Low Cost UAV Photogrammetry Accuracy Assessment

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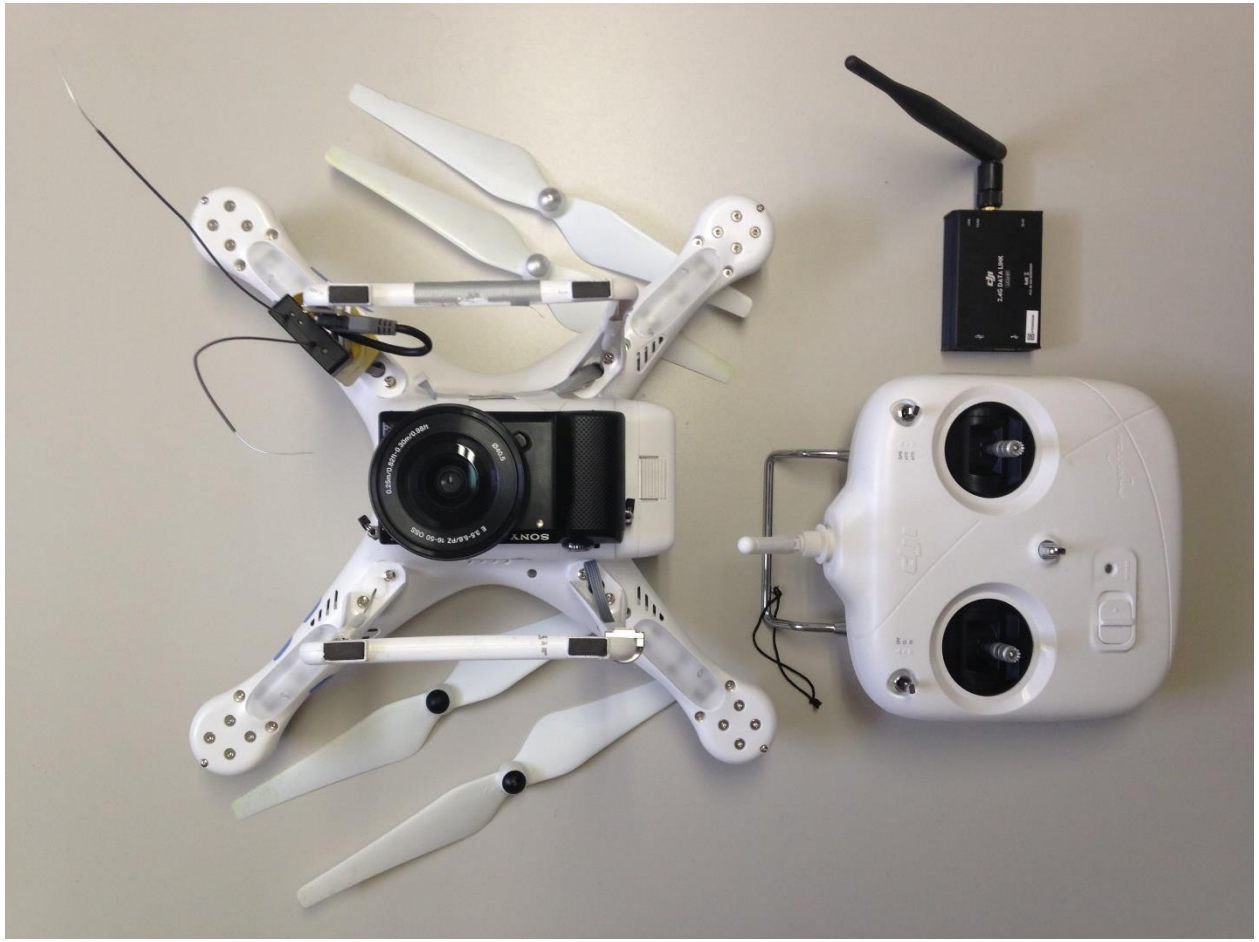
Overview

- Components of UAV mapping system
  - Unmanned Aerial Platform
  - Camera
  - Ground control station
- Field Procedures
  - Mission Planning
  - RTK GPS Ground Control Points
- Post Processing
  - Orthorectified image generation
  - Accuracy assessment
- Summary and Suggestions

