Data Accuracy

Objectives

- Explain the importance of data accuracy to the UAS process

- Introduce sensor and platform considerations affecting accuracy

Importance

Recall a point from Data Management:

For decisions to be meaningful, information must be:

- Timely
- Accurate
- Complete

We have to understand how our process affects accuracy

Accuracy

Two considerations for UAS:

- Sensor Accuracy
- Positional Accuracy

Sensor Accuracy - Resolution

4 Types:

- Spatial - smallest object that is discernible
- Temporal - how often an area is recorded
- Spectral - number, range, and size of wavelength band
- Radiometric - differences in radiance in each band

Spatial Resolution

We know this one:
Pixel Size

Smallest object discernable

Temporal Resolution

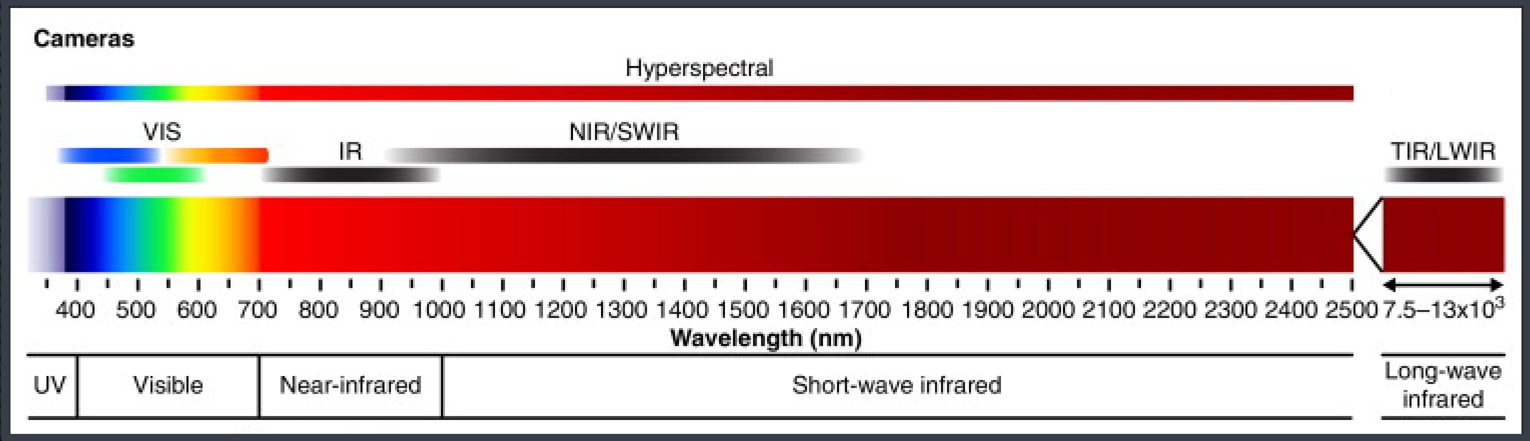
The revisit rate - think of a satellite with an 5 day constellation

This is the strength of UAS on an incident:

Real time or near real time on demand sensing and reporting

Spectral Resolution

For our purposes - visible light and infrared



FLIRVue Pro
Thermal IR
7.5 - 13.5 µm

Radiometric Resolution

Sensitivity to radiant energy (heat)

