Mapping with Drones

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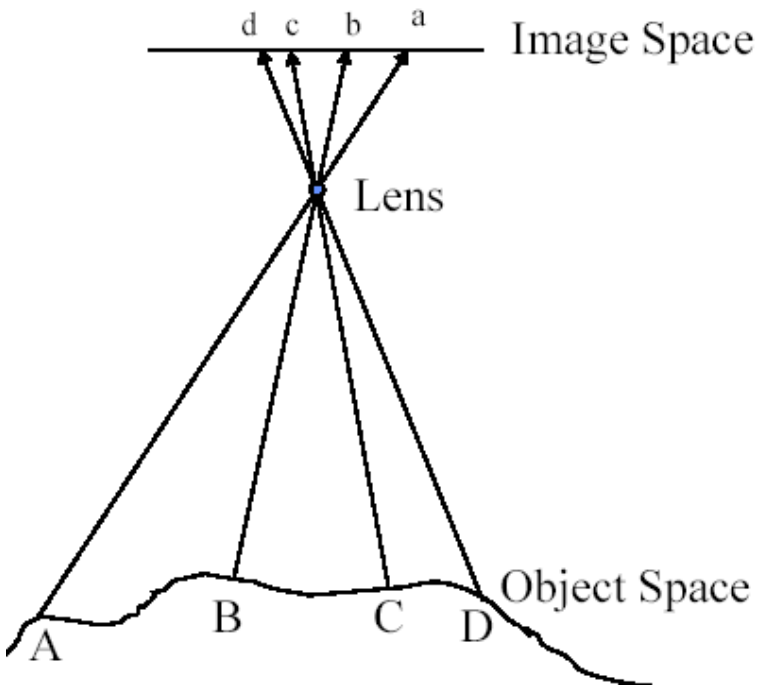
What is a MAP?


Asian Institute of Technology - Thailand
Image Acquired on 04.02.16 by Phantom 3 Professional © Geoinformatics Center.

Photogrammetry

Photo - light
gramma - something drawn
metrein - measure



Photogrammetry = measuring with photographs

Objective is…

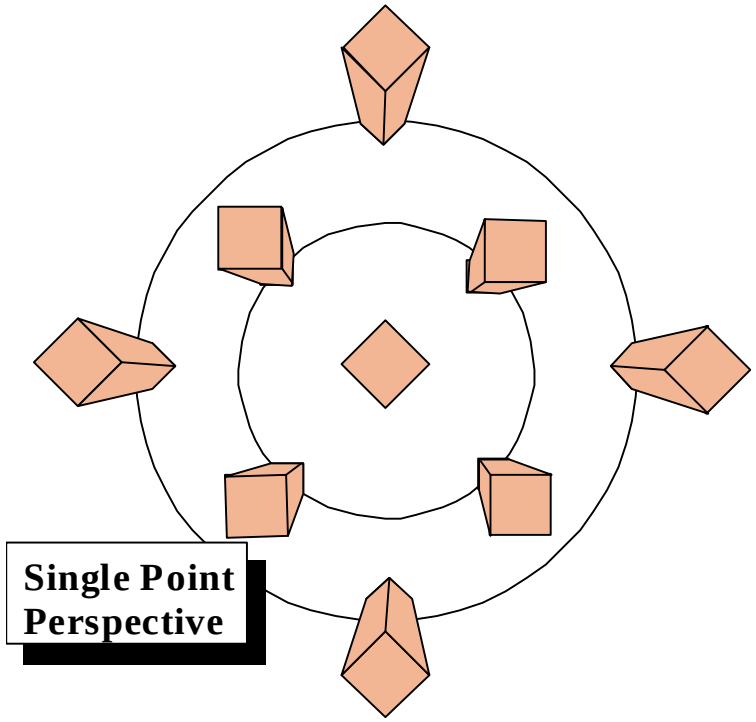
Inverse the process of photography (i.e. reconstruction of the object space from image space).