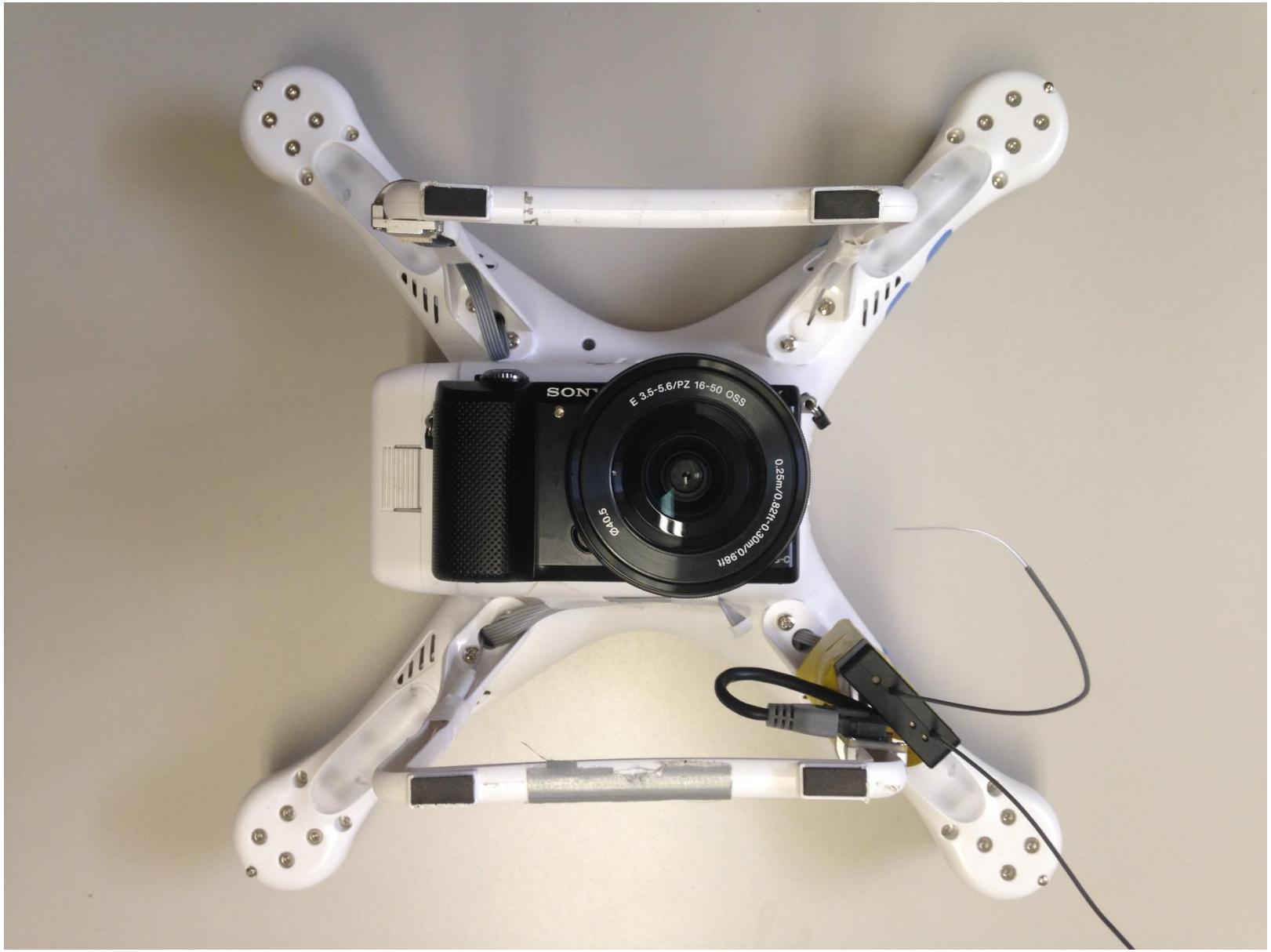
Aerial image of Head Hall, UNB

Components of Unmanned Aerial System

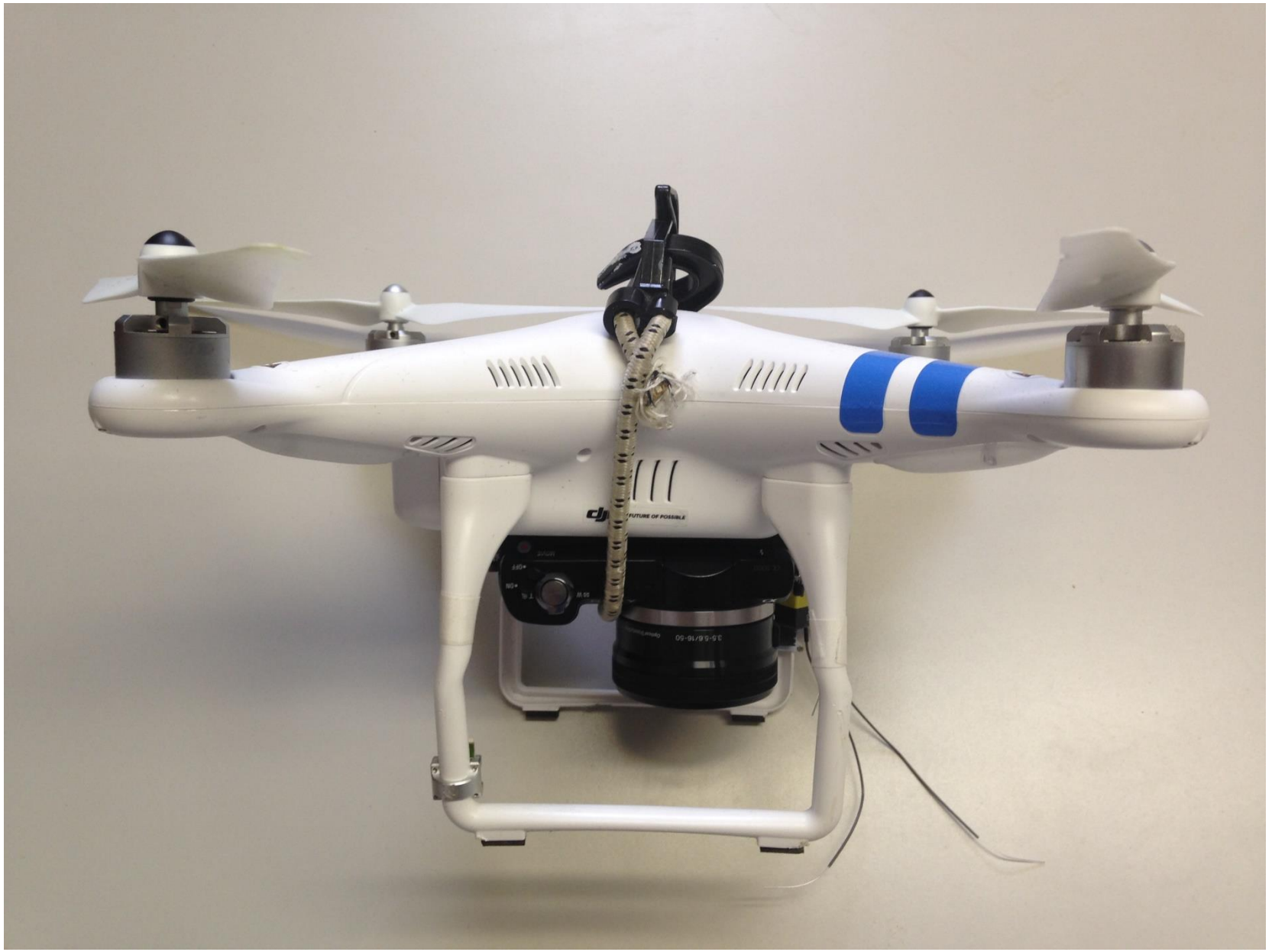
- Unmanned aircraft
  - DJI Phantom 2 Quad-copter
- Transmitter
- Communication link
  - 2.4Ghz Bluetooth Data link
- Mission planning
  - DJI Ground Control Station
- Image sensor
  - Sony Alpha 5000 20.1 Megapixel digital camera



