# UAS MAPPING:

## Making the Case
## for
## Ground Control Points

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VERTICAL ASPECT
UAS Mapping Training & Products

# Vertical Aspect, LLC

- Specializing in Unmanned Aerial System (UAS) Mapping
  - Services
  - Consultation
  - Training (Face-to face and Remote)
- Offer related hardware / software
  - Robota Eclipse Fixed Wing – Texas Dealer
  - Pix4D Pro Mapping / Virtual Surveyor Software
  - V-Map Ground Control Kit
- FAA Certification, Insured

# Purpose of Ground Control Points

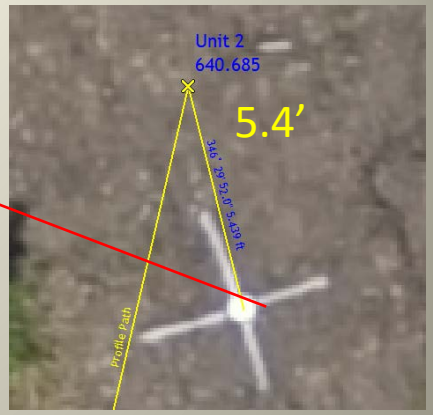
- Precisely known fixed points
  - Adjust a mapping project to these known fixed coordinates in order to obtain absolute accuracy in latitude, longitude and altitude.
- They will:
  - Correctly locate the project on the earth
  - Correctly scale the project in all three axes
  - Enable better measurements, volume calculations, etc.

# GCP vs. Checkpoint

- A GCP is used by the post processing software as part of it's solution to actually shift and adjust the end product
- Check points do not alter the final solution – they are used to independently verify that the correct solution was derived.