Results can be,

- ***Topographical/Planimetric/Thematic maps***
- ***3D Models***
- Coordinates of the required object points
- Rectified Photos

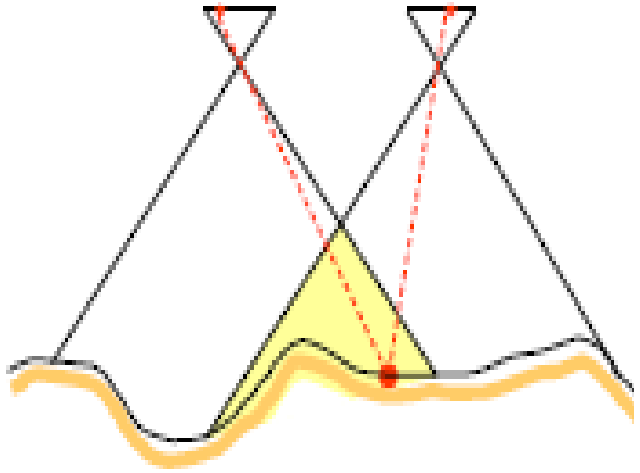
2D → 3D Why?

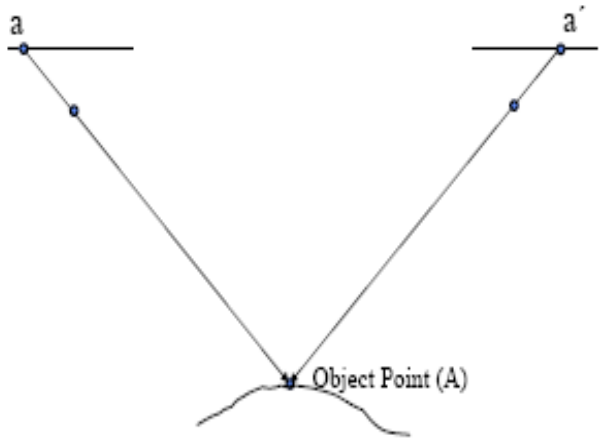
Can you used aerial photograph as a map directly?



The photo scale is different at the tops of the buildings than at the street level. The tops of the building are displaced radially outward relative to their location at the center.

How to prepare maps from Aerial Photographs?





