



DRONES EVERYWHERE

What are they good for?

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Overview

- Applications
- Drone systems
- Regulatory Restrictions
- Project Planning
- Data Processing
- Deliverables

What are they good for?

• Industries

Applications

- **Surveying/Construction/Mapping**
 - measurements / quantities / project status / orthophotos
- **Agriculture**
 - crop inventory & crop health
- **Real Estate**
 - sales
- **Emergency Response**
 - search & rescue, accident & crime investigation
- **Inspection**
- **Recreation/Photography**
- **.....more to come**

Multi-rotor vs. Fixed Wing



- Vertical take off
- Oblique Imagery
- Navigability



- Cover larger areas
- Typically Nadir Imagery
- Larger payload capacity – better sensors

Payload Options



- \$200k+
- Laser scanner and cameras
 - Penetrate vegetation
- Survey grade



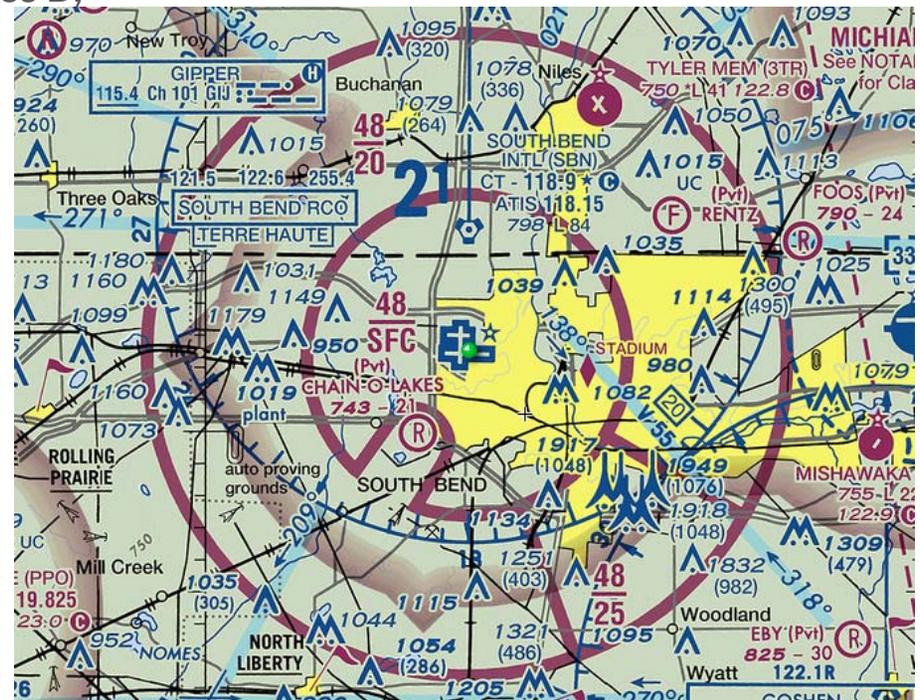
- \$1500
- 20 MP Camera
- Can be Survey grade with proper data processing
- Today, 84% of drone mapping is occurring on drone models that cost \$1500 or less. -DroneDeploy

Regulatory Restrictions

- FAA Small UAS Rule (14 CFR part 107)
 - Remote Pilot Certificate
 - Airspace Restrictions
 - Waivers (night, over people, within class B, C, D, or E airspace etc.)

Essentially:

