Utilizing Drones to Create Professional Quality 3D Models

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What are Professional Quality 3D Models?

- Dense Point Clouds
- 3D Polygonal Mesh (Triangulated Irregular Network, or TIN)
- DEM- Digital Elevation Model
  - DSM - Digital Surface Model. Data includes vegetation, structures, etc.
  - DTM - Digital Terrain Model. Data removes vegetation and structures (i.e. bare earth)
- Orthomosaic
  - Image that can be used to measure true distances.

FAA Regulations (Part 107) Small Unmanned Aircraft Requirements

- Remote pilot airman certificate (commercial)
- Must keep your drone within sight
- Maximum allowable altitude is 400 feet above the ground (higher if your drone remains within 400 feet of a structure)
- Can’t fly over anyone who is not directly participating in the operation.
- Avoid manned aircraft

Modelling Process

- Turns camera based images to accurate, georeferenced 2D maps and 3D models.
  - Do not crop or geometrically transform, i.e. resize or rotate, the images.
  - Using RAW data losslessly converted to the TIFF.
  - JPG compression may induce unwanted noise to the images.

Equipment - Drone

- Sufficient Payload & Flight Time
- Programmable Flight Paths
- Programmable Camera Triggering

Equipment – Digital Camera

- Appropriate Resolution
- Appropriate focal length
- Fixed lenses are preferred.
  - Avoid ultra-wide angle and fisheye lenses.
- Sufficient Shutter Speed to Avoid Blur

“Fisheye” Lens

- Commonly found on the GoPro camera
  - Causes a warped look

Original

“De-Fished”