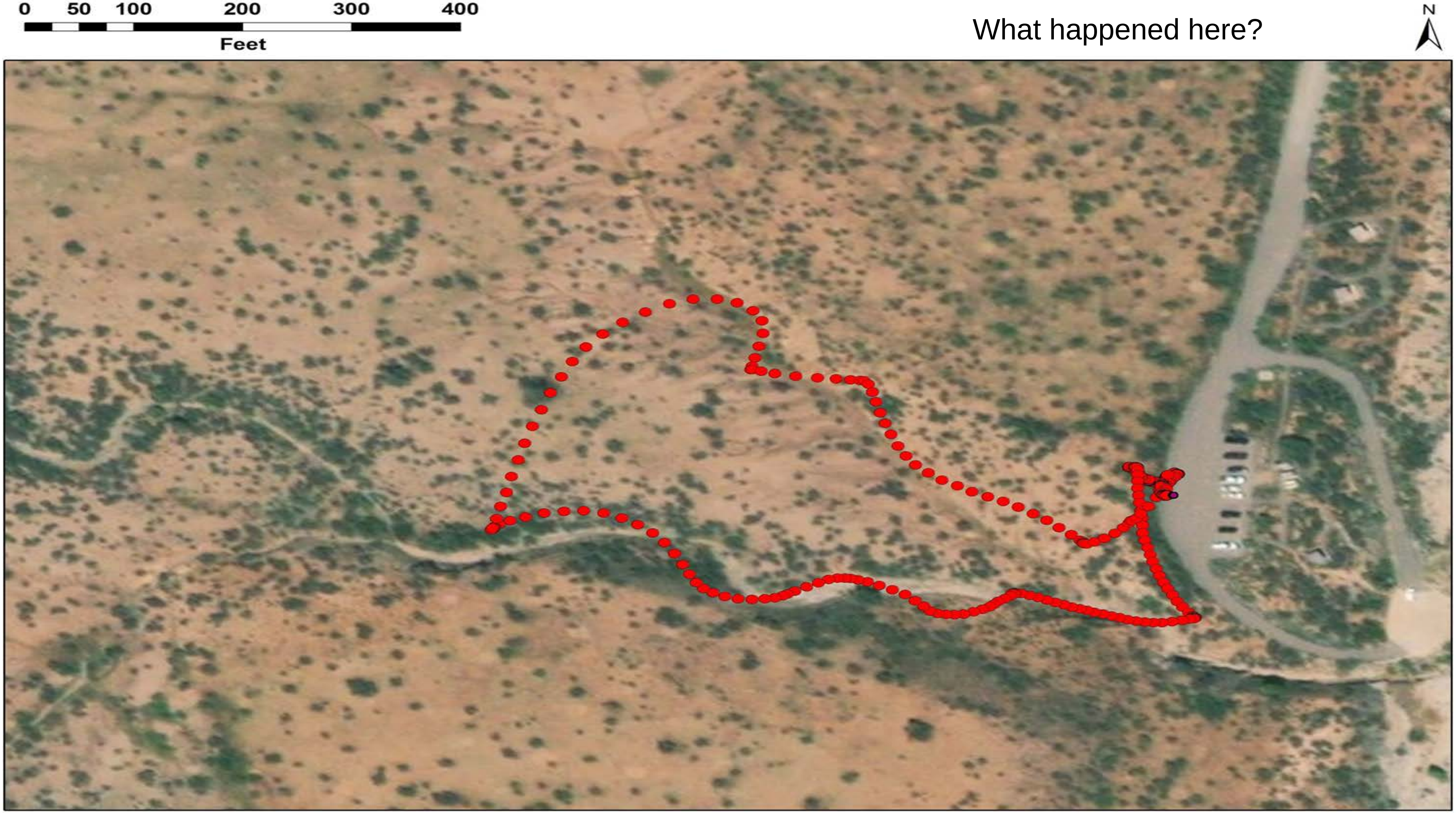
FLIRVue Pro R temp range:
-40/+1022°F
Accurate to within about 40°

Positional Accuracy

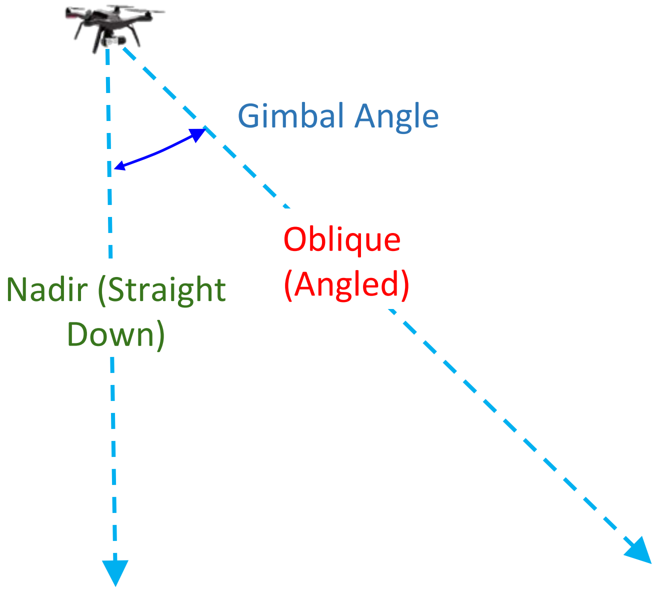
Considerations:

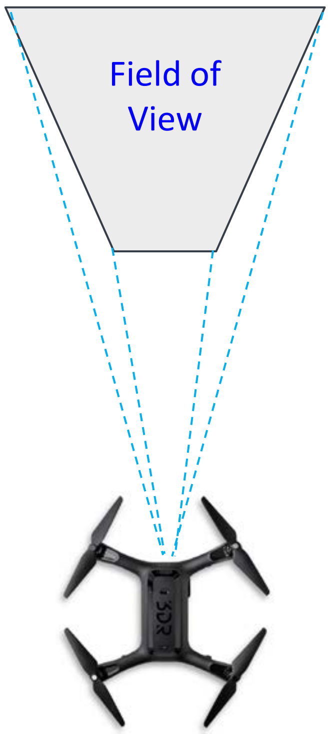
- GPS location accuracy
  - Number of satellites
  - Type of receiver
- Flying technique
- Equipment configuration

What happened here?



