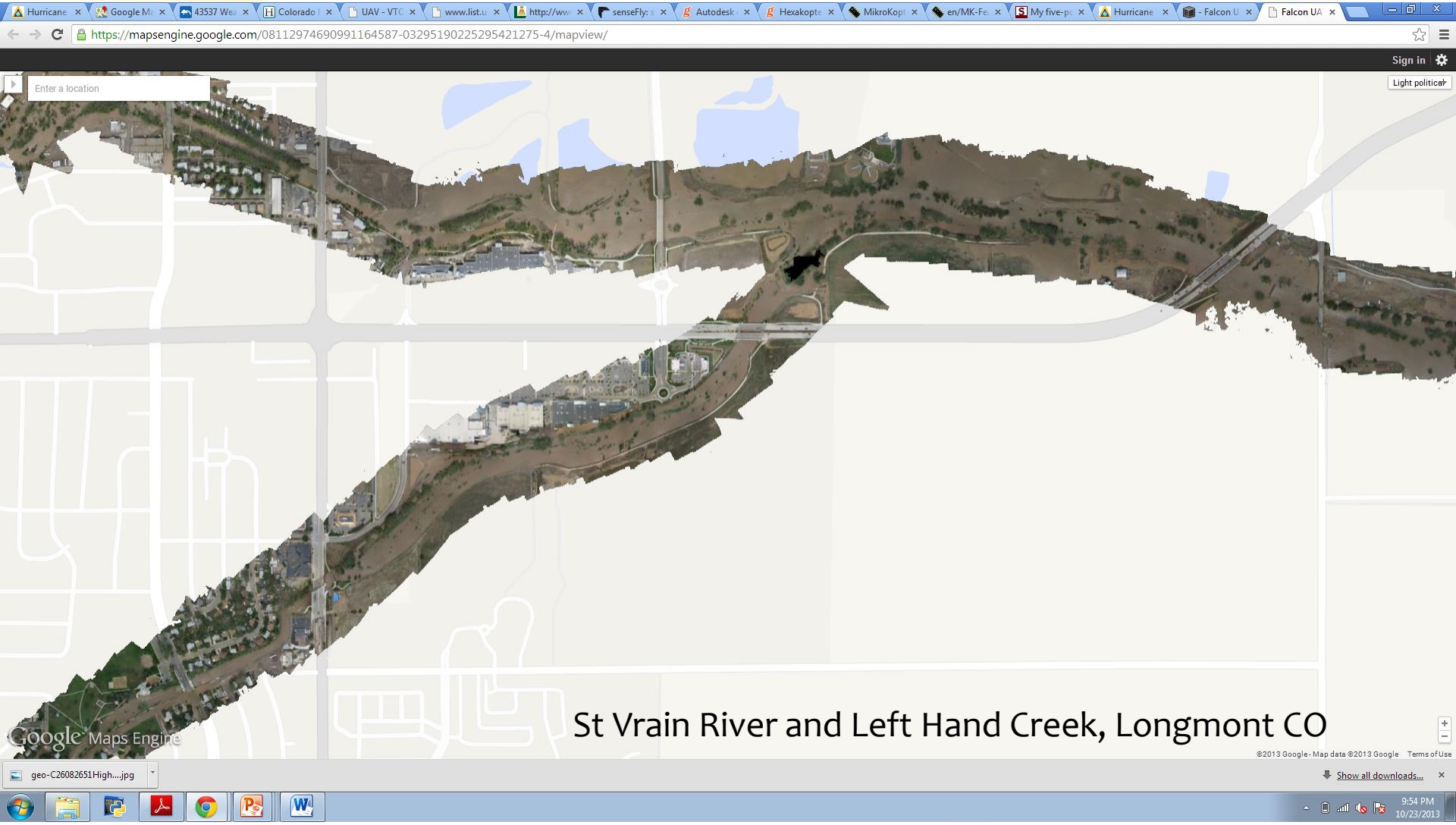
50cm (16”) per pixel orthophoto

High Island TX after Hurricane Ike, Sept 2008

Small UAVs for Response and Recovery

- Larger manned/unmanned aircraft fly at high altitudes, collect imagery at ~ 1 foot per pixel over large areas
- Smaller unmanned aircraft fixed wing or multirotor (hexacopter/octocopters) fly lower (100-400 feet) collect imagery at higher GSD (1 inch) over smaller areas
- Provide high resolution imagery, relatively inexpensive to operate, can revisit sites to document recovery progress
- May be able to collect imagery in weather where larger aircraft cannot (ceiling)