- Glass G Airspace
- Under 400 feet AGL
- Daytime



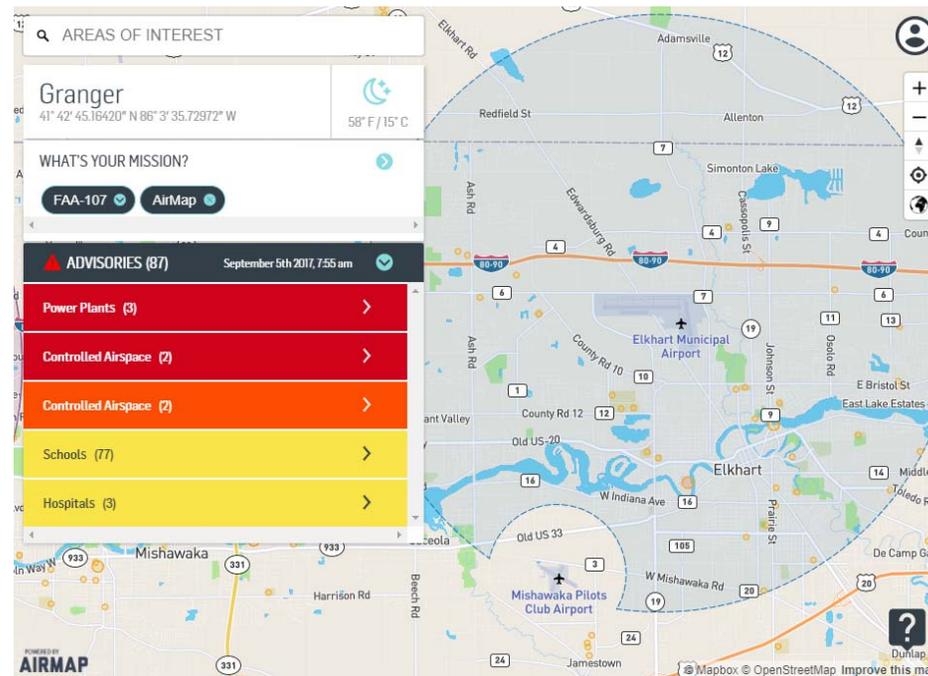
<https://skyvector.com/>

Project Planning

- Numerous mission planning apps available
- Considerations include
 - Airspace and critical facilities
 - People
 - Image overlap
 - Ground Sample Distance
 - Flight time (and number of batteries)

Project Planning

- B4UFLY mobile app
- Airmap
 - <https://app.airmap.io/>



Technical Considerations

- **Ground Sampling Distance**
 - Distance between two adjacent pixel centers
 - Horizontal accuracy 1-2x GSD
 - Vertical accuracy 1-3x GSD
 - Determined by camera and altitude
- **Image overlap**
 - Minimum 70% side and front
- **Elevation changes across site can impact overlap and GSD**

GSD Calculator



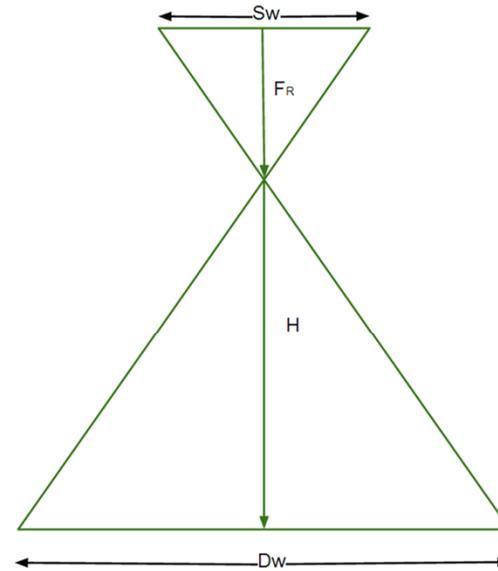
GROUND SAMPLING DISTANCE CALCULATOR

Instructions

1. Enter the Sensor Width (millimeters) in cell **C14**
2. Enter the Focal Length (millimeters) in cell **C15** (real focal length, not 35 mm equivalent)
3. Enter the Flight Height (meters) in cell **C16**
4. Enter the Image Width (pixels) in cell **C17**
5. [Optional] Enter the Image Height (pixels) in cell **C18**
6. Hit Enter

Calculator

Sw	13.125	= the sensor width of the camera (millimeters)
FR	15.4	= the focal length of the camera (millimeters)
H	100	= the flight height (meters)
imW	4608	= the image width (pixels)
imH	3456	= the image height (pixels)
GSD	1.85	= Ground Sampling Distance (centimeters/pixel)
Dw	85	= width of single image footprint on the ground (meters)
DH	64	= height of single image footprint on the ground (meters)