Image Geometry

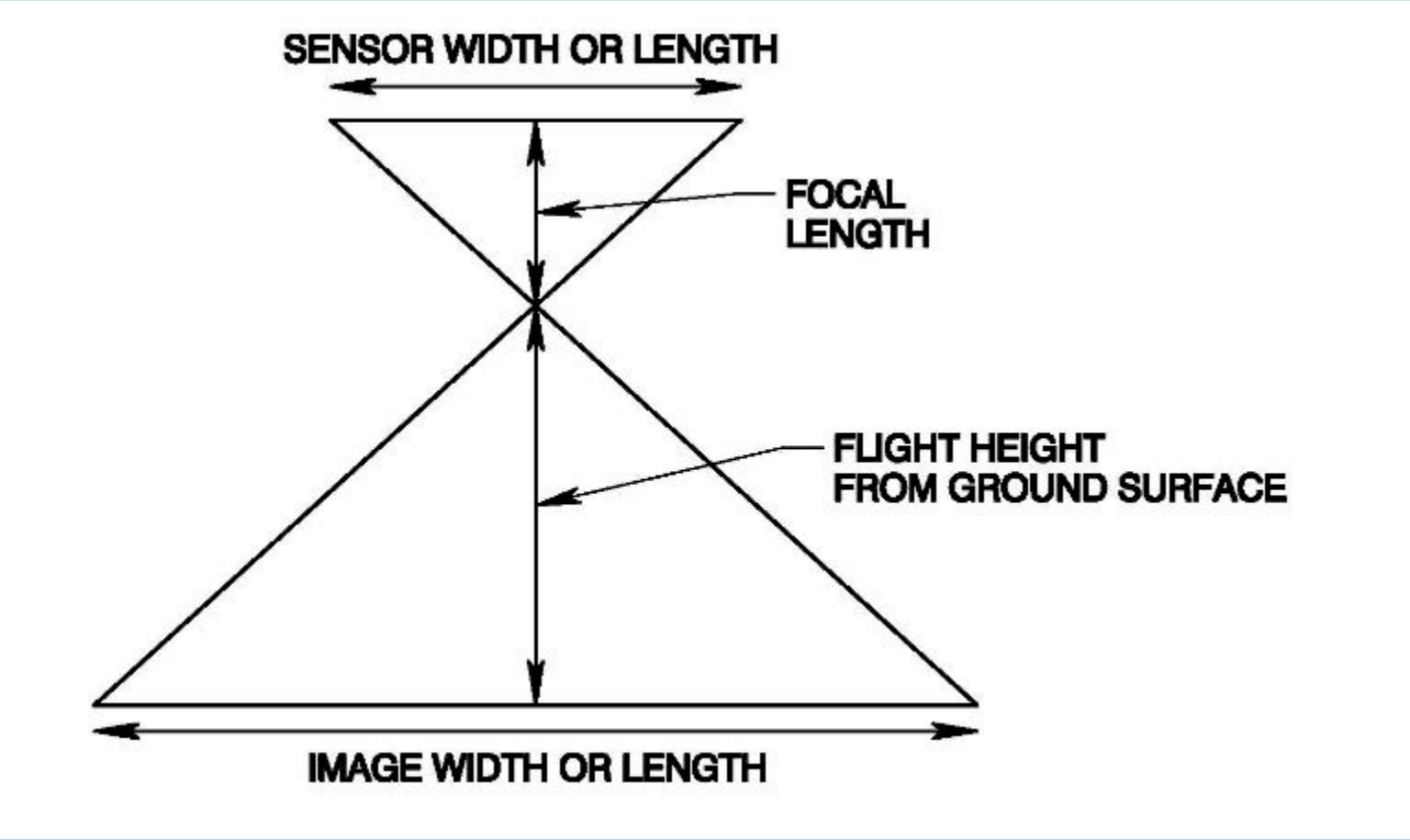


Image Geometry

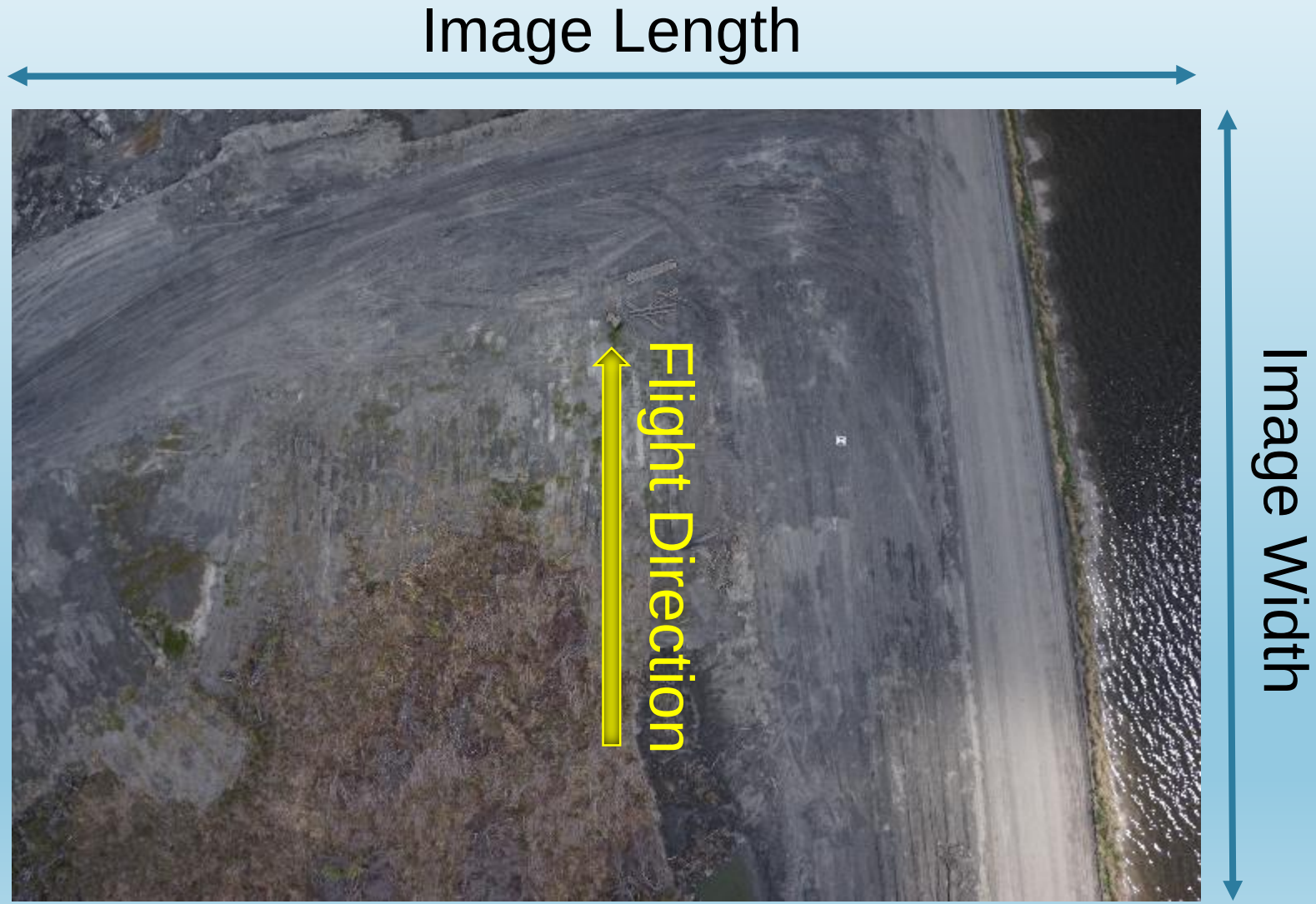


Image Geometry
Sony R10C Camera

- Sensor Length = 23.6 mm (5,456 pixels)
- Sensor Width = 15.7 mm (3,632 pixels)
- Focal length = 20 mm
- 20 MP Resolution