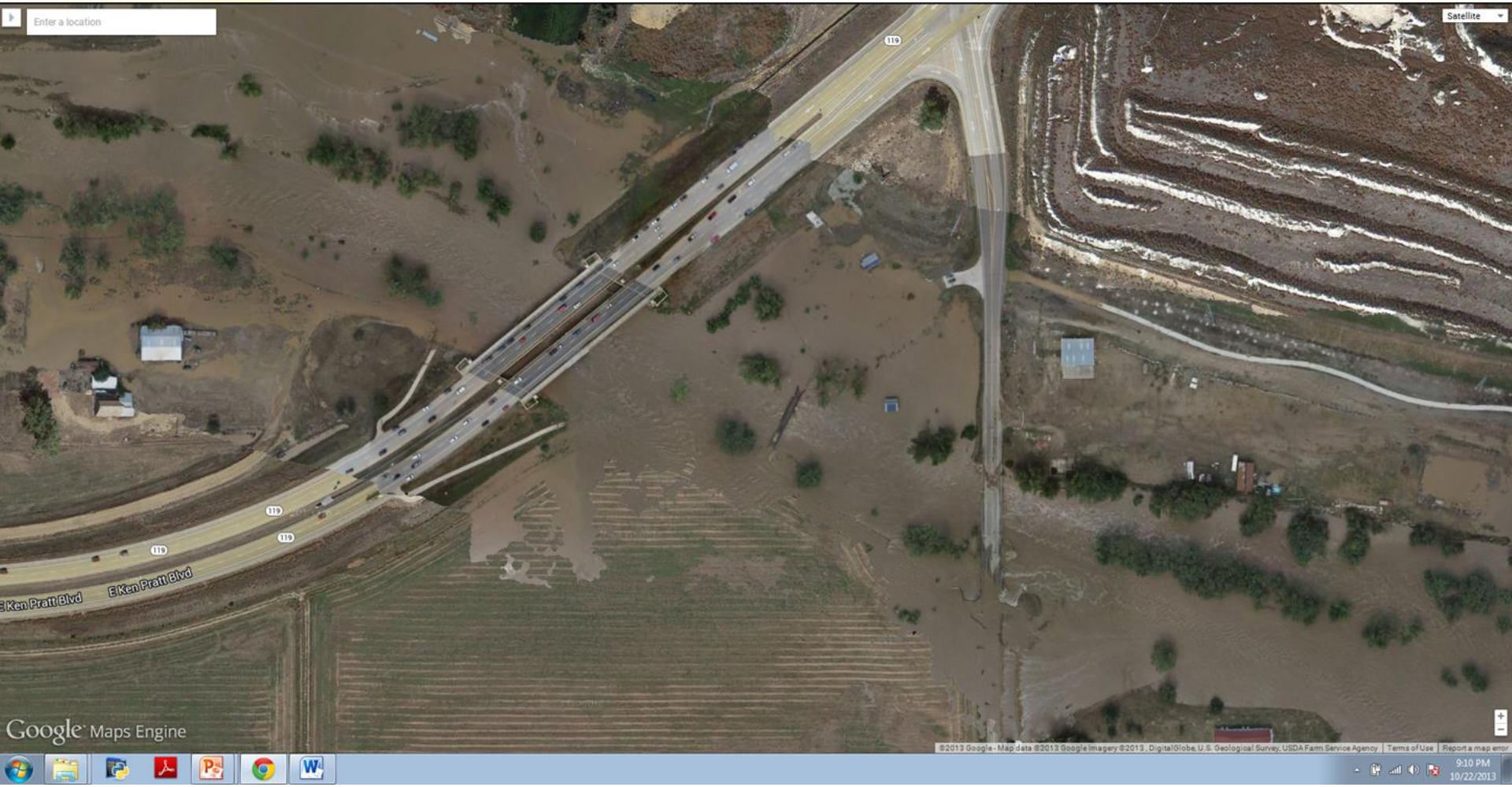
Falcon UAV Orthomosaic



St Vrain River and Left Hand Creek, Longmont CO

St Vrain River before flood

St Vrain River during flood