Dw = The footprint width / distance covered on the ground by one image in width direction

www.pix4d.com

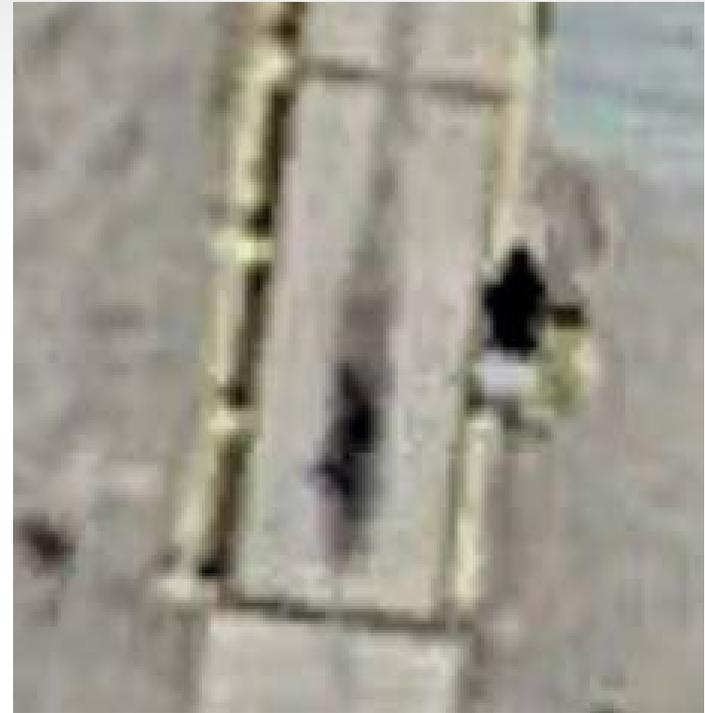
<https://support.pix4d.com/hc/en-us/articles/202560249#gsc.tab=0>



GSD Comparison



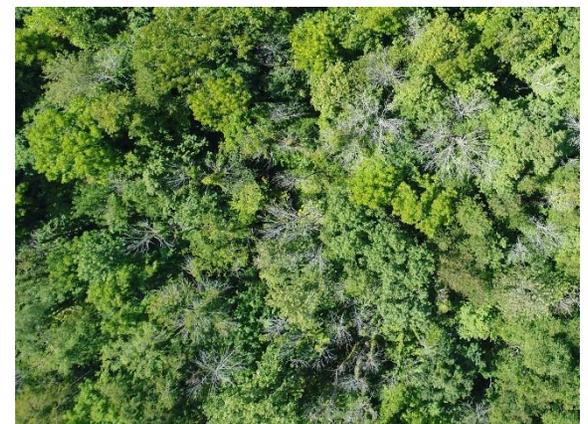
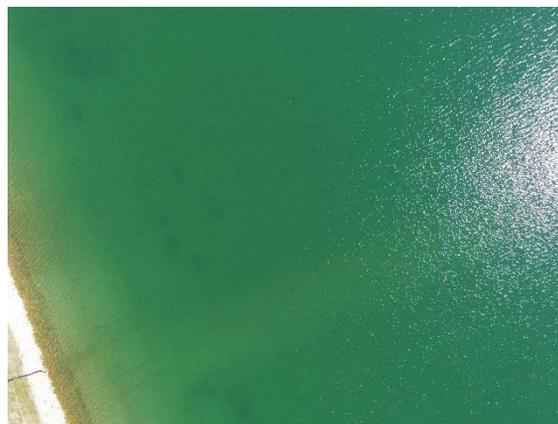
1-inch GSD



Google Earth (6-inch GSD)

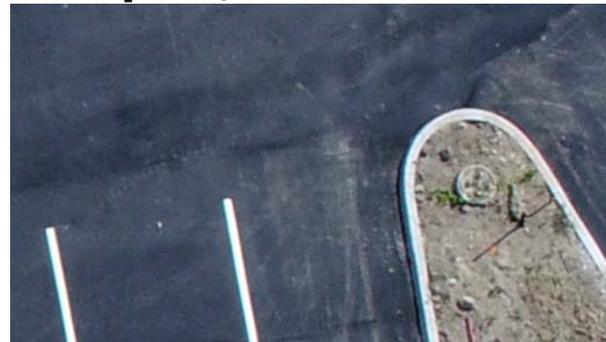
Image Overlap

- Challenging image content
 - Motion such as water and vegetation
 - Repetitive data such as agricultural fields
 - Fly higher to improve matching, if possible