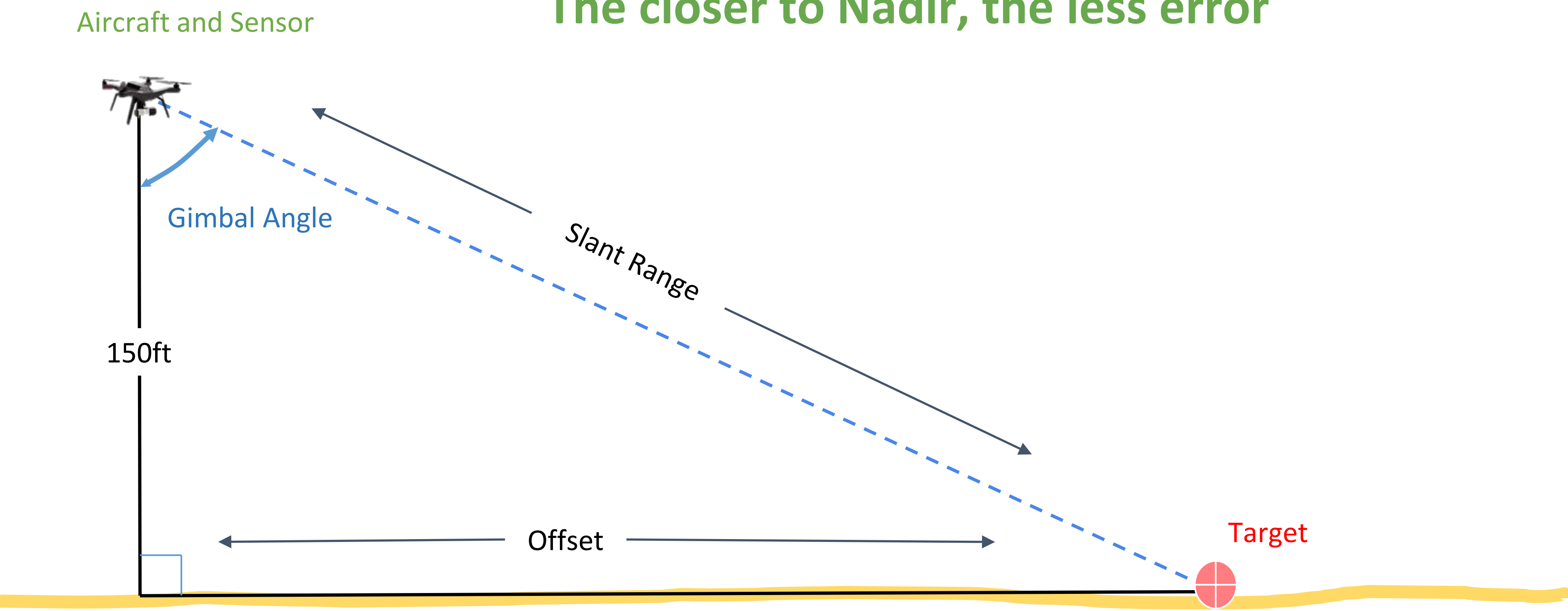
Sensor Terminology





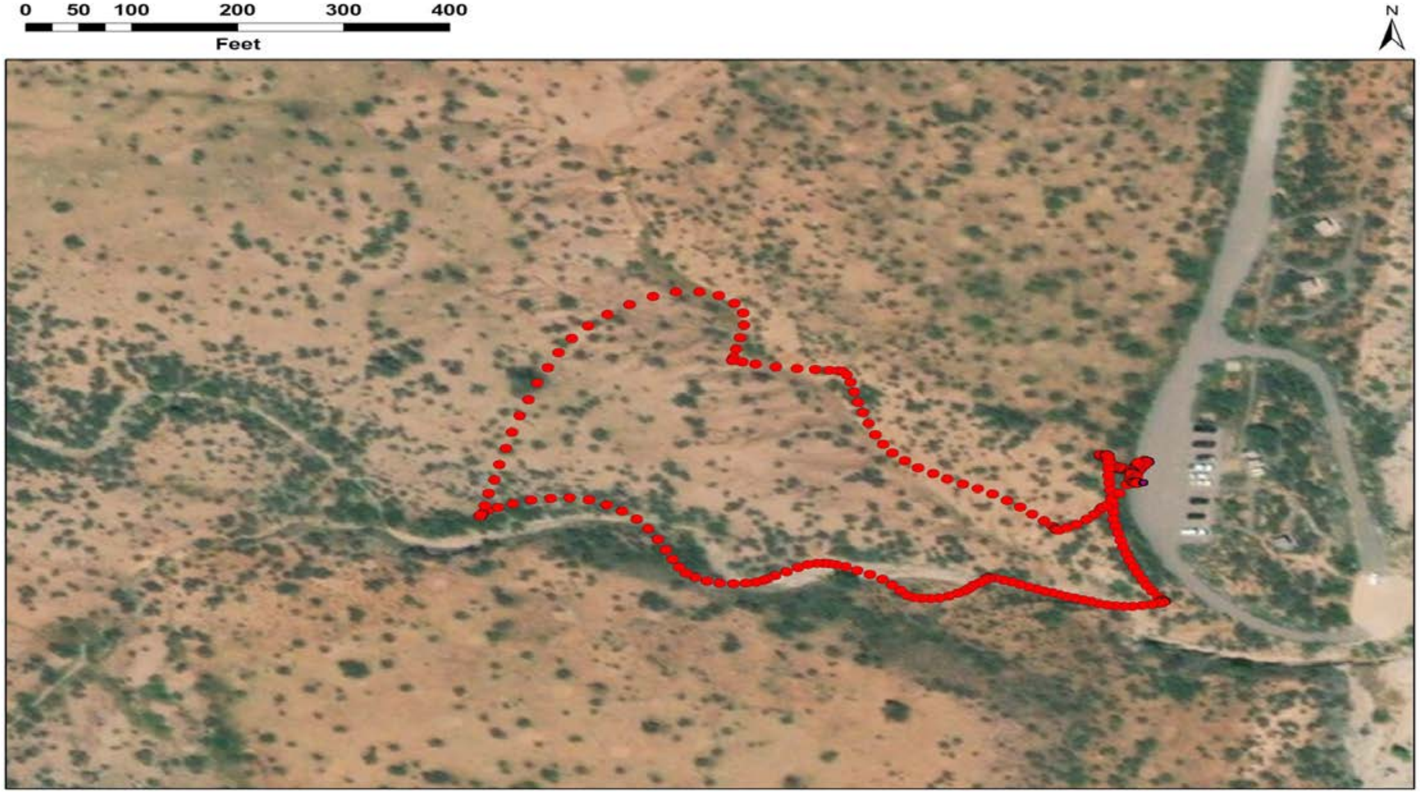
Increased gimbal angle and offset can increase error in positional accuracy

The closer to Nadir, the less error



Tip A: Use a small gimbal angle

Tip B: Don’t overfly your sensor



CWN Digitization Example:

ScanEagle
Wendover, UT

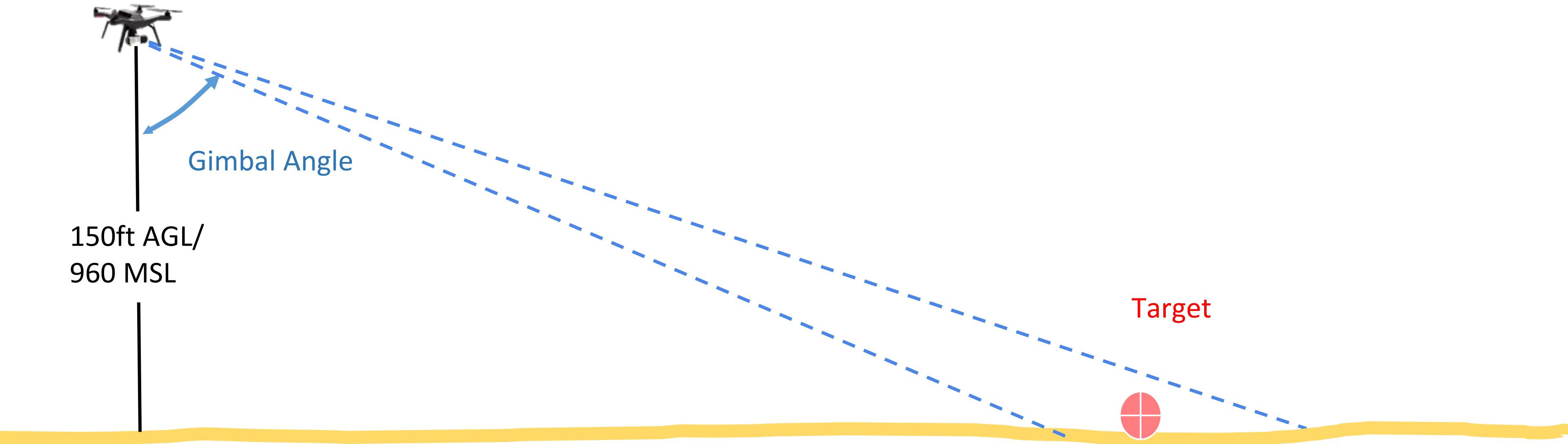
Calculating the target location

Need these equipment readings (ESRI Multiplexing to MISB)

AIRCRAFT
Location: 45 30.5, -115 25.1
Altitude*: 150’ (45.7m) AGL, 960m MSL
Roll: 0.0123°
Pitch: +3.589°
Yaw (Heading): 100°

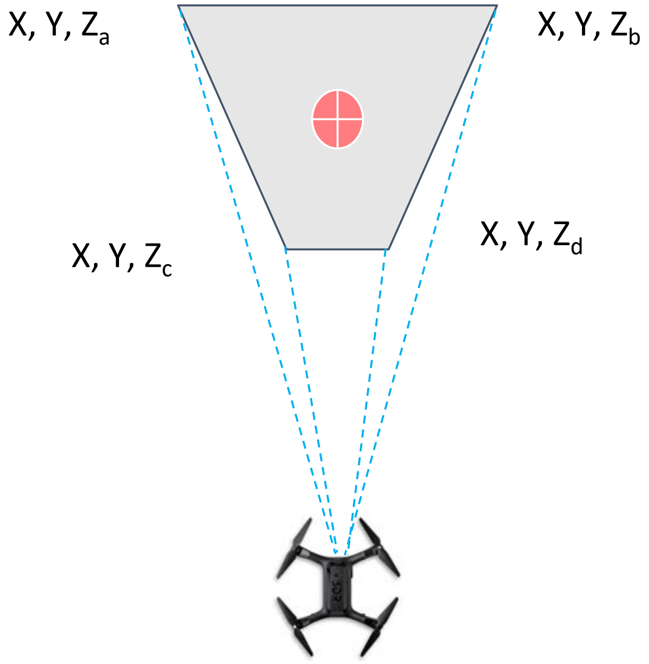
GIMBAL
Relative Roll Angle: 0°
Relative Pitch (Gimbal Angle): -45°
Azimuth Angle: 100°

CAMERA
Image Time Stamp (UNIX): 551376222
Sensor Horizontal FOV: 118.2°
Sensor Vertical FOV: 69.5°



Calculating the target location

- Input values are used to triangulate each corner of the FOV and/or target location
- Elevation data, such as a digital elevation model, assists with accuracy
- Same basic idea applies to CWN aircraft



More info: https://community.esri.com/message/625504
http://www.gwg.nga.mil/misb/docs/standards/ST0601.14.pdf

The resolution of the video frame is set to be 1920 × 1080 pixels. The scale between the distance and pixels is assumed to be a linear relationship, and is presented in Equation (7) as:

$$scale_x$$

$$sc$$

For the transformation of a north-east (NE) world-to-camera frame with the angle of the Ψ, the rotation matrix is defined as

$$\mathbf{R}_{\mathbf{W}}^{\mathbf{C}} = \begin{bmatrix} \cos(\Psi) & -\sin(\Psi) \\ \sin(\Psi) & \cos(\Psi) \end{bmatrix} \tag{9}$$