Left to right: Phantom 2, Sony a5000, 2.4G Bluetooth datalink, Controller



Bottom View of the Phantom 2 with Sony Alpha 5000 attached for vertical imaging (410g payload)



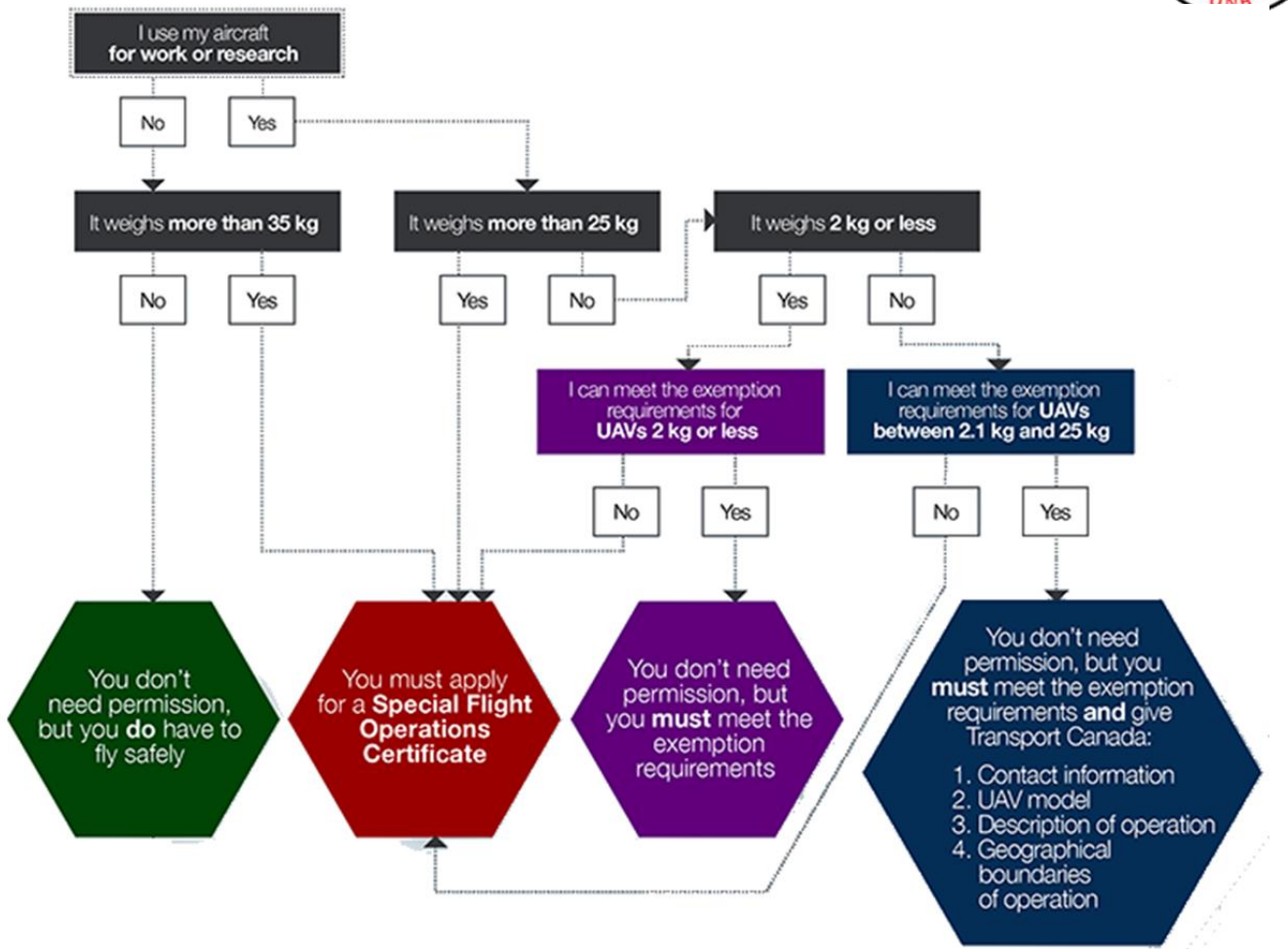
Side view of Phantom 2 with Sony Alpha 5000 attached for vertical imaging (Total 1130g payload)

Choosing a UAV mapping system

- Things to look for in a camera
  - Interverlometre(time lapse)
  - Light weight
  - Good resolution
  - Wide angle lens
  - Manual Exposure
  - Raw file option
  - Manual focus
  - Shutter type
  - Lens calibration(distortions)
- Things to look for in a UAV
  - GPS
  - Digital compass
  - Accelerometer
  - Gyro
  - Battery capacity
  - Communication range
  - Ground control station
  - Payload
  - Gimbal system