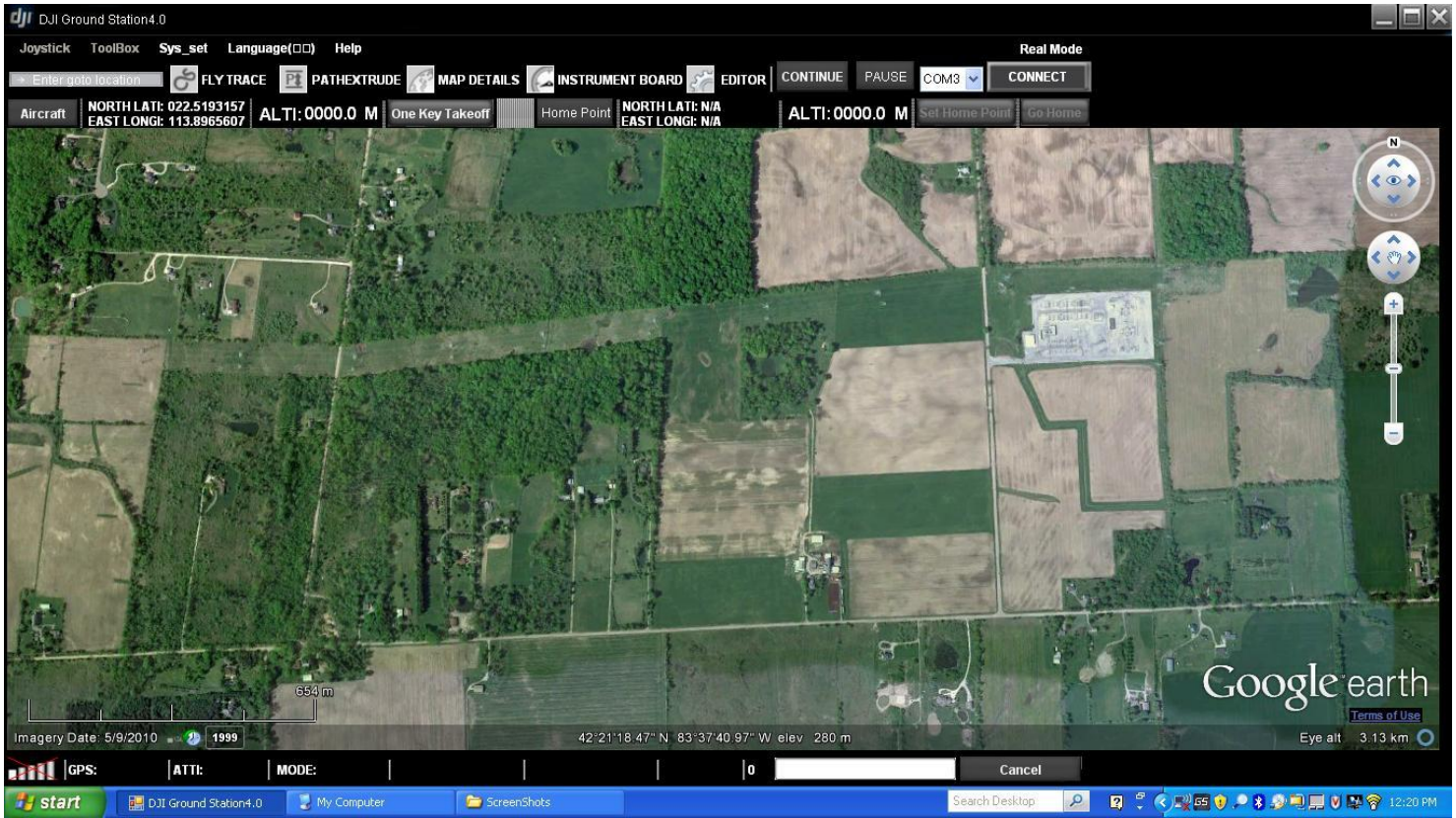


Mission planning

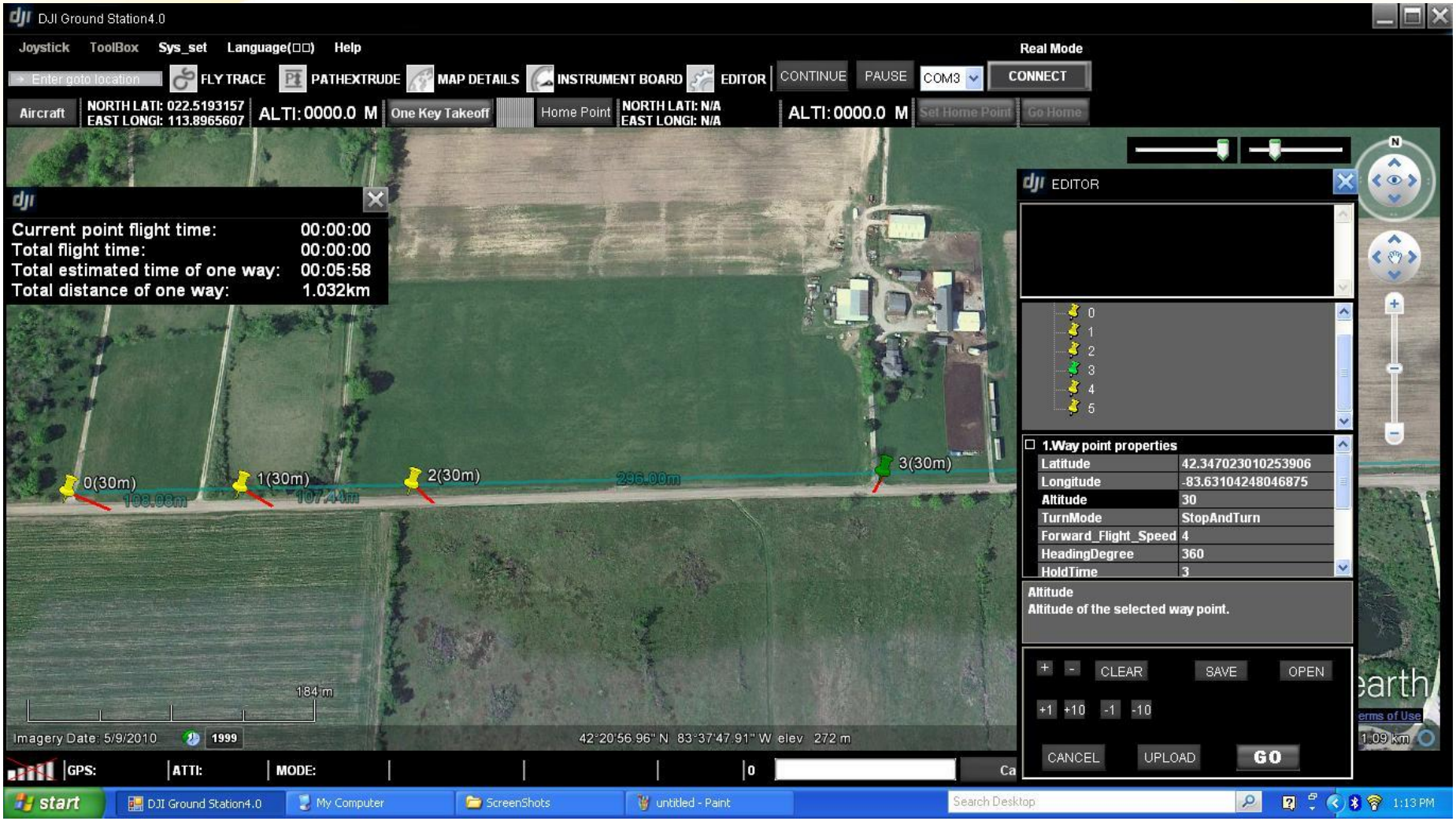
- Allows planning flight trajectory using known GPS locations or map interface
  - Recognizable landmarks, signs, bridges, buildings may be missing or damaged
  - Multiple locations can be inventoried on a single flight