3D

Real World

Central Projection

Aerial Photo -2D

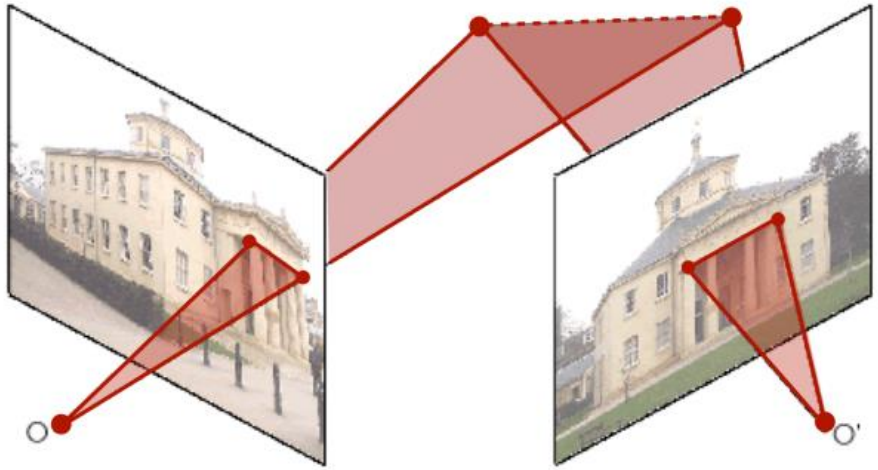
Ground Model -3D

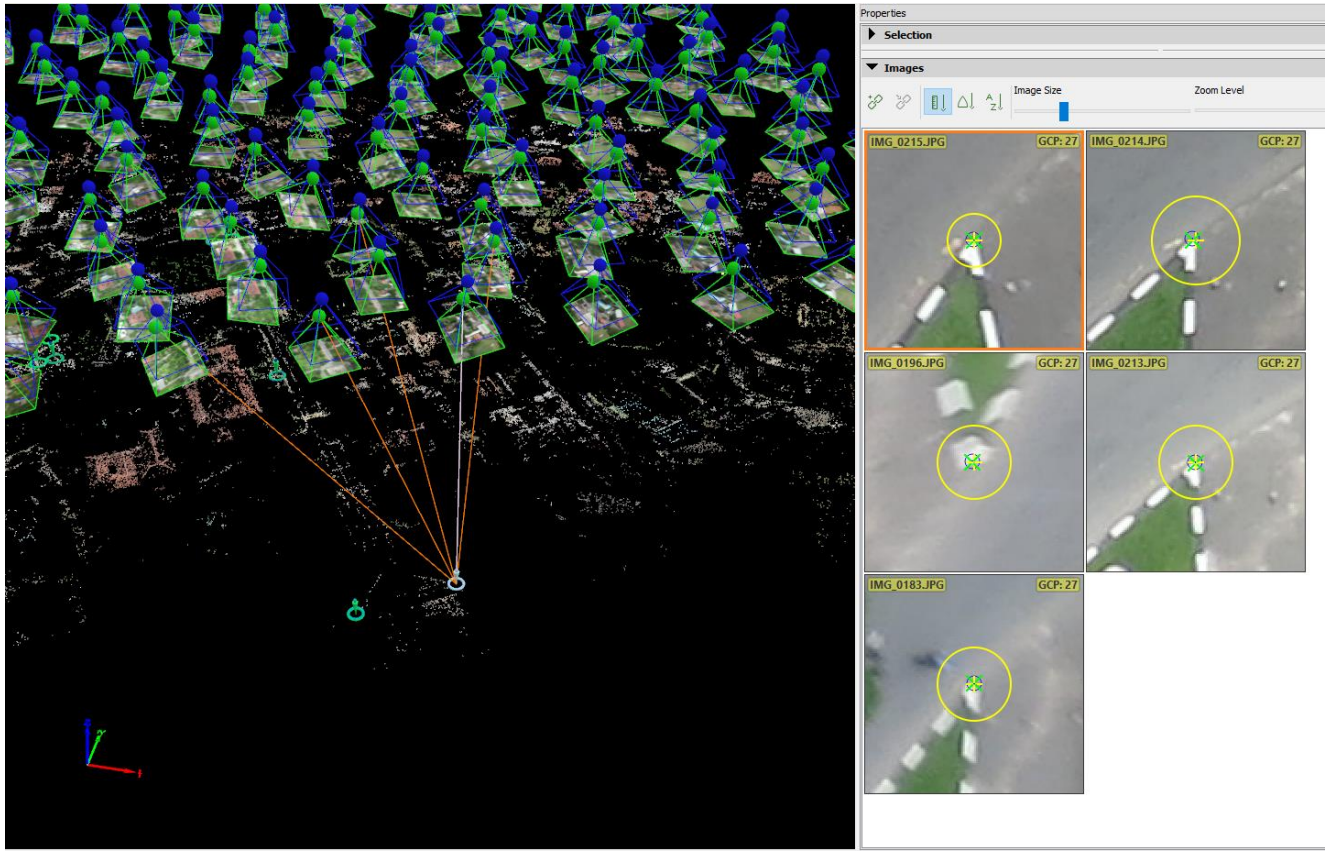
Orthogonal Projection