Image Geometry
Sony R10C Camera

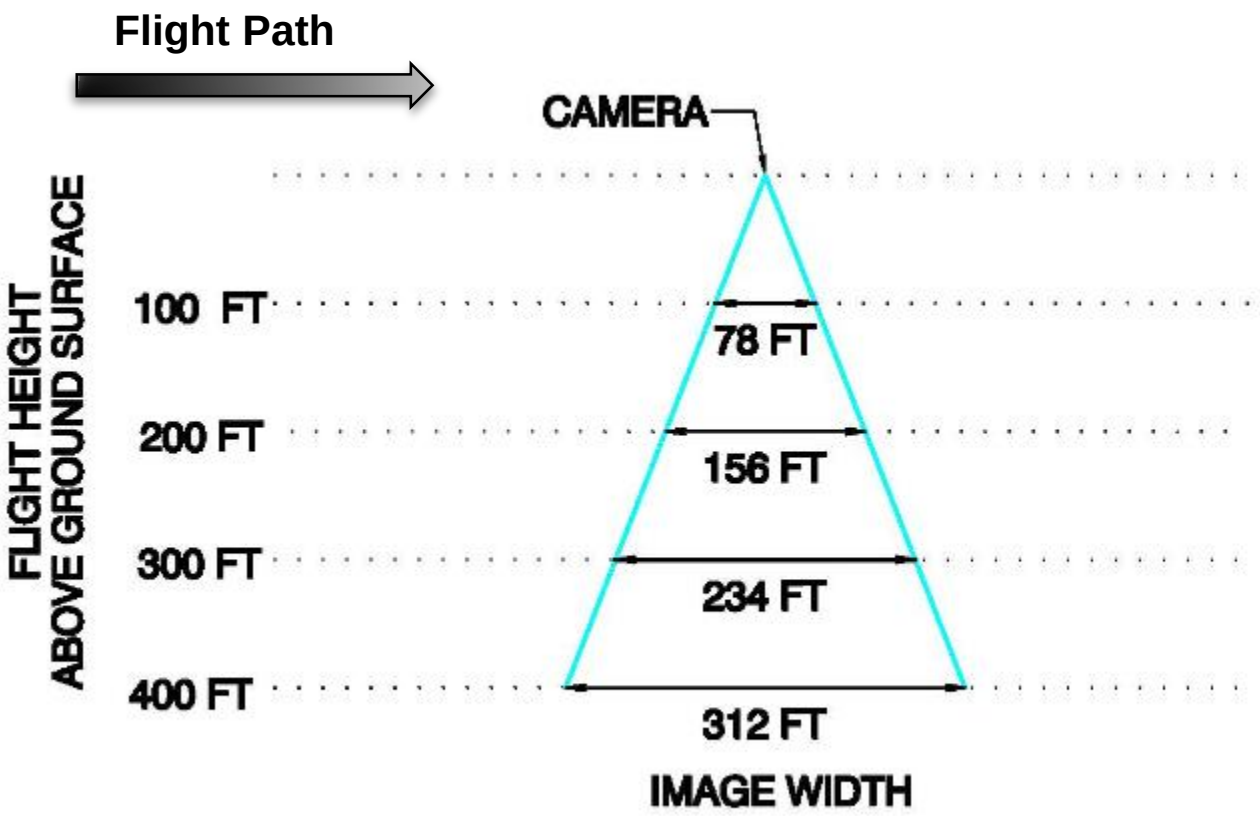


Image Geometry
Sony R10C Camera

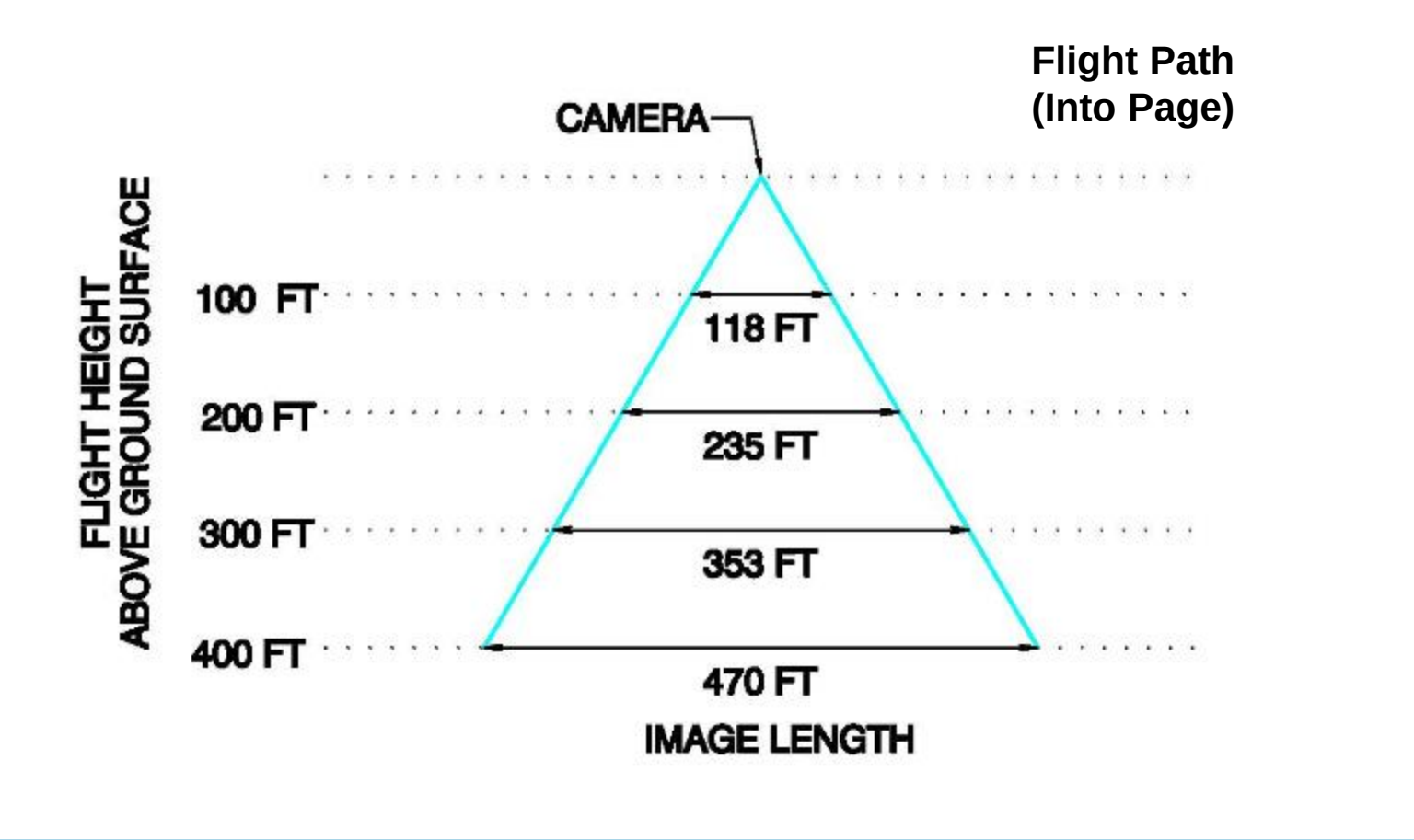