Field procedures

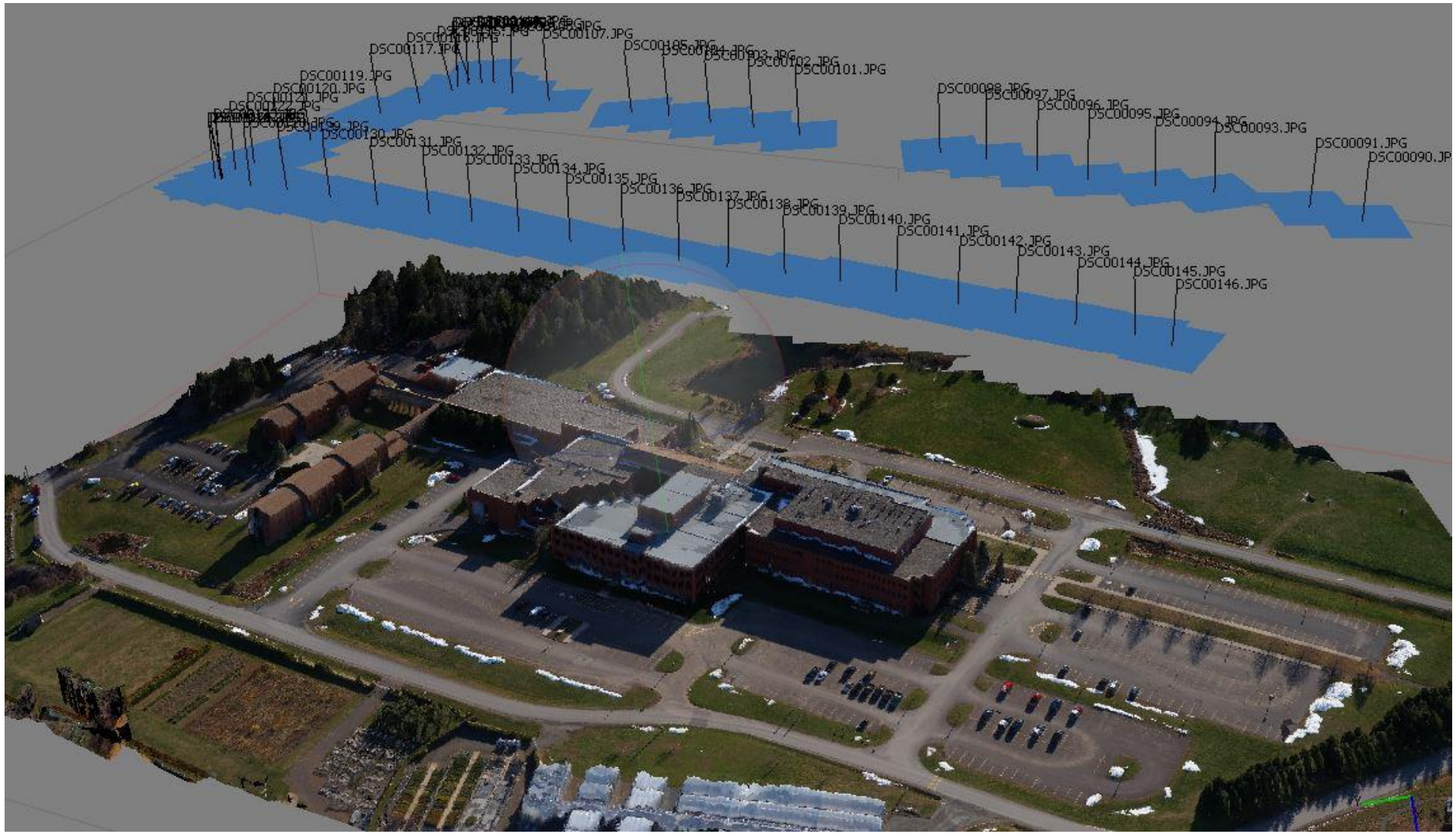
- H. J. F Forestry Complex
- Safety testing
- Mission Planning
- UAV operation
- RTK GPS survey for Ground control points
- Regulations and restrictions



UAV Exemption flowchart published by Transport Canada

Effective as of 2014 Nov 27th

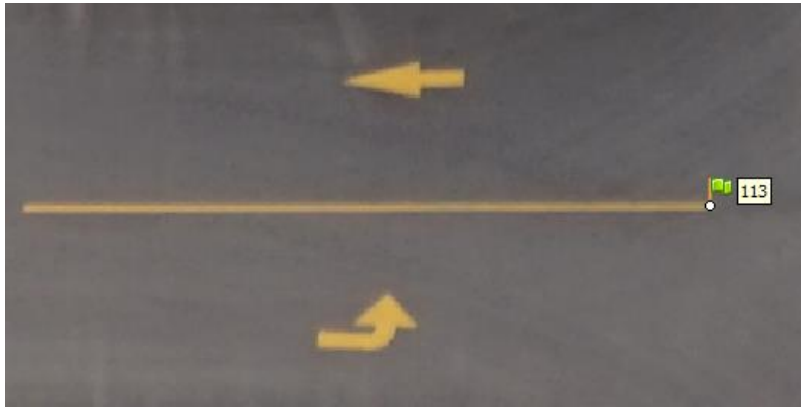
Autonomous flight plan using DJI Ground Station 4.0



Screenshot showing the relative locations of each of the 52 images recorded (represented with blue rectangles) above the study area. Software used: Agisoft Photoscan Pro.

Ground Control Points

- RTK GPS survey
- Total 26 points
- Visible and distinguishable
- GCP is primary source of control
- 9 points used for processing
- 11 points used for assessment



Data Processing

- Benefits of geotagged images. Ex) GPS enabled camera
- Choosing the right photogrammetry software
- Total processing time: Approx. 12 hours
- Recommend computer system requirement
- Nadir vs Oblique, overlapping area
- Agisoft Photoscan professional