Map -2D

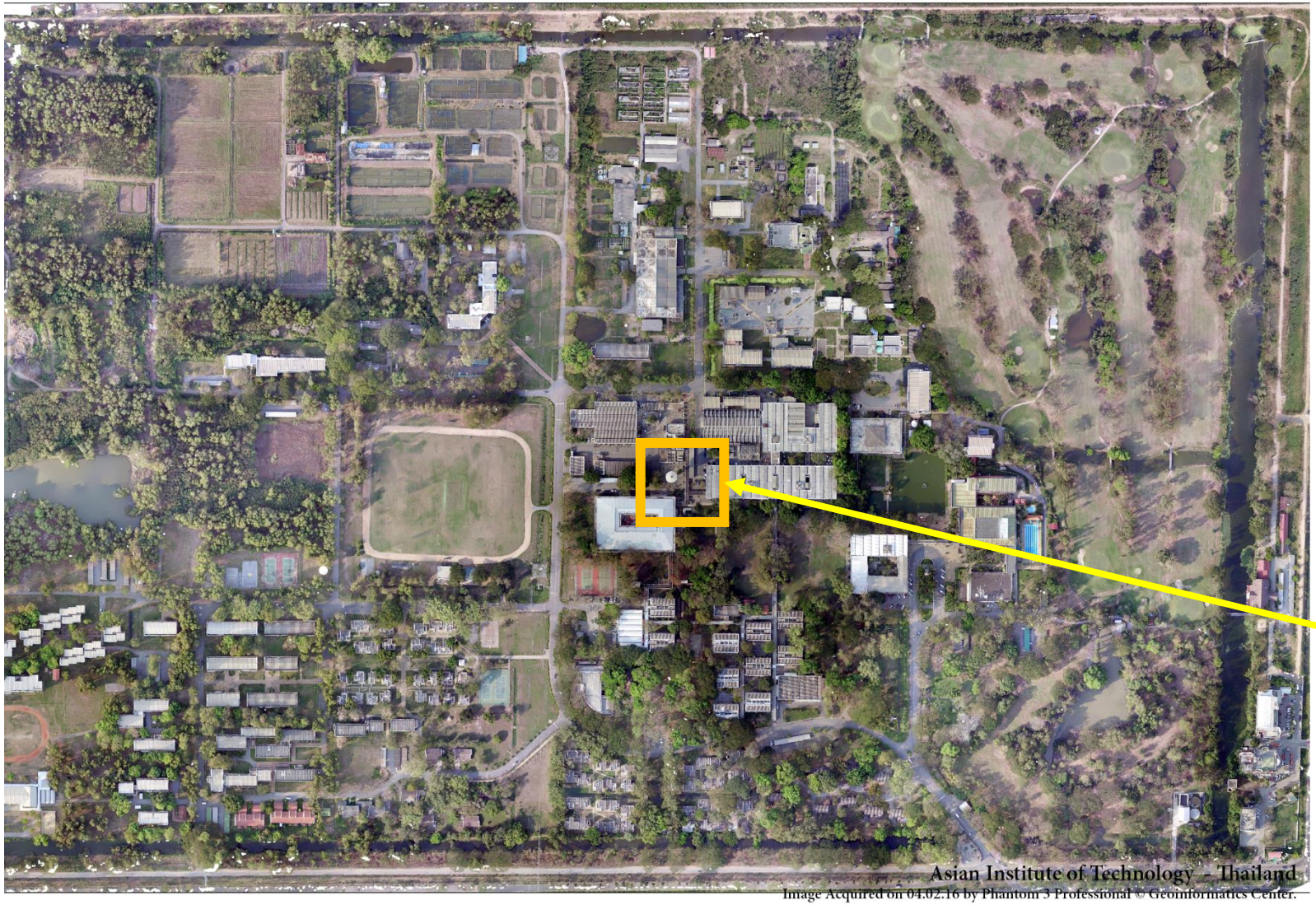
2D → 3D

Multiple observations from different directions allows for estimating the 3D location of points via triangulation