Image Geometry
Sony R10C Camera

Image Length ~ 470 Ft @ ~ 400 Ft

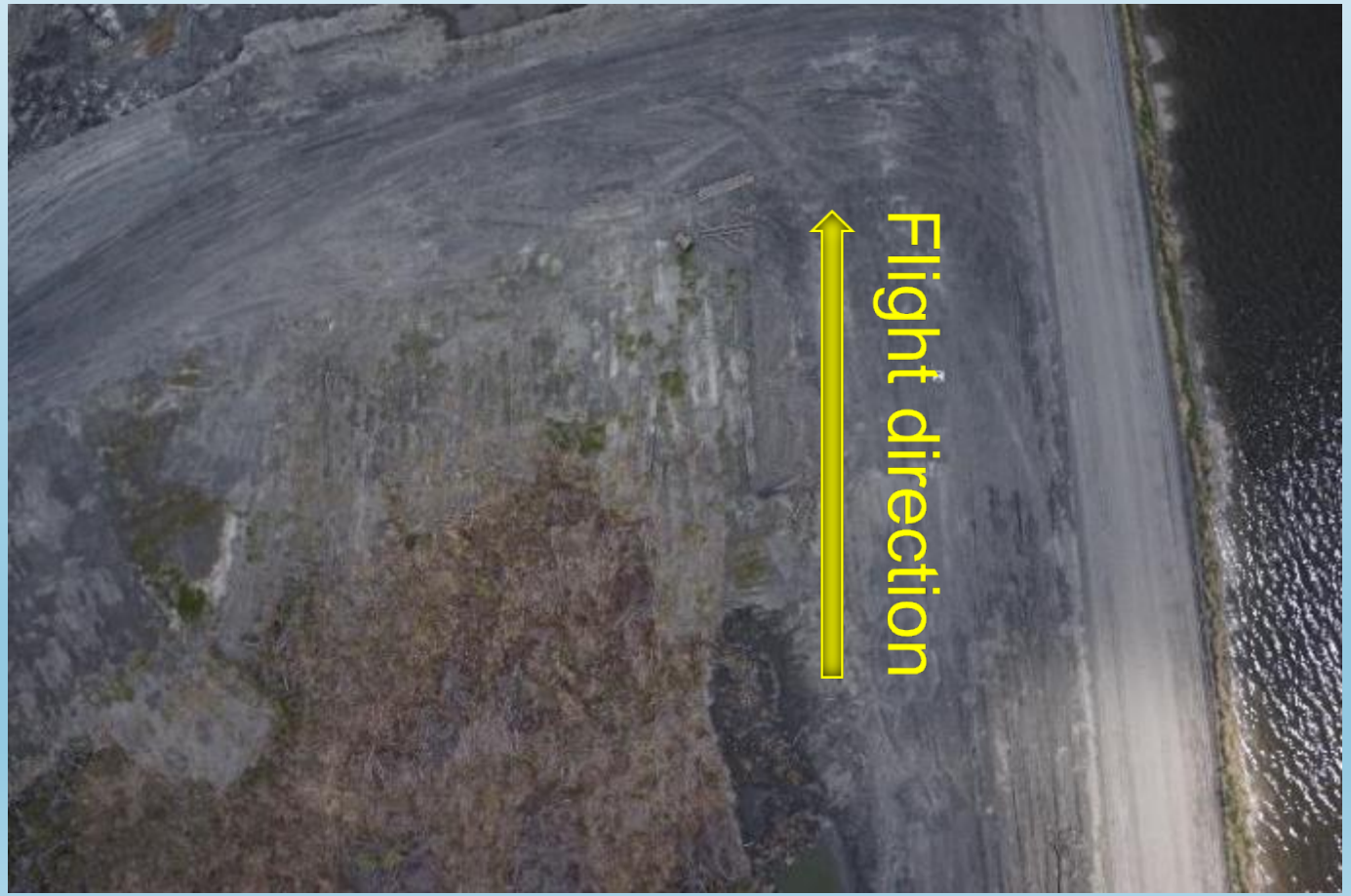
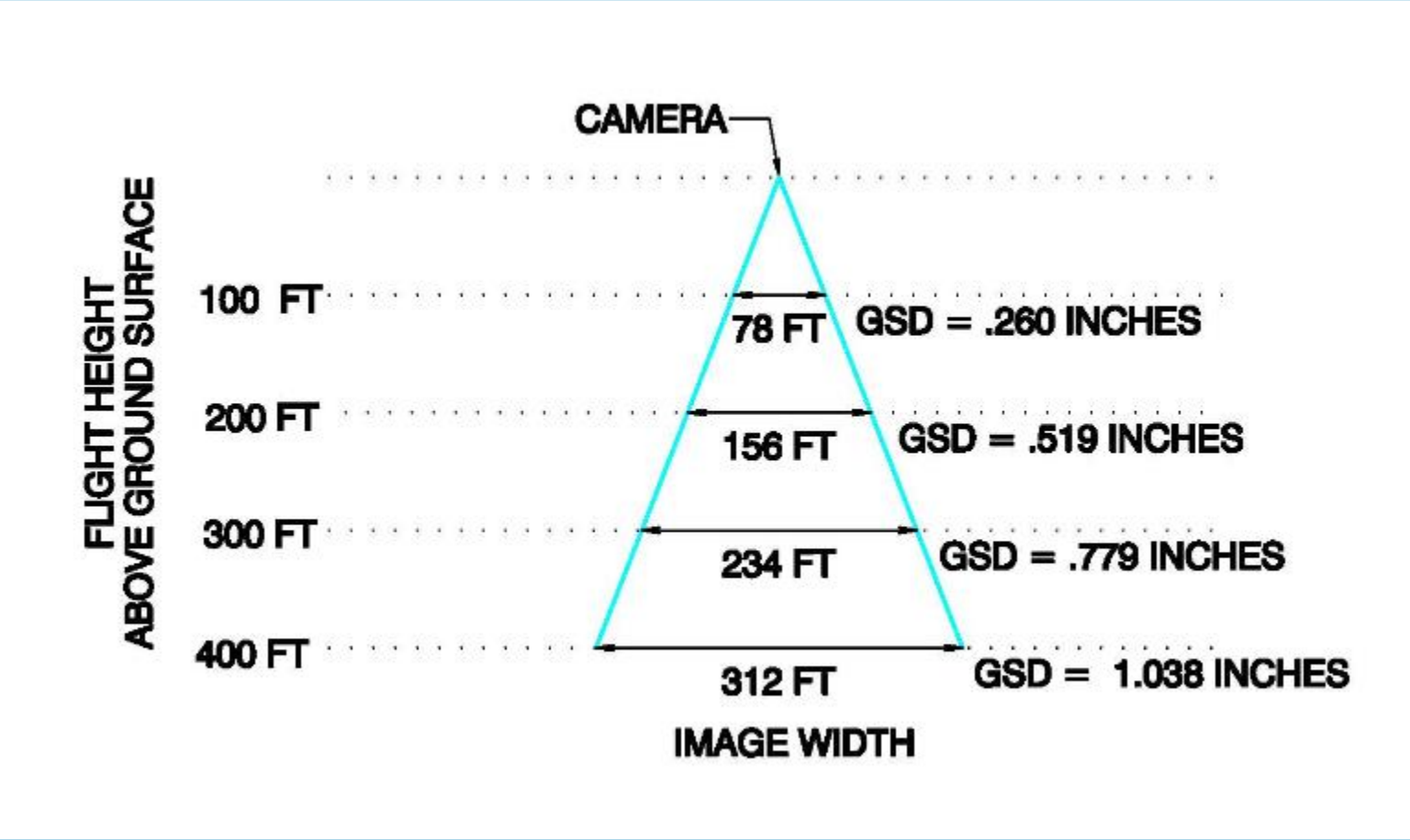