Mission Planning

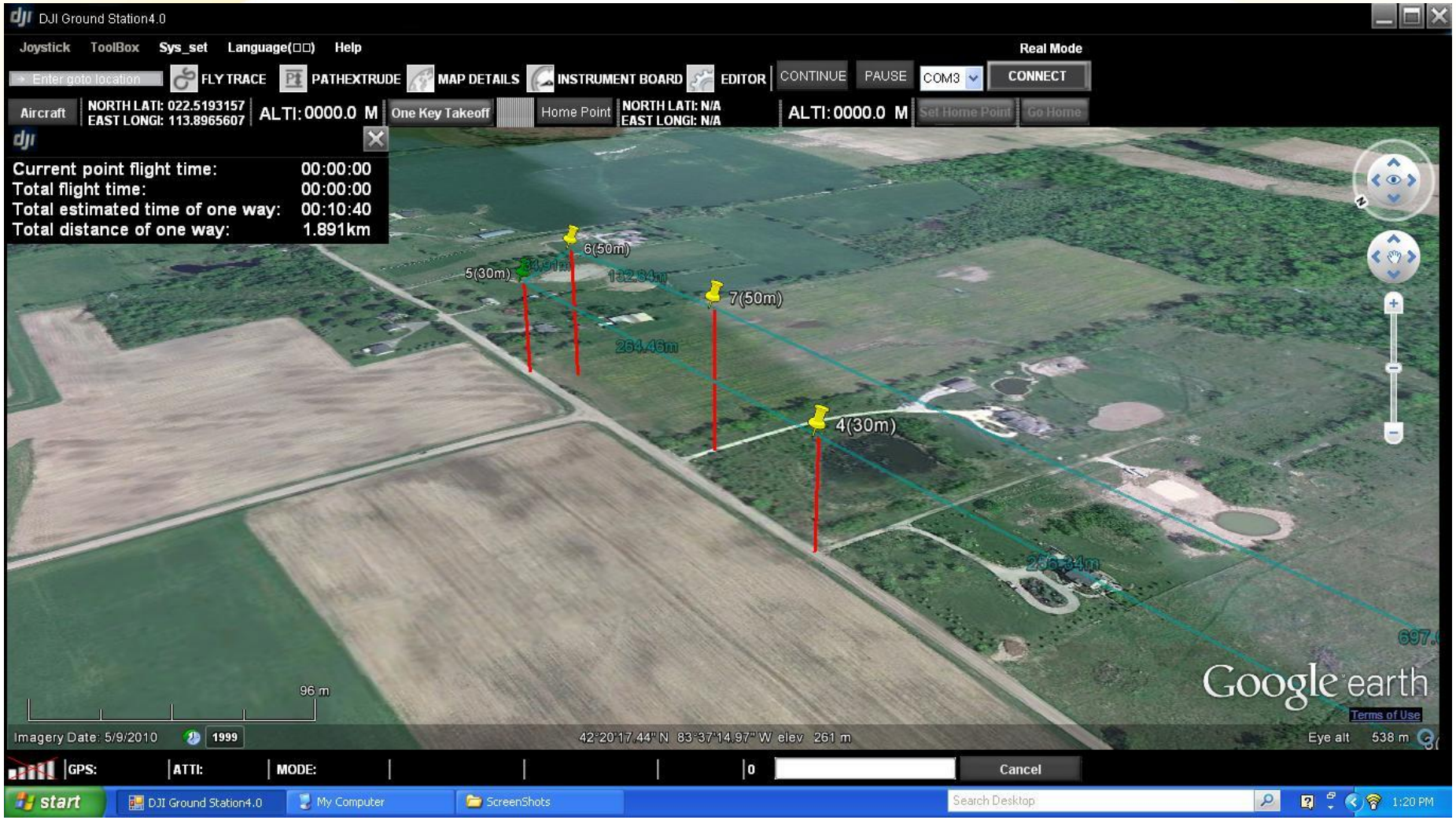
- Ground Station software
  - Set waypoints for helicopter collect
  - Google Earth interface
  - Ability to set the altitude and speed



Mission planning



Mission planning



Mission Planning

Image courtesy Ohio DOT

Infrastructure inspection

- Use of smaller UAVs for local infrastructure inspection
  - Road usable?
  - Bridge/culvert unusable, damaged but usable, undamaged?
  - UAV able to reach infrastructure beyond obstacles, faster inventory, documentation for recovery phase

Other useful data

- High resolution (<1cm/px) imagery can be used for evaluation of area around structure
- Structure from motion algorithms can derive point cloud to create high resolution DEM

Image courtesy Ohio DOT

Photogrammetric point cloud

Photogrammetrically derived point cloud of the Muscatatuck IN Urban Training Complex
Image courtesy Ohio DOT

High Resolution Orthomosaic

Orthomosaic courtesy Ohio DOT

Infrastructure evaluation

Orthomosaic courtesy Ohio DOT

Infrastructure evaluation

Orthomosaic courtesy Ohio DOT

Infrastructure evaluation

photo courtesy Ohio DOT

Incident management

Muscatatuck Urban Training Center, Indiana
Orthomosaic courtesy Ohio DOT

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Summary

- Many proposed systems, varying sizes and capabilities
- Potential to provide useful information for response and recovery operations
- Difficult to get COA approved to fly
- Many proposed systems, little actual experience
- September 2015 FAA UAS in the NAS