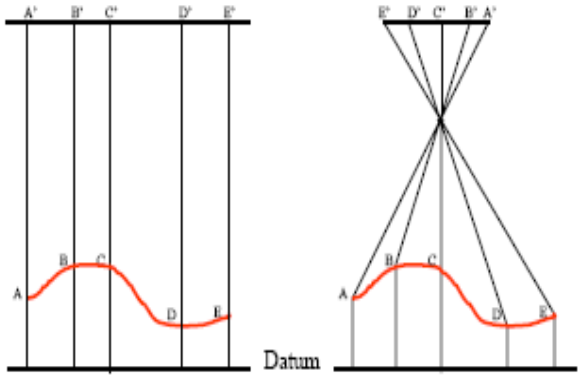


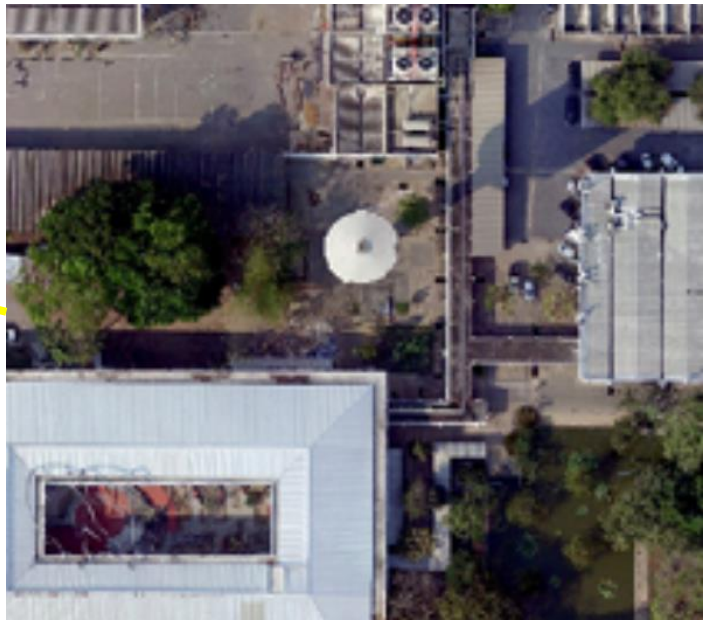


Orthoimages



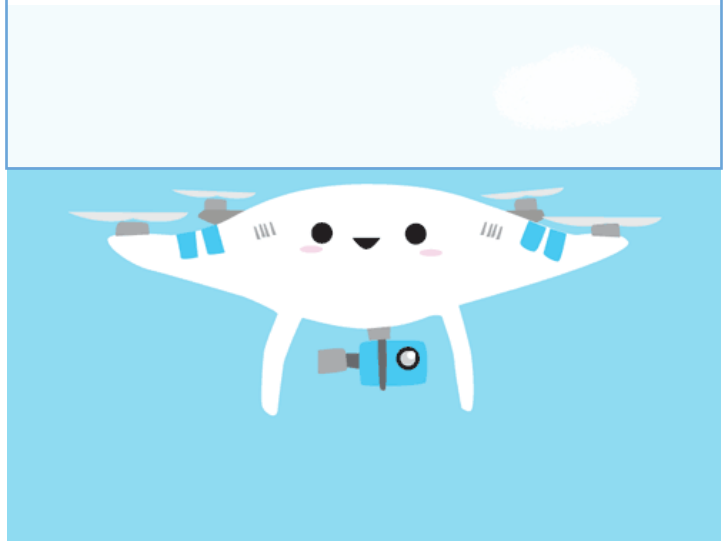
Orthogonal versus Central Projection





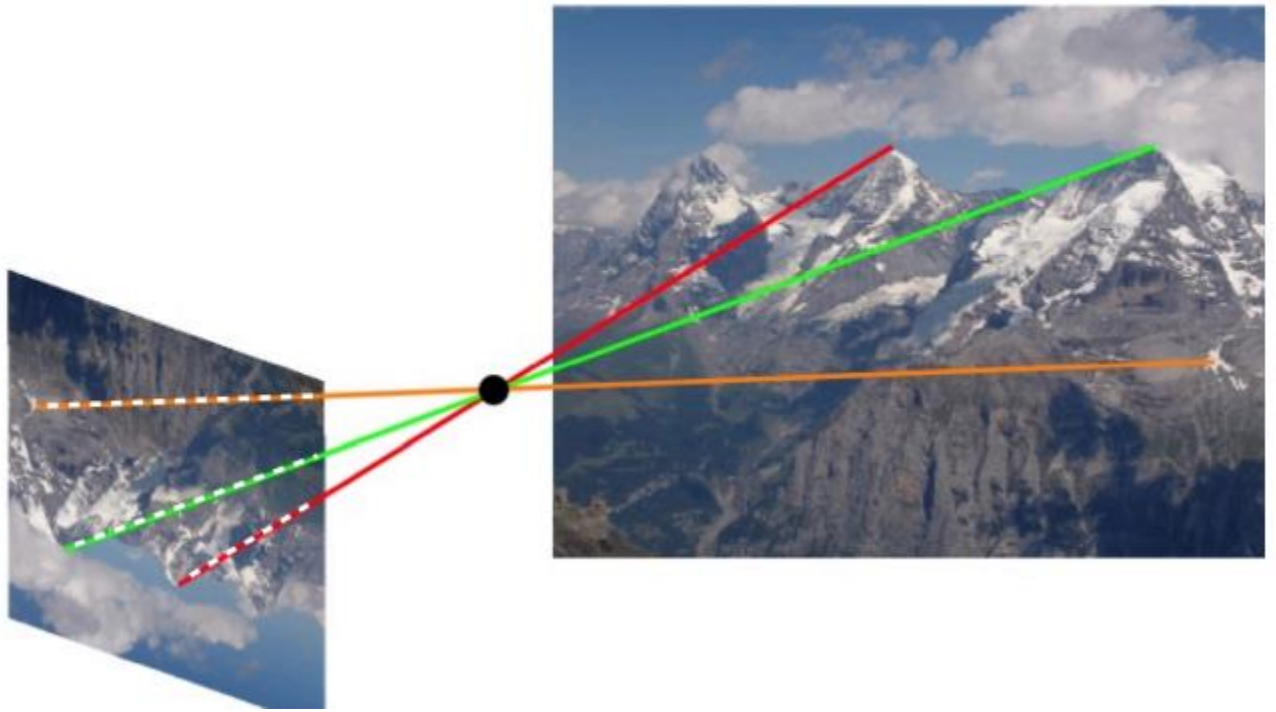
Drones for Mapping – How it Works

Drone	Camera	Algorithm
• Platform to carry imaging sensor through accurate flight path.	• Captures overlapping images while in motion	• Computer Vision + Photogrammetry • Extracts geometry through matches of thousands of key-points for generating accurate maps and 3D models.