Image Width ~ 312 Ft
@ ~ 400 Ft

Ground Sample Distance (GSD)

- The Ground Sampling Distance (GSD) is the distance between two consecutive pixel centers measured on the ground.
- The higher the altitude of the flight, the bigger the image GSD value.
- The bigger the value of the image GSD, the lower the spatial resolution of the image and the less visible details.

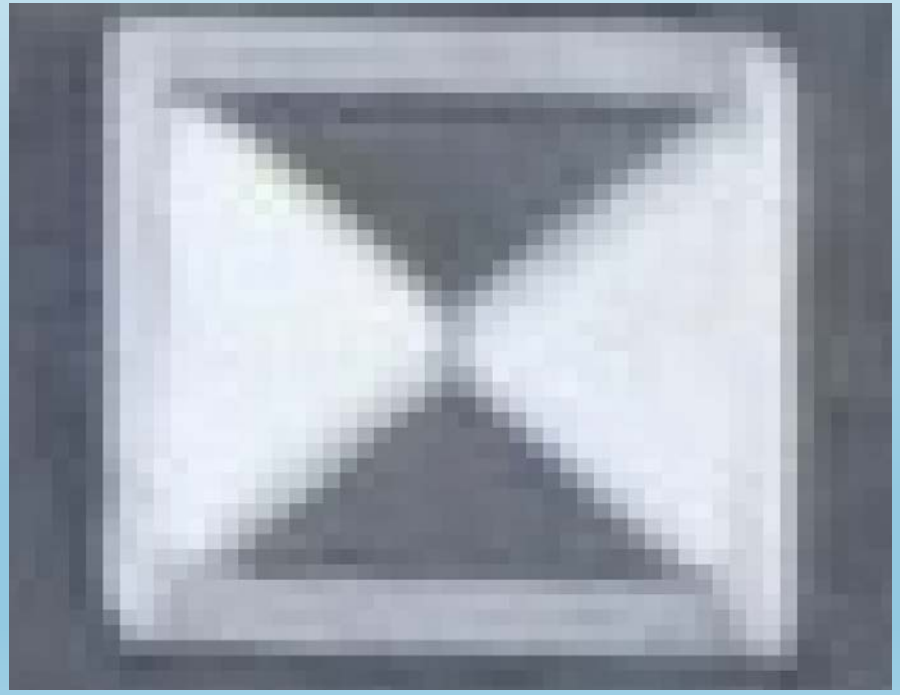
Ground Sample Distance (GSD) Sony R10C Camera