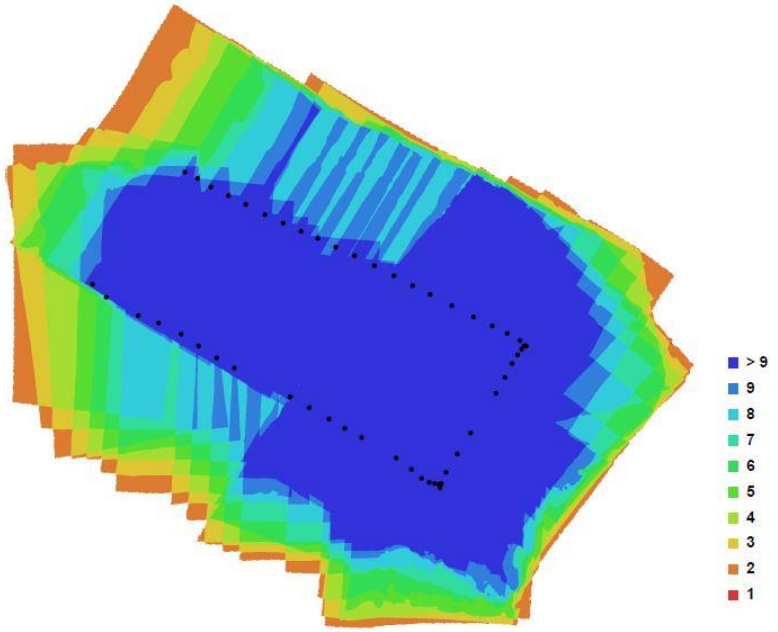
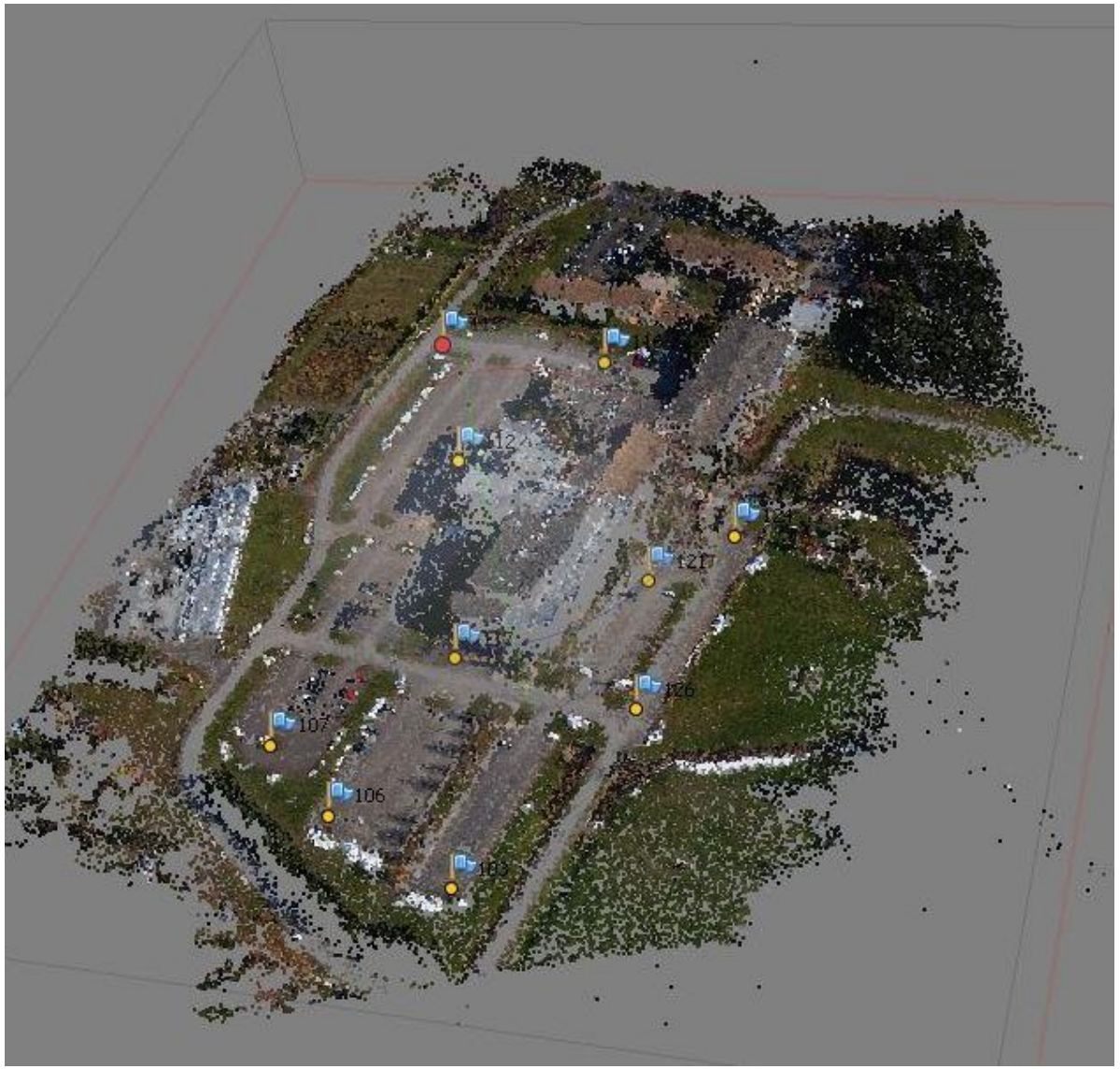
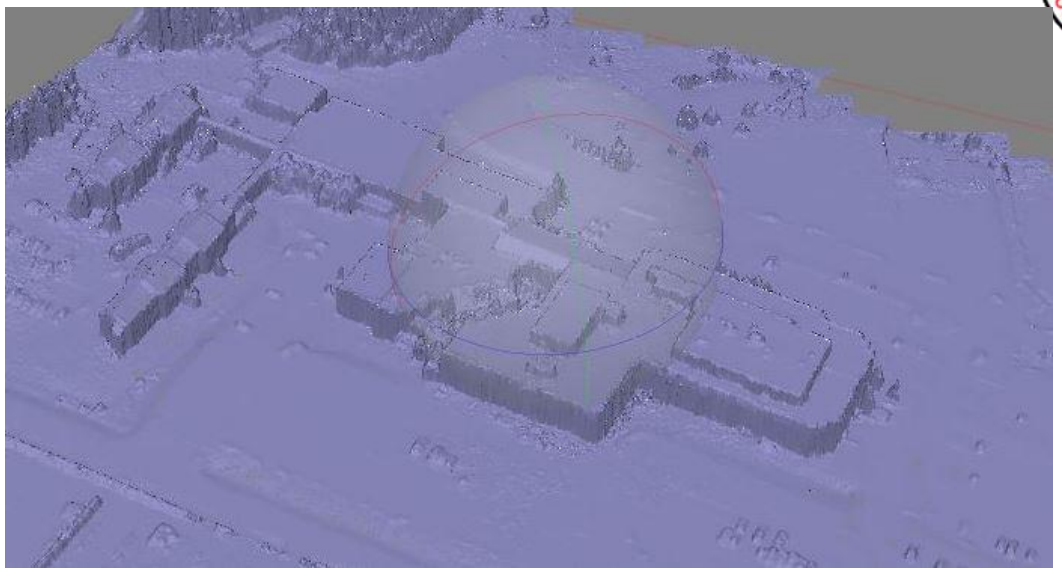