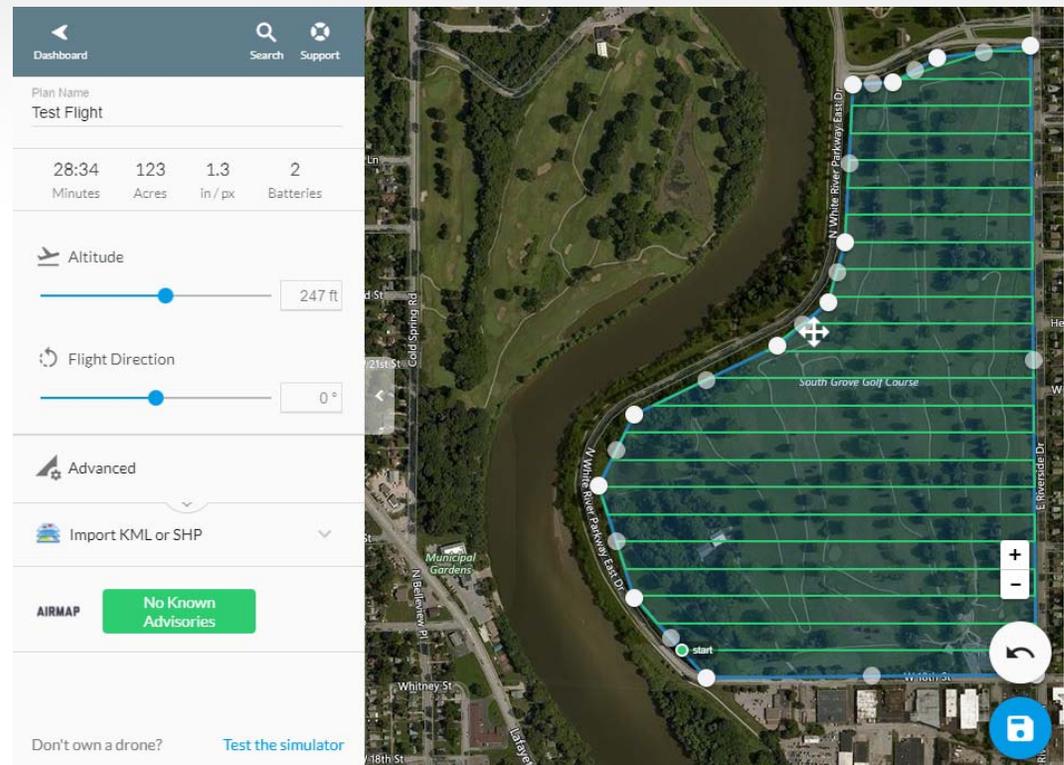
Ground Control Points

- Required for survey grade accuracy
- Used to scale and place the image content
- 4-6 perimeter
- 1-2 centered
- 2-3 additional independent check points
- Can use targets, parking lot stripes, sidewalk seams



Flight Plan

- Enclose project area
- Verify GSD with project requirements
- Adjust altitude to modify battery use and GSD



<https://www.dronedeploy.com>

Data Processing

- Several software suites exist to process the raw images into usable products
- Pix4D
- Photoscan
- DroneDeploy



PhotoScan

3D Modeling and Mapping



DroneDeploy

Data Processing

- Image matching (1000's of matches per image)

DJI_0550.JPG (Camera)

Camera Model: FC6310_8.8_4864x3648
Number of Marked MTPs and GCPs: 0
Number of Automatic Tie Points: 16523
Computed Position [US survey foot]: 3185864.46, 1711549.8

Initial Position and Orientation

Initial Position [US survey foot]: 3185871.12, 1711544.8
Initial Orientation (Omega, Phi, Kappa) [degree]: -0.00, 0.10, 91.23
Initial Accuracy (Horizontal, Vertical) [US survey foot]: 5.00, 10.00



DJI_0551.JPG (Camera)

Camera Model: FC6310_8.8_4864x3648
Number of Marked MTPs and GCPs: 1
Number of Automatic Tie Points: 15115
Computed Position [US survey foot]: 3185789.53, 1711548.9