Camera Resolution Effects on GSD

GoPro Hero 4 @ 400 Ft AGL

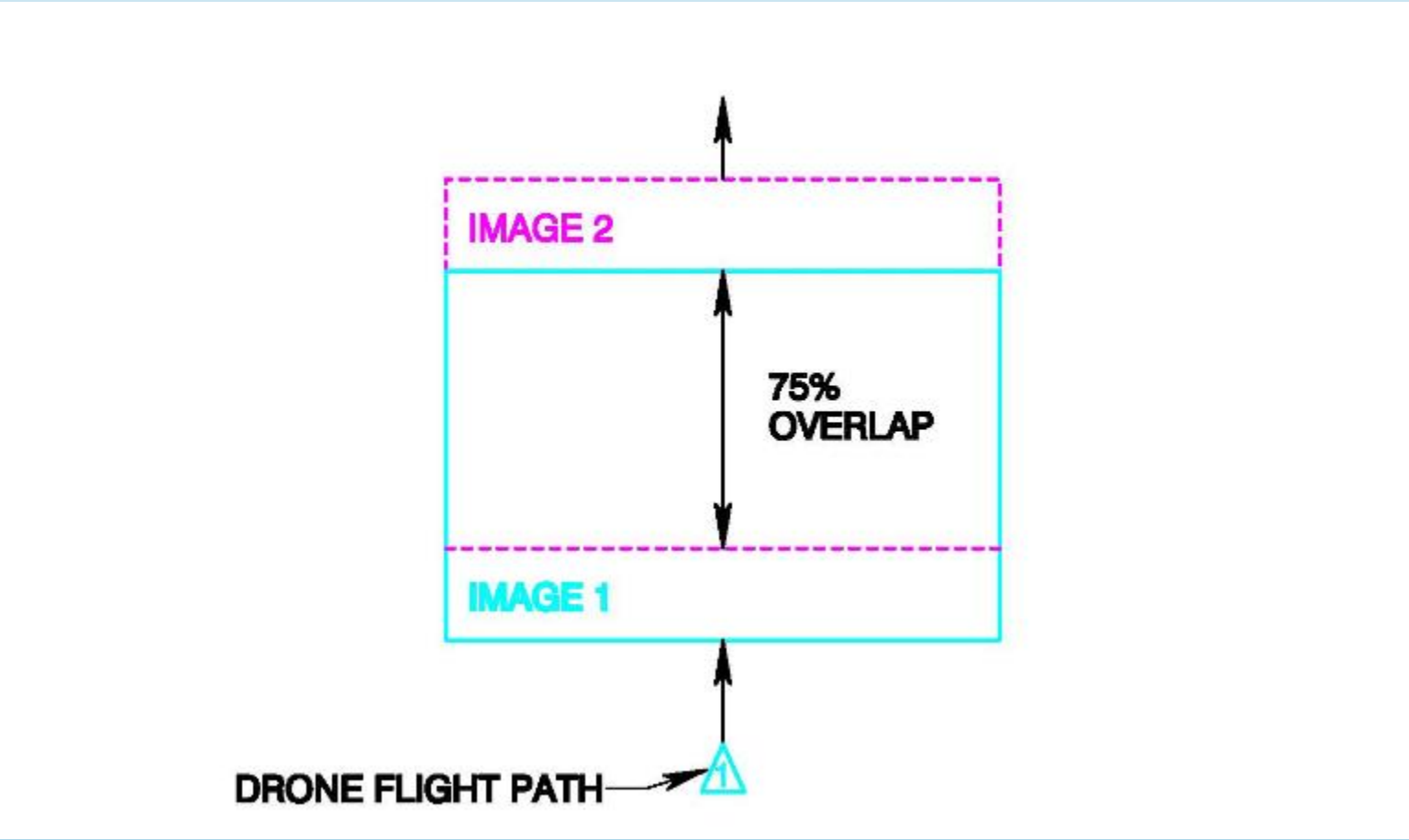
R10C @ 400 Ft AGL



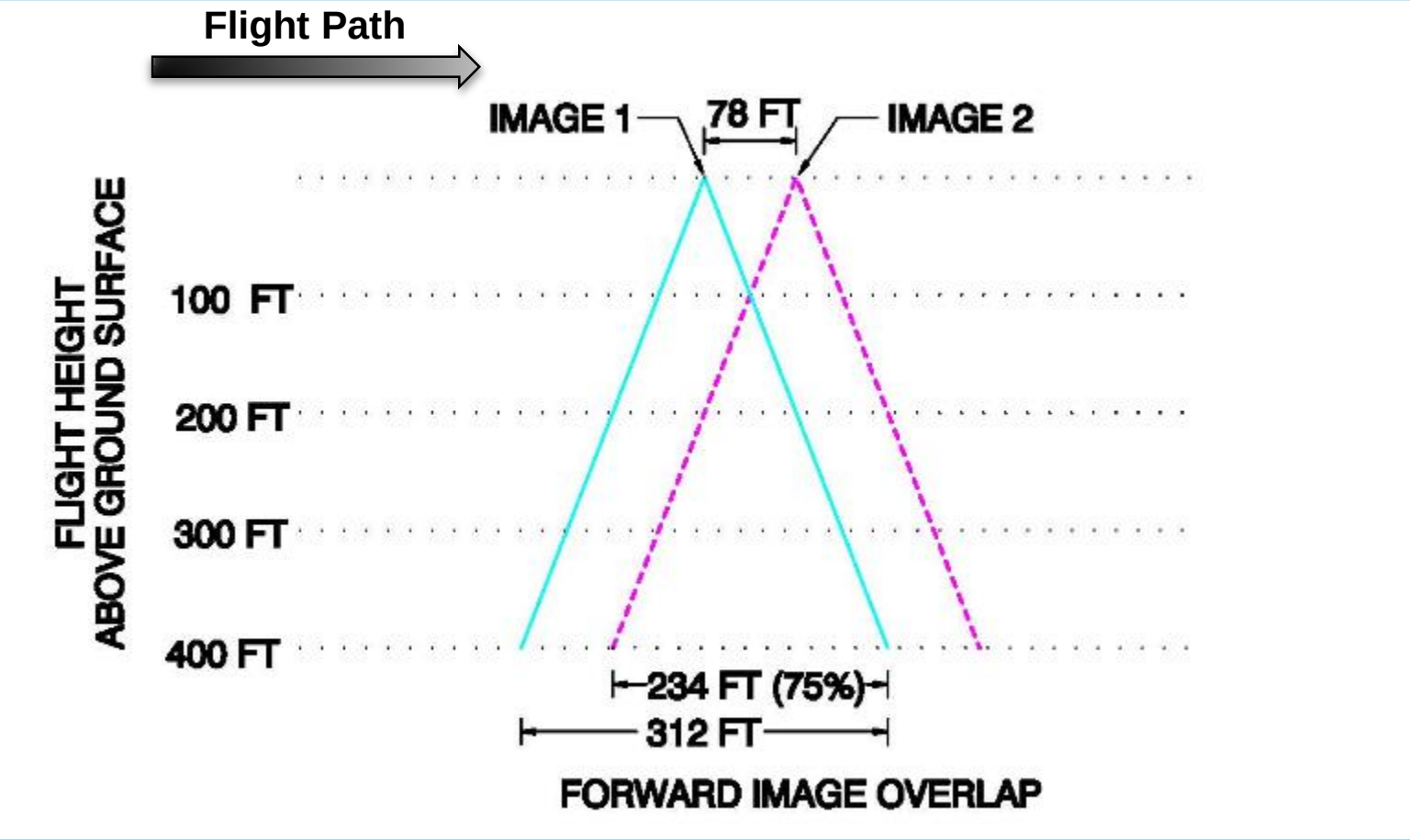
Modelling Process

- Objects to be reconstructed must be visible on at least two photos.
  - Flight Path will have straight and parallel flight lanes for pictures to ensure picture overlap.
  - In case of aerial photography, ~75% forward image overlap and ~60% side image overlap.