Cameras to Measure Directions

An image point in a camera image defines a ray to the object point



Cameras for Drones

- Consumer grade cameras
  - Point and shoot cameras
  - Mirrorless cameras
  - DSLR (heavy payload; not much conventional)

Sony WX – Default camera for eBee

Sony A6000

Canon EOS 5D

- Multi Spectral Cameras
  - Parrot Sequoia

Drones for Mapping – How it Works

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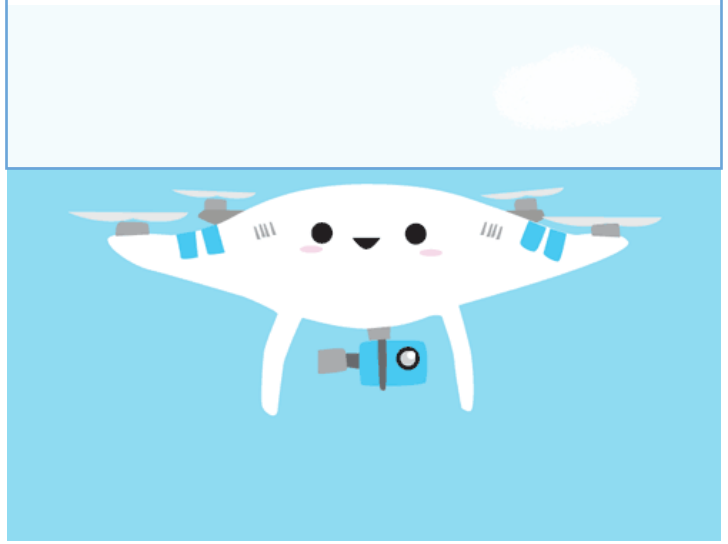