Initial Position and Orientation

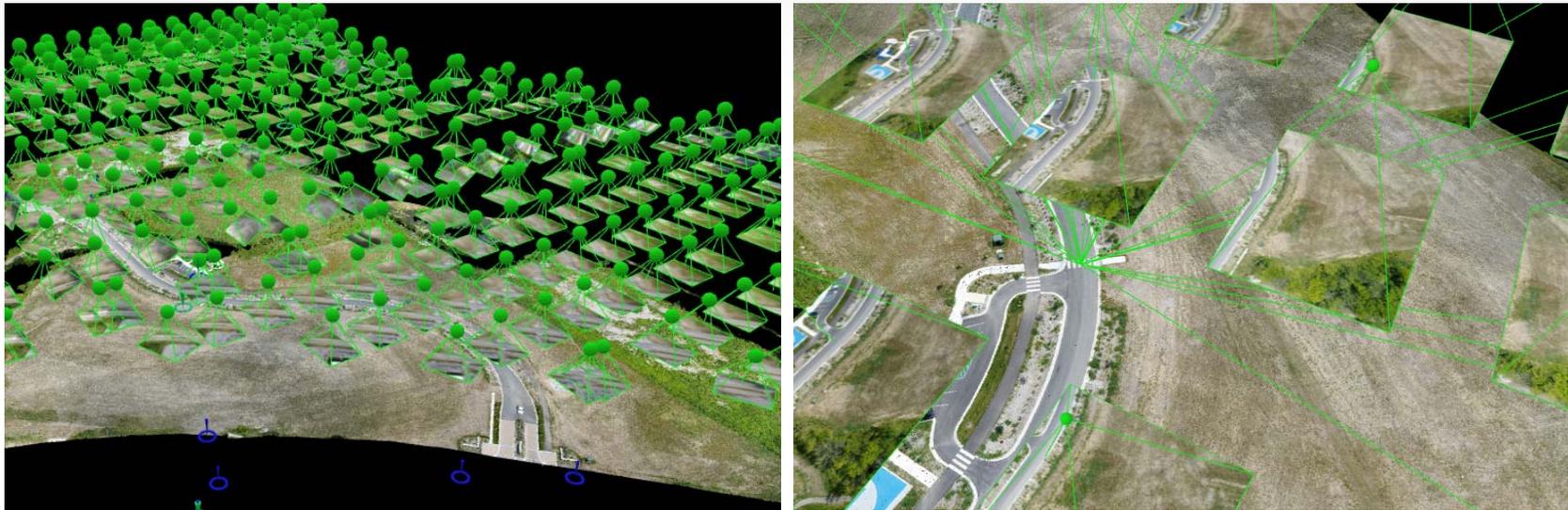
Initial Position [US survey foot]: 3185811.86, 1711544.8
Initial Orientation (Omega, Phi, Kappa) [degree]: -0.00, 0.10, 90.93
Initial Accuracy (Horizontal, Vertical) [US survey foot]: 5.00, 10.00



- Mark ground control points that have been surveyed



Data Processing



Calibrated Images

Data Processing



Point Cloud



Orthomosaic

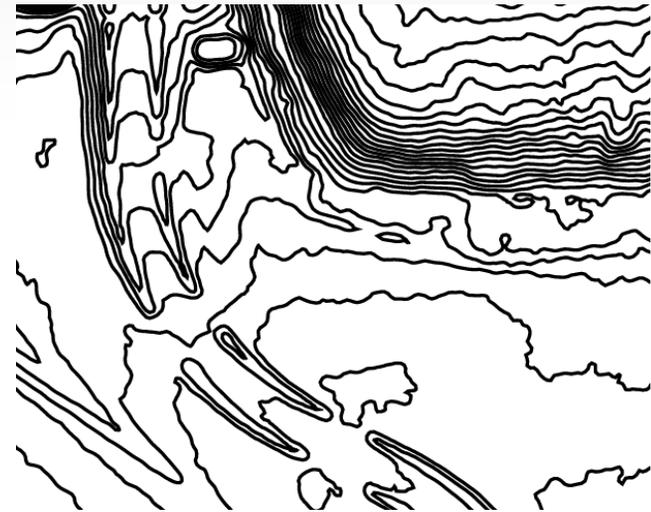
Data Processing



3D Textured Mesh

Products

- **Orthomosaic**
 - Xref into Autocad
- **Point Cloud**
 - Generate contours, surface model
 - measure between points
- **3D textured mesh**
 - Great for visualization



Caveats

- Point cloud and corresponding contours will be on top of grass and trees
- Inherent limitation of photogrammetric method
- Can be overcome with expensive lidar solutions if an aerial only application is needed
- Ground survey with drone flight for orthophoto is a good hybrid method.

Questions?

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