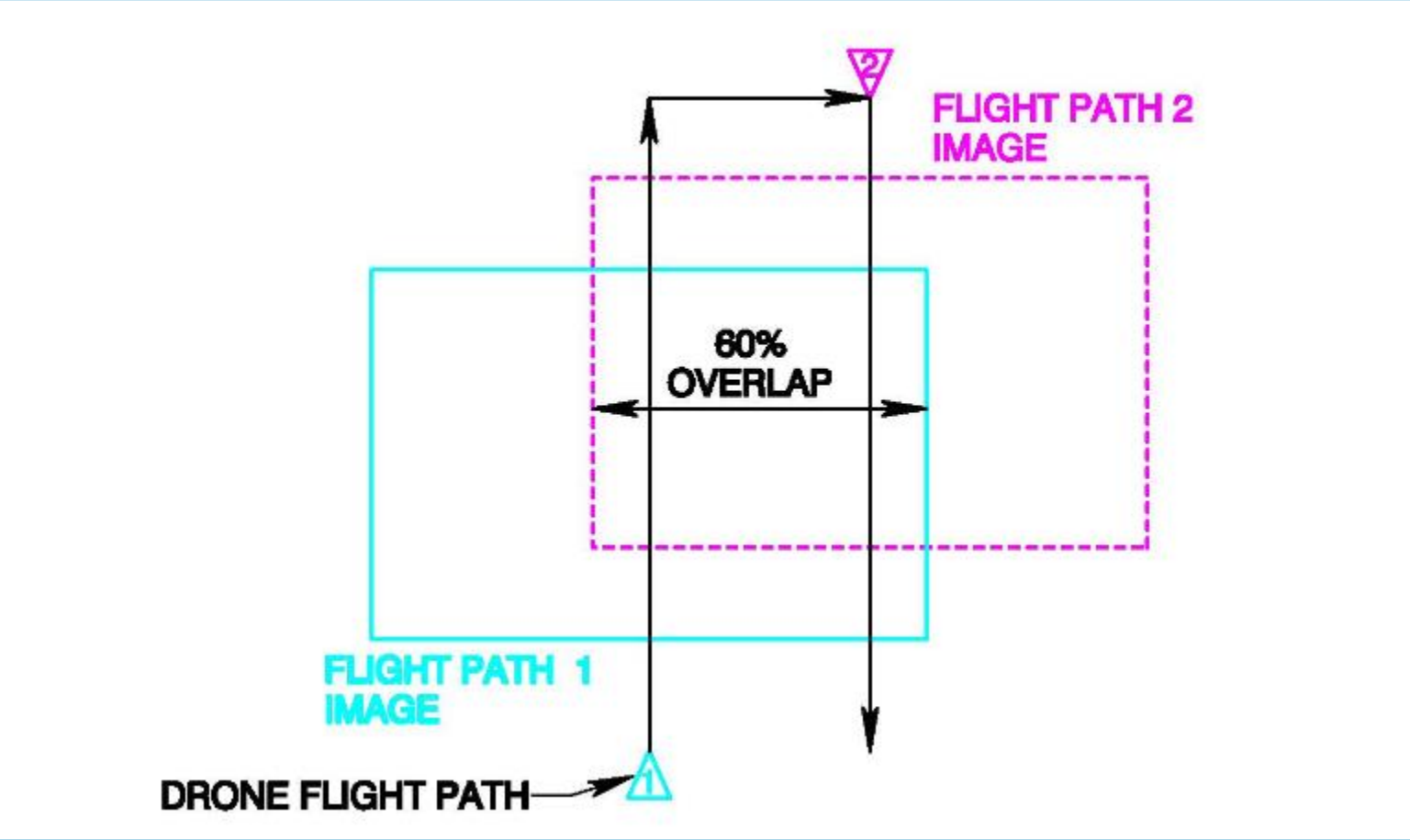
Forward Image Overlap



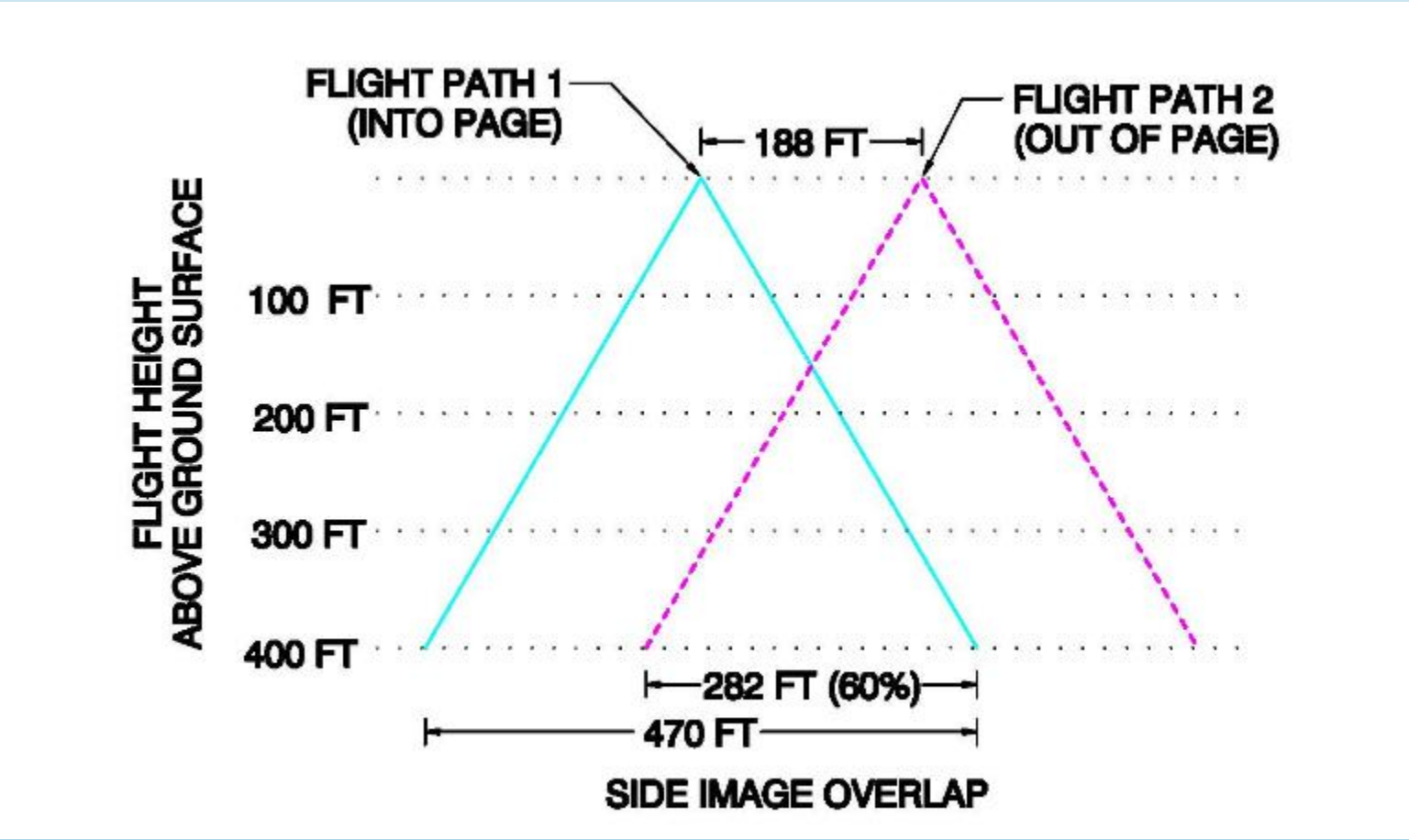
Forward Image Overlap @400FT AGL



Side Image Overlap



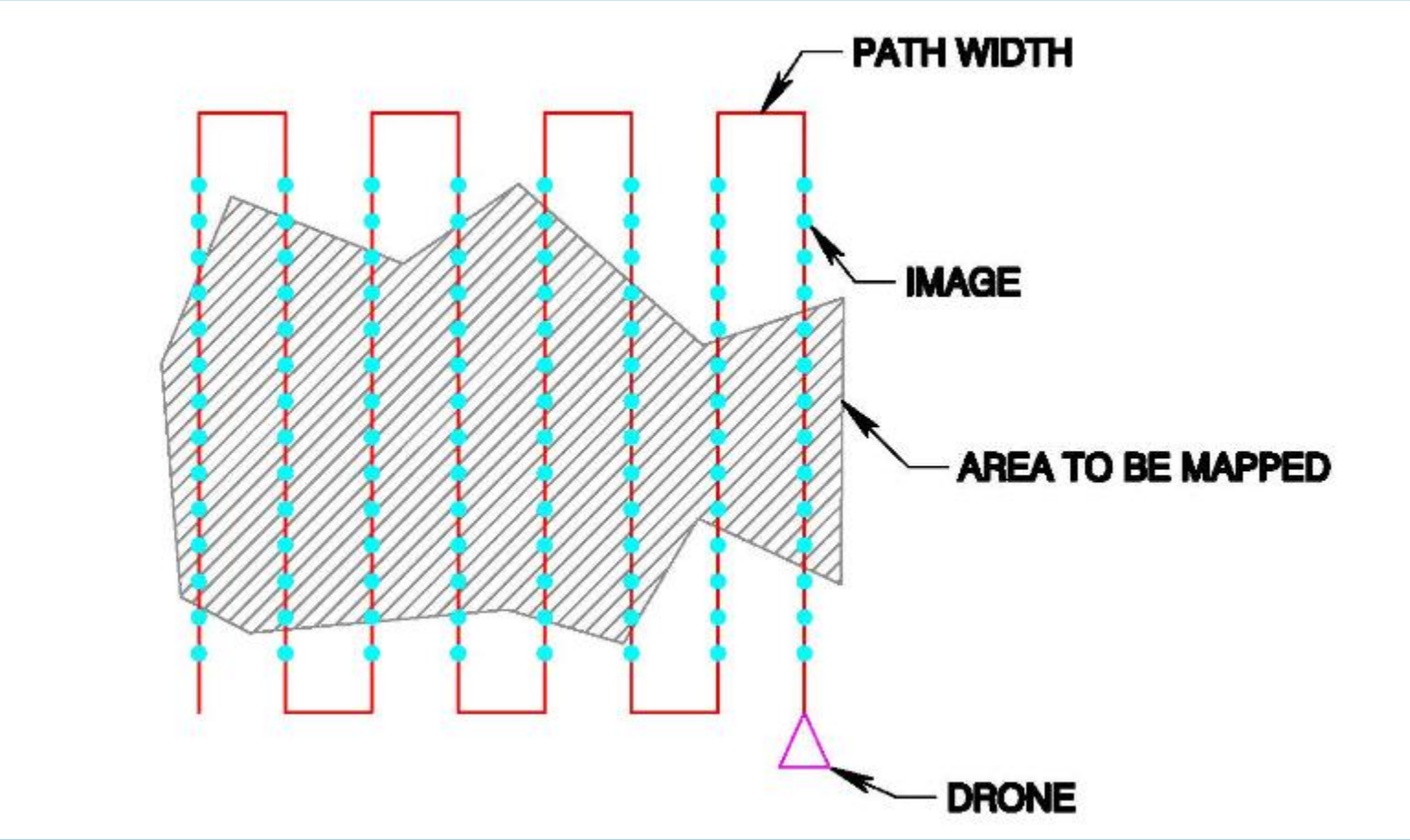
60% Side Overlap @400FT Flight Height



Planning a Mission

- Determine Area to be Mapped.
- Determined Desired Model Accuracy (flight height).
  - Frequency of Pictures (Forward Overlap).
  - Number of Flight Paths (Side Overlap).
- Flight Takeoff Point.
  - Minimum and Maximum Heights Above Surface.
- Control Panel Layout.

Planning a Mission



Target Area Example

Choosing the Correct Take Off Point

- Center of Mapped Area.
  - Reduces flight time for multi-battery missions.
- Take Off from Higher Elevations of Mapping Area.