Fig. 1. Camera locations and image overlap.

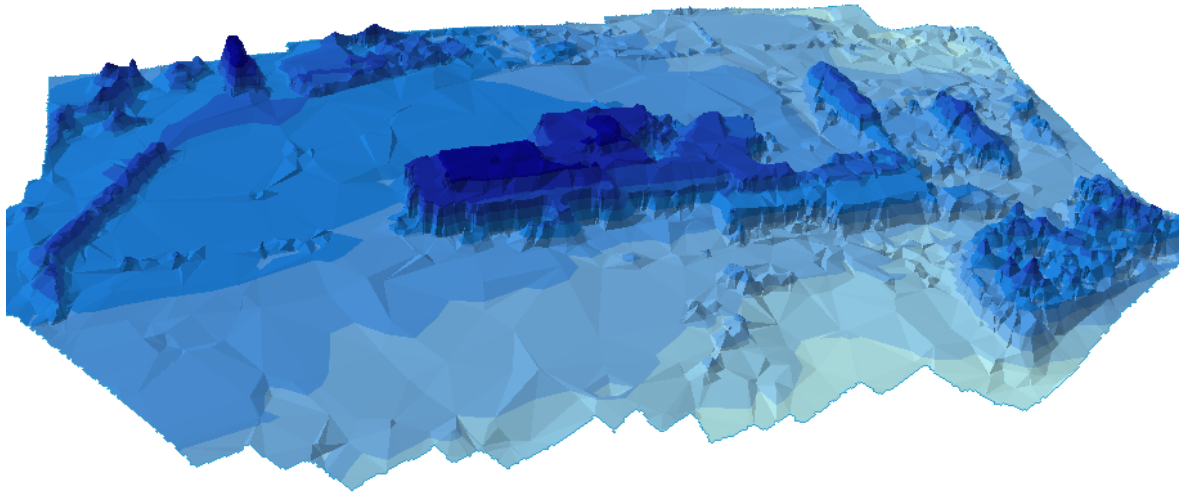
3D point Cloud (168,682 points) generated



3D model generated by Photoscan Pro.



3D model generated by ArcMap 10.2



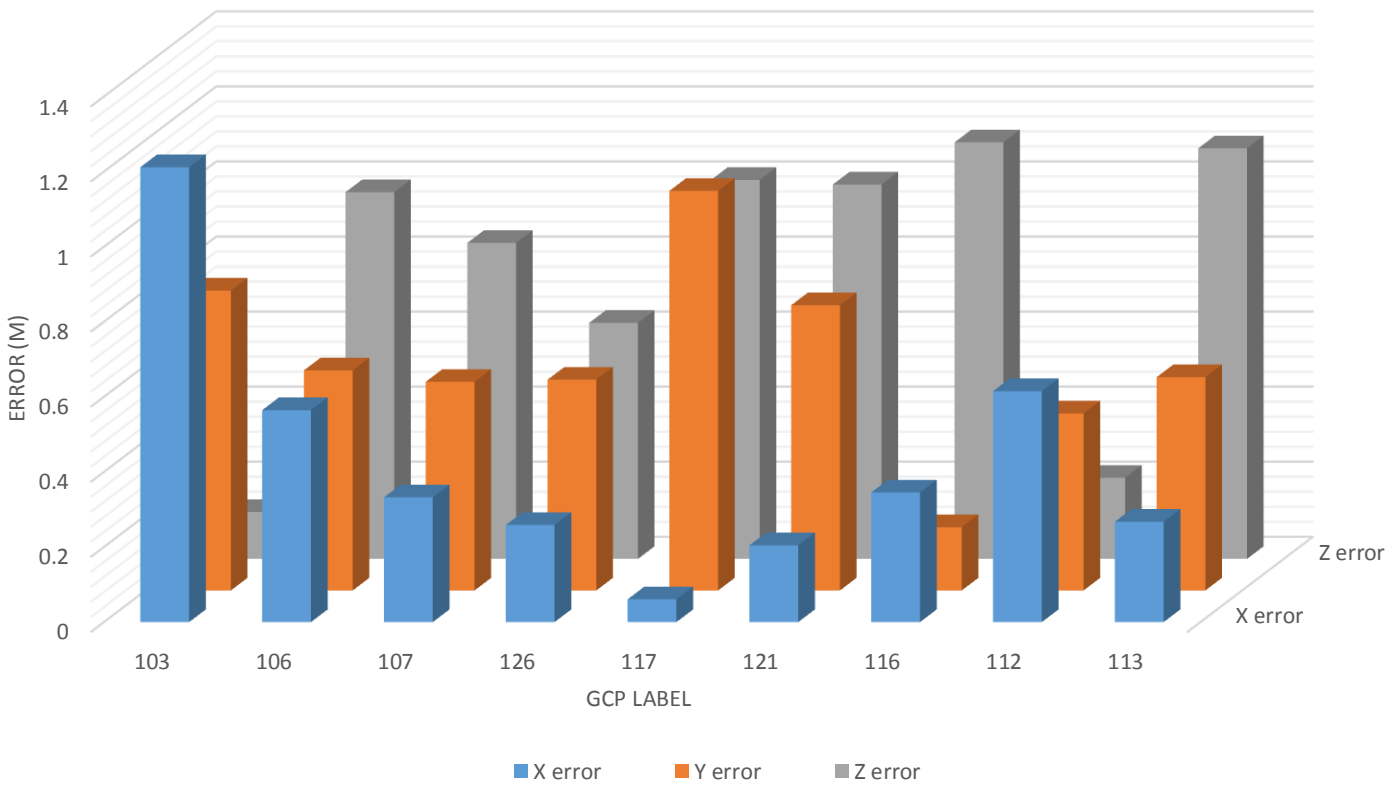
Screenshot of texturized model with Images draped over 3D model