# Accuracy Error without GCP



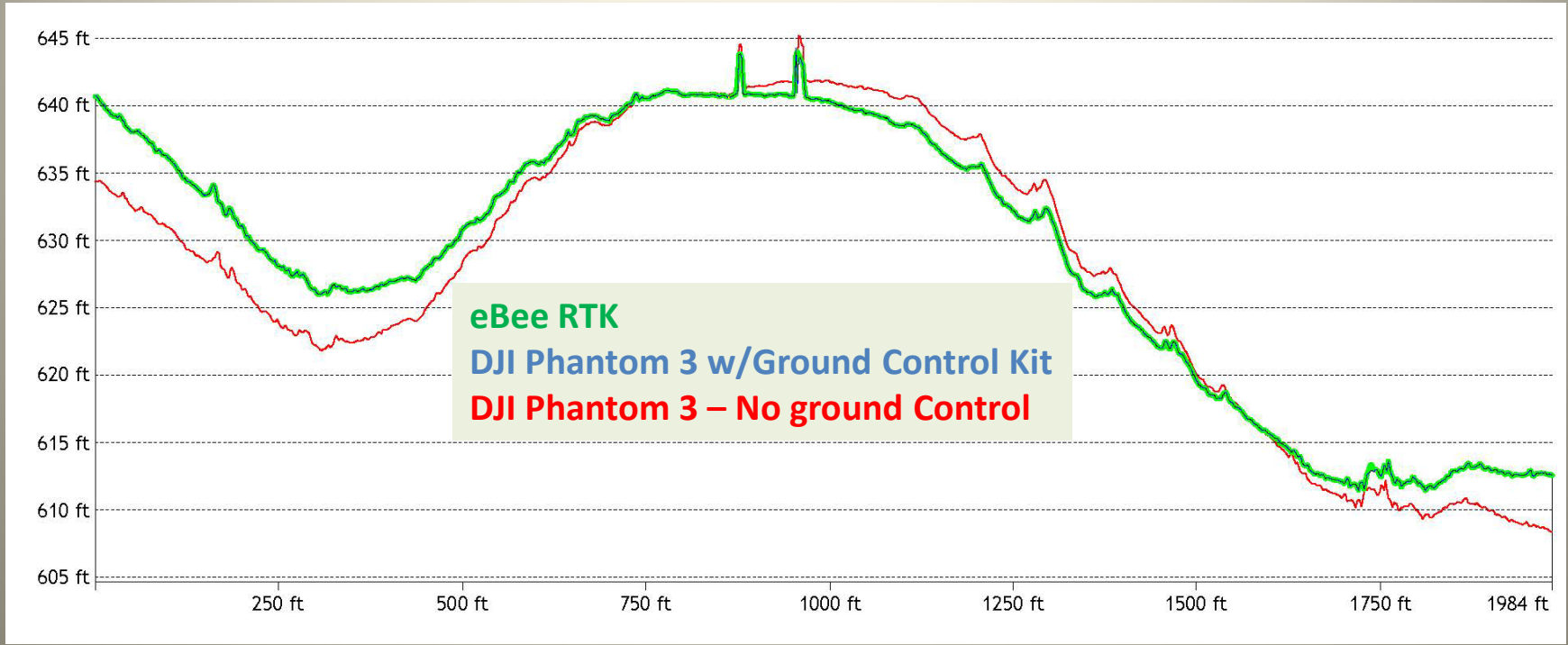






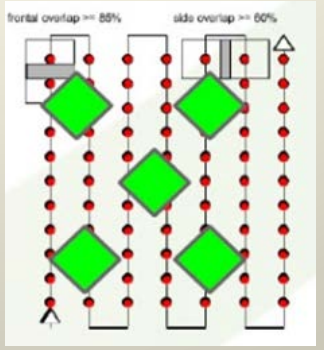
5

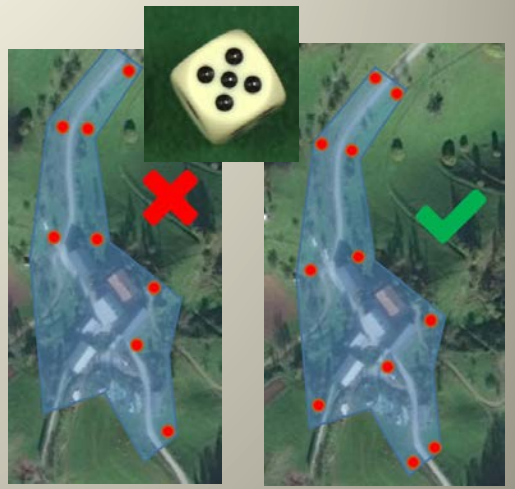
# Elevation Profile Comparison



# Positioning of GCPs

- Randomly, well distributed in dataset
- Center and *near* edges
  - Like number 5 on a die



- Maximum 1000'-1500' apart
- Analogy - *securing sheet of tissue paper in light breeze laying on cork board.* *(The GCPs are the "thumbtacks")*

# Poor GCP Positioning

- On the edge of a large vertical shift (i.e. edge of raised sidewalk, retaining wall, roof, curb).
  - [It's too easy, when zooming in the photo and marking the GCP in the photos to mark the ground next to the building edge vs. the actual target itself)
- Underneath a tree
- Too close to edge of the photo set (not shown in enough photos)

# Target Attributes

- Easily visible from the air (generally white with black markings works best)
- Permanent ground feature
  - Flat ground, good contrast, no overhead obstructions
- Precise center
- Generally, will be tradeoffs between easy portability and durability
  - Examples (show pictures)
    - Spray painted “X” approx. 2 to 4 feet long a side
    - Folding target
    - Flat plastic plate with surveying spike in the center
    - 4 large ceramic tiles (2 flat white, 2 flat black)
- Uniquely marked targets for each GCP ease in identification
- Commercially procured targets (Search “Aerial Targets”)

# Methods for Measuring GCPs

RTK Rover

GPS Static Observation (OPUS)

UAV Ground Control Kit

# Sample Targets

Folding, reversible

Permanent center

Commercially Available *(Search for Aerial Targets)*

4 non-glare 8” ceramic tiles

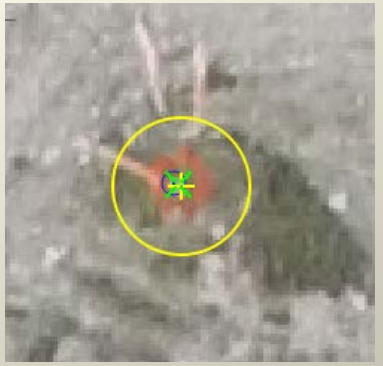


Numbering targets aids in identification

*(Especially in an arbitrary coordinate system)*

# Poor Targets

- Ambiguous spray painted circle on the ground
- Anything that can blow away or be disturbed.
- Anything not flat (too easy to incorrectly mark it, and have a bad “z” axis solution
  - Plastic bag or sheet with wrinkles
  - Rocks near the center
- On the edge of a wall