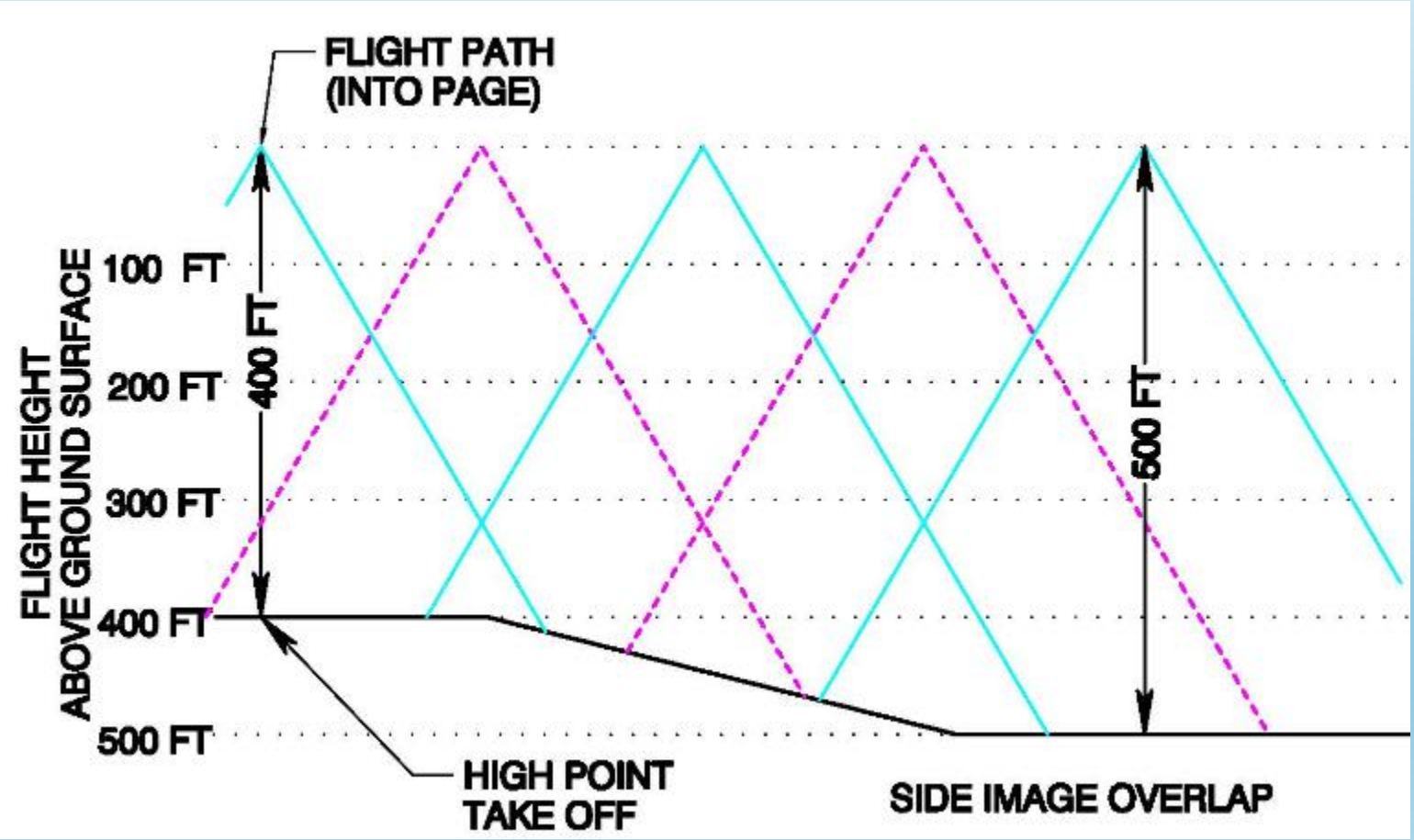
High Point Take Off

- High Point Take Off Pros:
  - Ensures Desired Image Overlap.
- High Point Take Off Cons:
  - Lower Resolution for Low Areas of Mapped Area.

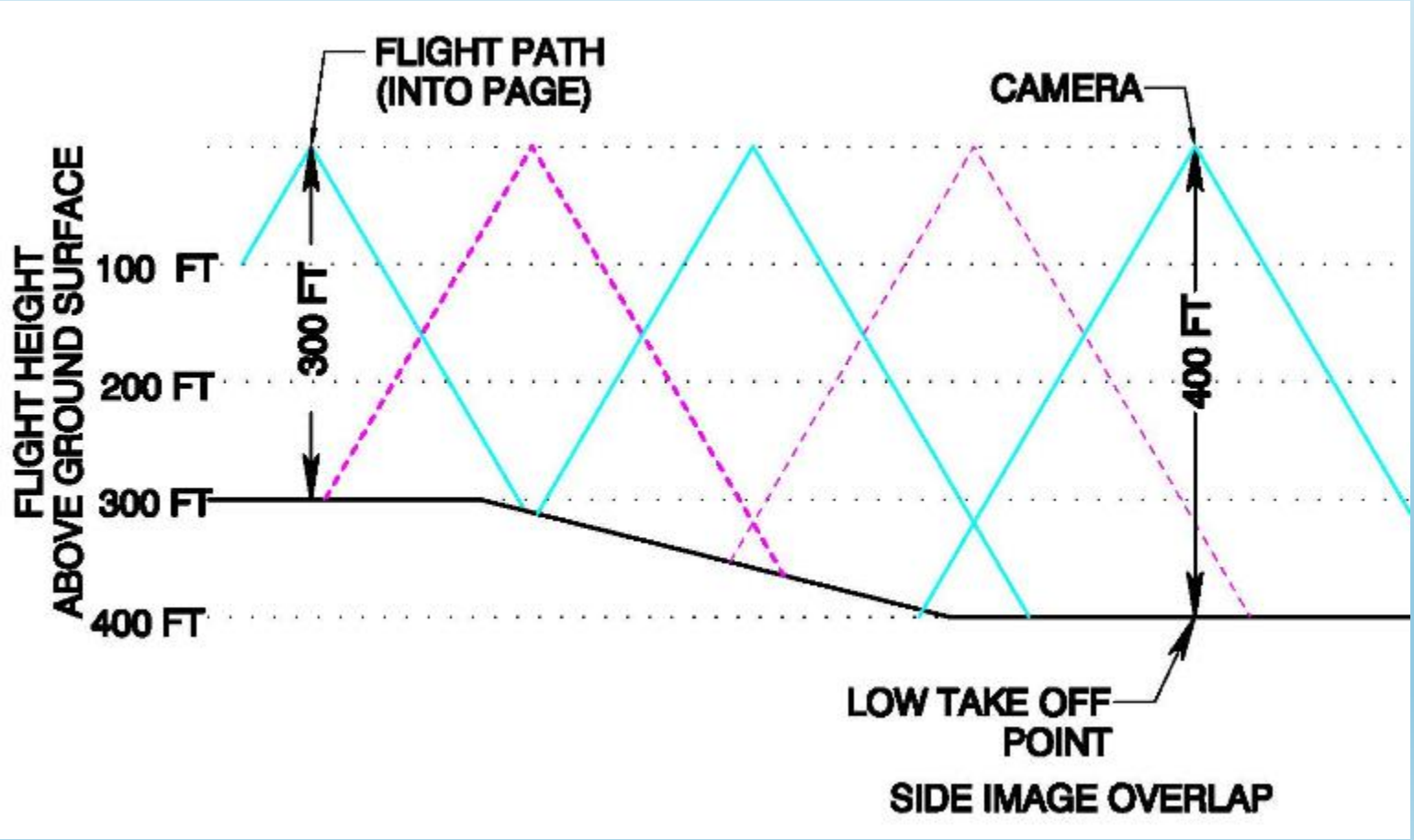
Low Point Take Off

- Low Point Take Off Pros:
  - Ensures Desired Image Resolution (assuming adequate image overlap).
- Low Point Take Off Cons:
  - Reduced Image Overlap.

High Point Take Off
Side Image Overlap



Low Point Take Off
Side Image Overlap



Control Points

- The model's accuracy depends on the number, distribution, and measured accuracy of the GCPs.
- **Relative Accuracy** : Defined by comparing individual features on a map / reconstructed model / orthomosaic with other features on the same model. (Site Control)
- **Absolute Accuracy** : Defined by the difference between the location of features on a map / reconstructed model / orthomosaic and their true position on the Earth.