Final orthorectified and georeferenced mosaic generated using the 3D model and images

Results: Final Orthorectified Mosaic Image

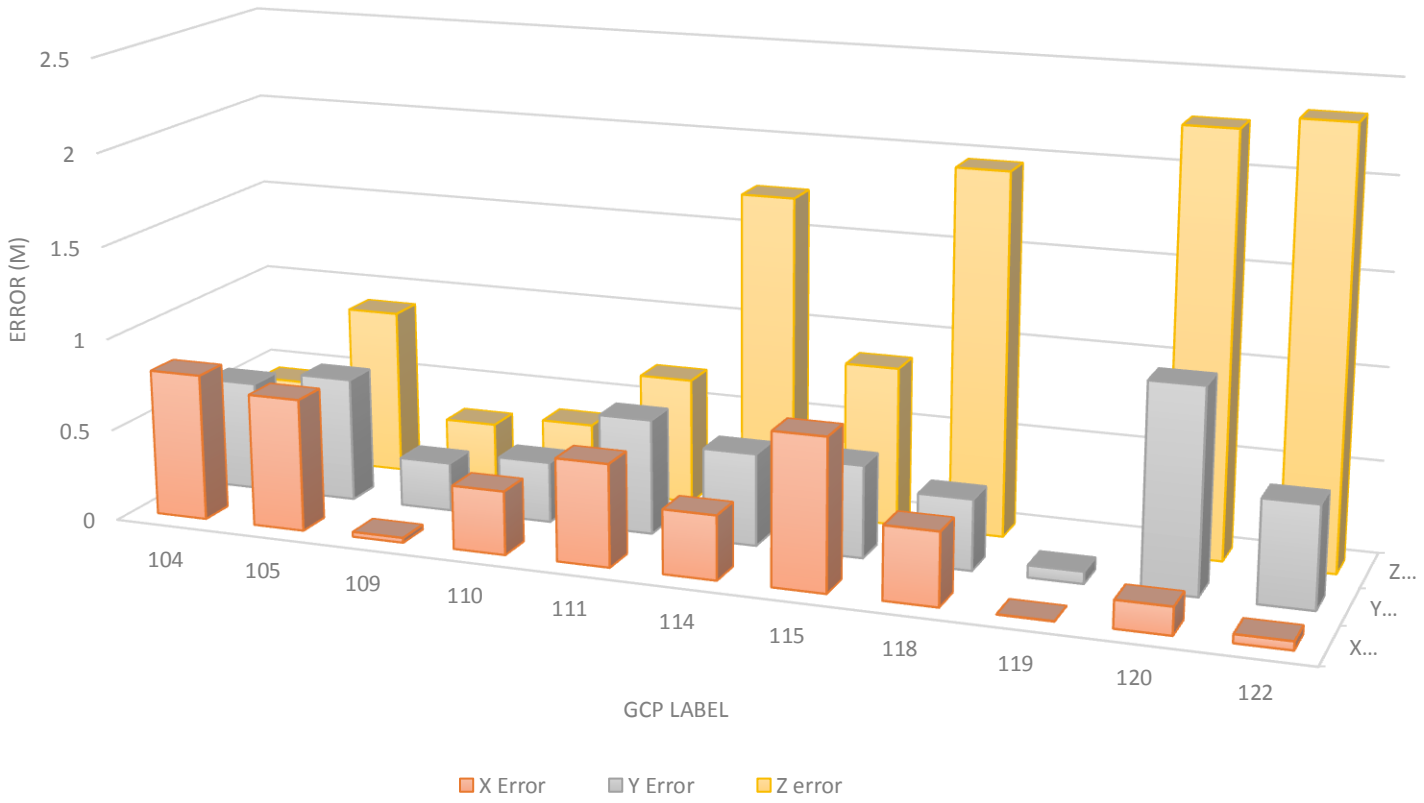
- Total number of Images: 52
- Flying Altitude: 150 m
- Ground Resolution: 0.04 m/pix
- Error: 2.90606 pix
- Tie-points: 168682
- Total number of GCP: 9
- Image pixel size: 13302 x 12093
- Image memory size: 240 MB
- Coverage area: 0.13 Sq. km
- NAD83 CSRS NB double stereographic projection

Accuracy Assessment: Software results



- X error = 0.535 m
- Y error = 0.657 m
- Z error = 0.854 m
- Horizontal Accuracy
  = 0.848 ± 0.40 m
- Vertical Accuracy
  = 0.854 ± 0.35 m

Accuracy Assessment: Manual Inspection



- X error = 0.381 m
- Y error = 0.507 m
- Z error = 1.188 m
- Horizontal Accuracy
  = **0.634 ± 0.39 m**
- Vertical Accuracy
  = **1.188 ± 0.76 m**

Summary

- Total cost: Approx. $1,500
- Low end UAV photogrammetry can provide reliable horizontal accuracy
- Vertical accuracy require denser ground control network to be reliable
- UAV photogrammetry is extremely time and cost efficient
- UAV photogrammetry can fill in the gaps of existing technology

