



How Accurate is your Imagery: Ground Control Points

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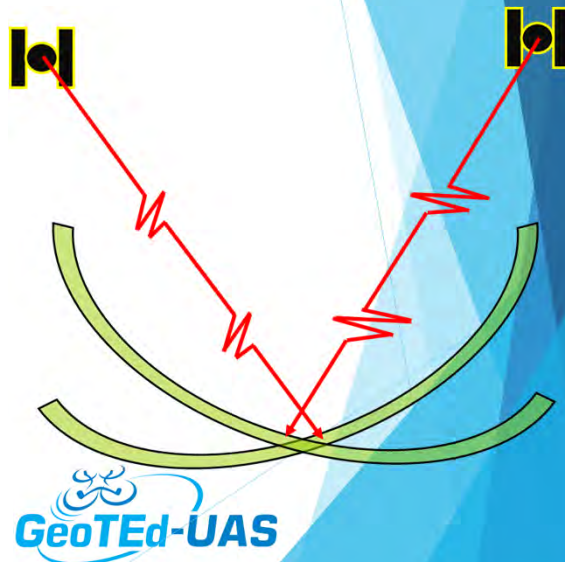
Brief Overview of GNSS

- ▶ GNSS = Global Navigation Satellite System.
- ▶ Includes GPS, GLONASS, Galileo, and other systems.
- ▶ GNSS receivers determine their position by receiving time stamped transmissions from multipole satellites.
- ▶ GPS = Global Positioning System
 - ▶ US version.



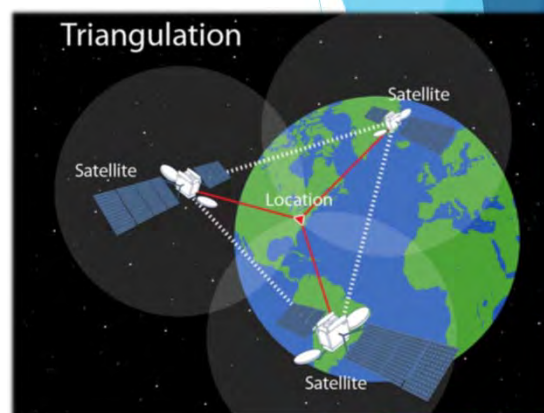
How GNSS Works, Simplified.

- ▶ Satellites send out time stamped transmission of its ID and location.
- ▶ Receiver compares timestamp to current time and calculates the distance the radio waves travelled.
- ▶ Receiver calculates area that overlaps all known satellites.



GNSS Requirements.

- ▶ For this to work the receiver must have:
 - ▶ Contact with 3 satellites for 2D fix.
 - ▶ Contact with 4 satellites for 3D fix.
 - ▶ More are normally better.
- ▶ Accuracy relies on:
 - ▶ Accuracy of receiver clock.
 - ▶ Quality of signal.
 - ▶ Number of satellites.
 - ▶ Arrangement of satellites.



GNSS Accuracy

- ▶ Normal consumer GNSS is accurate to about 4m.
 - ▶ This includes most sUAS.
- ▶ Poor accuracy can be caused by:
 - ▶ Satellites being too close to each other or the horizon.
 - ▶ Not having line of sight to satellites.
 - ▶ Reflection of satellite transmission off of clouds, buildings, trees, etc.
 - ▶ Electromagnetic interference.
 - ▶ Like UAS motors, cameras, and computers.
 - ▶ Most sUAS wrap the GNSS with copper foil.



How to We Improve GNSS Accuracy?

- ▶ Use a RTK or PPK capable unit.
 - ▶ RTK = Real time correction.
 - ▶ PPK = Post processed corrections.
 - ▶ Both are more expensive.
- ▶ Use Ground Control Points (GCP).
 - ▶ Increase accuracy.
 - ▶ Allow for sUAS imagery to have a real world reported accuracy.
 - ▶ Time consuming.
 - ▶ Does require high end GNSS receiver.



What is a GCP?

- ▶ A GCP is anything that:
 - ▶ Does not move.
 - ▶ Can be clearly identified both on the ground and from your imagery.
 - ▶ Is located in an open area with good GNSS signal.
- ▶ Using a high quality GNSS record the location of the GCP.
 - ▶ We use a Trimble GPS.
- ▶ Correct the location data using PPK.
- ▶ This is then used to correct the imagery during post processing.



Tips for Working with GCP

- ▶ Make sure the GCP can be seen!
- ▶ Whatever you use make sure there is a point that allows you to click on the same spot +/- a few pixels.
- ▶ Take a minimum of 3 GCP for correction.
- ▶ Ideally a minimum of 6.
 - ▶ 3 GCP and 3 for check points.
 - ▶ Check points do not correct the imagery, they allow the post processing software to check the accuracy of the georeference.
- ▶ Take at least 100 points at each GCP.





Demonstration with Pix4D

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