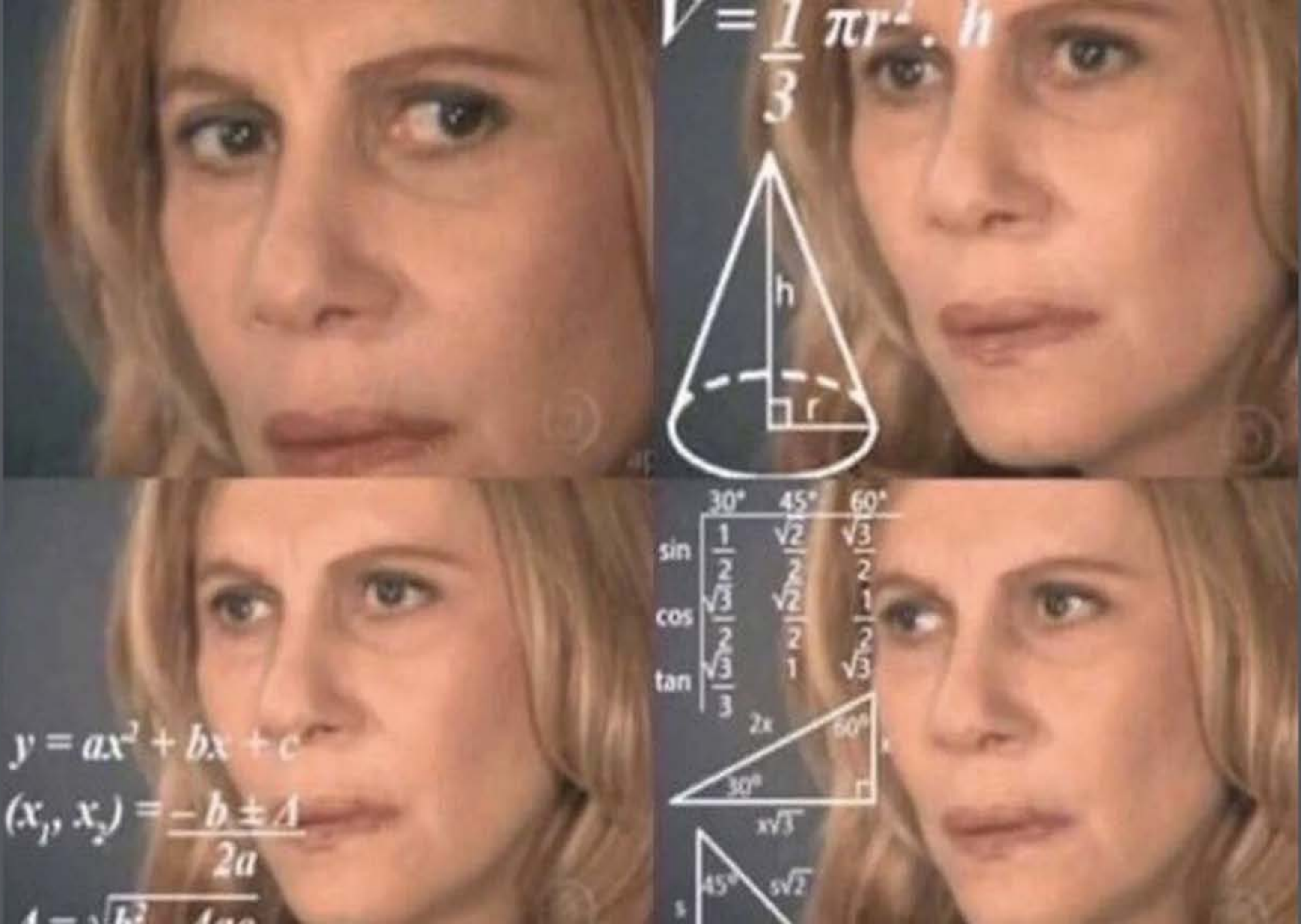
where Ψ is the yaw angel of the aircraft. Thus, the position offset in the world frame can be solved with

$$\boldsymbol{P} = {\mathbf{R}_{\mathbf{W}}^{\mathbf{C}}}^{\mathrm{T}} \mathbf{offset}_{\mathbf{target}} = \begin{bmatrix} P_E \\ P_N \end{bmatrix} \tag{10}$$

Therefore, the target's GPS coordinates can be determined using

$$\boldsymbol{GPS}_{\boldsymbol{target}} = \boldsymbol{GPS}_{\boldsymbol{cam}} + \begin{bmatrix} P_E / f_x \\ P_N / f_y \end{bmatrix} \tag{11}$$

More info: https://community.es



$V = \frac{1}{3} \pi r^2 \cdot h$
h
r
30°
45°
60°
sin
cos
tan
2x
60°
30°
$x\sqrt{3}$
45°
$y = ax^2 + bx + c$
2a

Takeaways

- Understand how resolution affects results
- FOV calculations can affect positional accuracy
- Be cautious of target coordinate data from video
- Minimize gimbal angle/offset when possible

Questions?