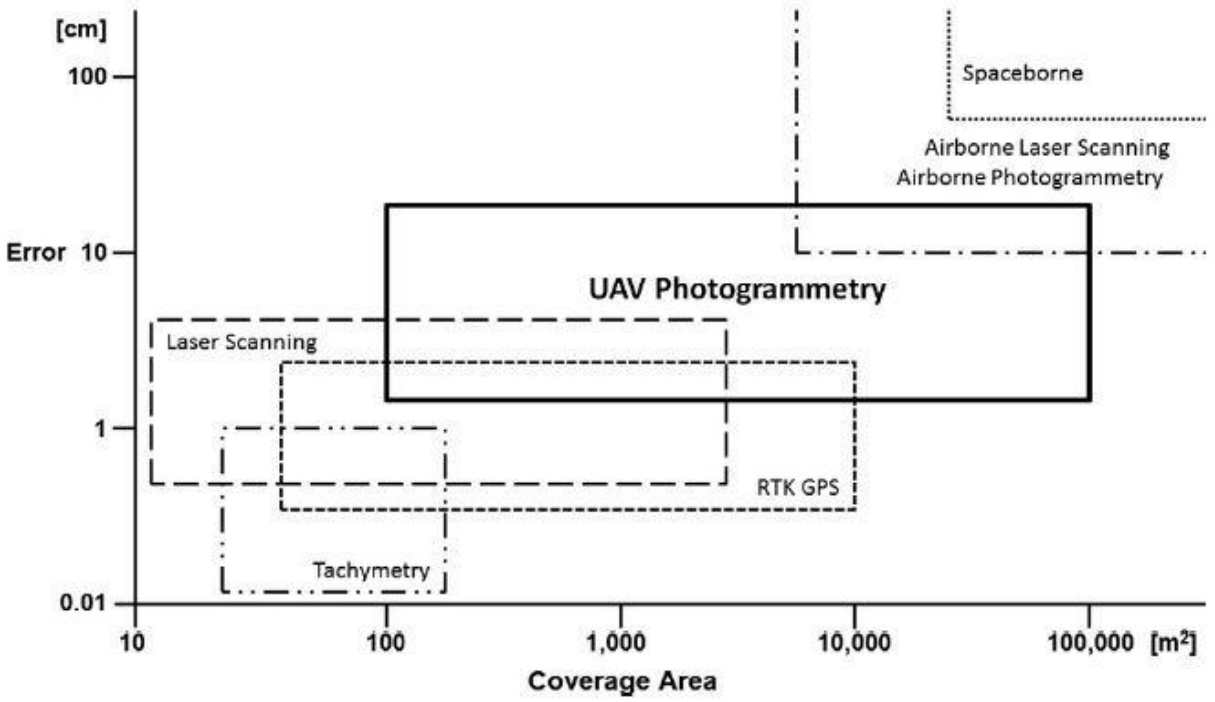
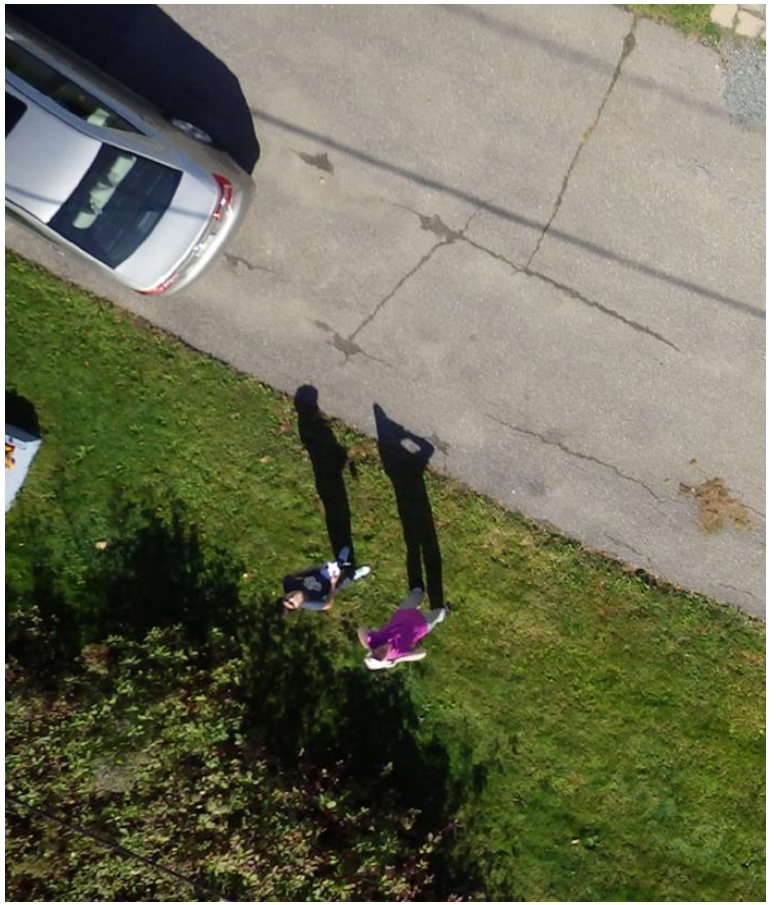


Figure source: S. Siebert, J. Teizer *"Mobile 3D mapping for surveying earthwork projects using an Unmanned Aerial Vehicle (UAV) system"*

Suggestions

- Ground based LiDAR + UAV photogrammetry
- Digital Camera Calibration
- Sub decimeter accuracy UAV photogrammetry
- Large scale UAV photogrammetry
- Accuracy comparison on volumetric survey: UAV photogrammetry vs. Conventional RTK GPS
- Programming Shadow reduction algorithm
- Specific project 3D mapping (Ex. Pipeline, road)



Questions

Orthorectified Mosaic image showing Mac-ta-quac dam, New Brunswick, Canada