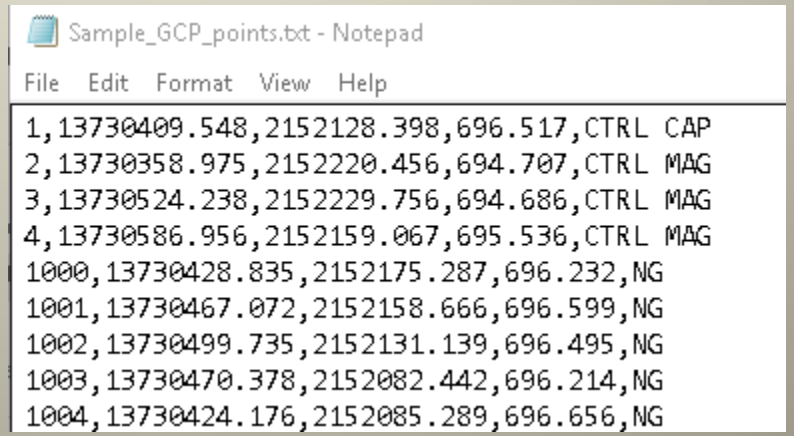


# Incorporating GCP into Projects

- Post processing needs to be able to visually find and then match each GCP with the images being taken).
- GCPs don’t need to be geolocated prior to flight, but they do need to show up in the images
  - Drone data collection crew – mark/document GCPs
  - Surveying Crew – geolocate them afterwards

# Format for GCP File

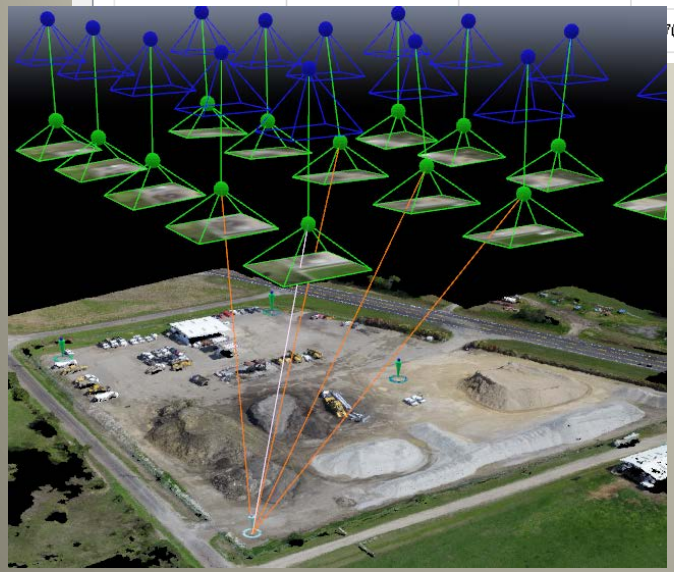
- .csv or .txt file (ASCII).
- Label, x (Easting), y (Northing), z (elevation)



# Using GCP within Pix4D

GCP/MTP Table

| | Label | Type | X [ft] | Y [ft] | Z [ft] |
|---|---|---|---|---|---|
| 7 | 1 | 3D GCP | 2619899.438 | 7117393.447 | 614.042 |
| 4 | 2 | 3D GCP | 2619588.227 | 7117374.745 | 608.715 |
| 5 | 3 | 3D GCP | 2619589.665 | 7116863.734 | 603.775 |
| 0 | 4 | 3D GCP | 2620108.803 | 7116846.384 | 620.425 |
| | | | | 7096.527 | 612.503 |



3 (3D GCP)

| | |
|---|---|
| Label: | 3 |
| Type: | 3D GCP |
| X [ft]: | 2619589.665 |
| Y [ft]: | 7116863.734 |
| Z [ft]: | 603.775 |
| Horizontal Accuracy [ft]: | 0.100 |
| Vertical Accuracy [ft]: | 0.100 |
| Number of Marked Images: | 5 |
| $S_0^2$ [pixel]: | 0.3445 |
| Theoretical Error S(X,Y,Z) [ft]: | 0.065, 0.048, 0.089 |
| Maximal Orthogonal Ray Distance D(X,Y,Z) [ft]: | 0.071, -0.137, 0.053 |
| Error to GCP Initial Position [ft]: | -0.207, 0.132, -0.244 |
| Initial Position [ft]: | 2619589.665, 7116863.734, 603.775 |
| Computed Position [ft]: | 2619589.872, 7116863.602, 604.019 |

Automatic Marking | Apply | Cancel | Help

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