General Workflow of UAV Mapping

Flight Planning

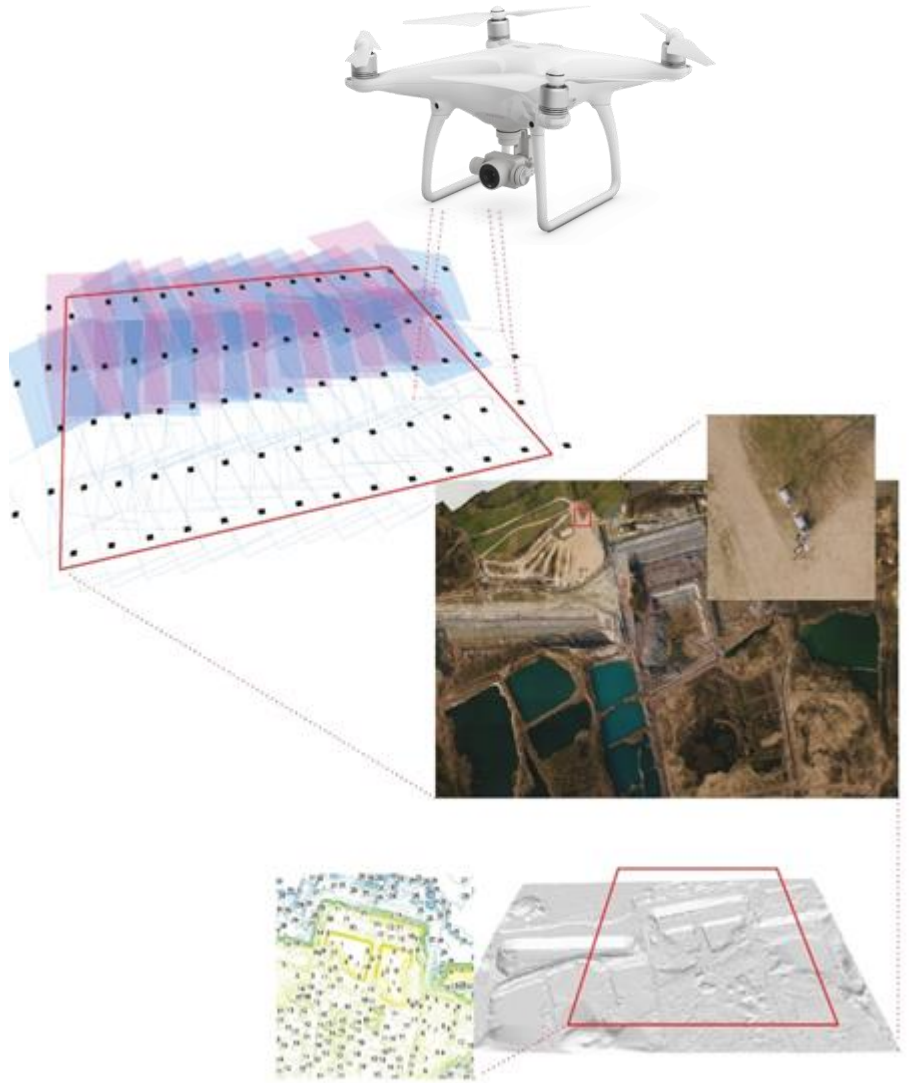
- Fight Map
- Specifications

Image Acquisition + GCPs

Photogrammetric Processing

- Camera Calibration
- Sparse Cloud Generation
- Dense Cloud Generation
- Mesh
- Texture

Orthoimage, DSM and 3D Model Generation



General Workflow of UAV Mapping

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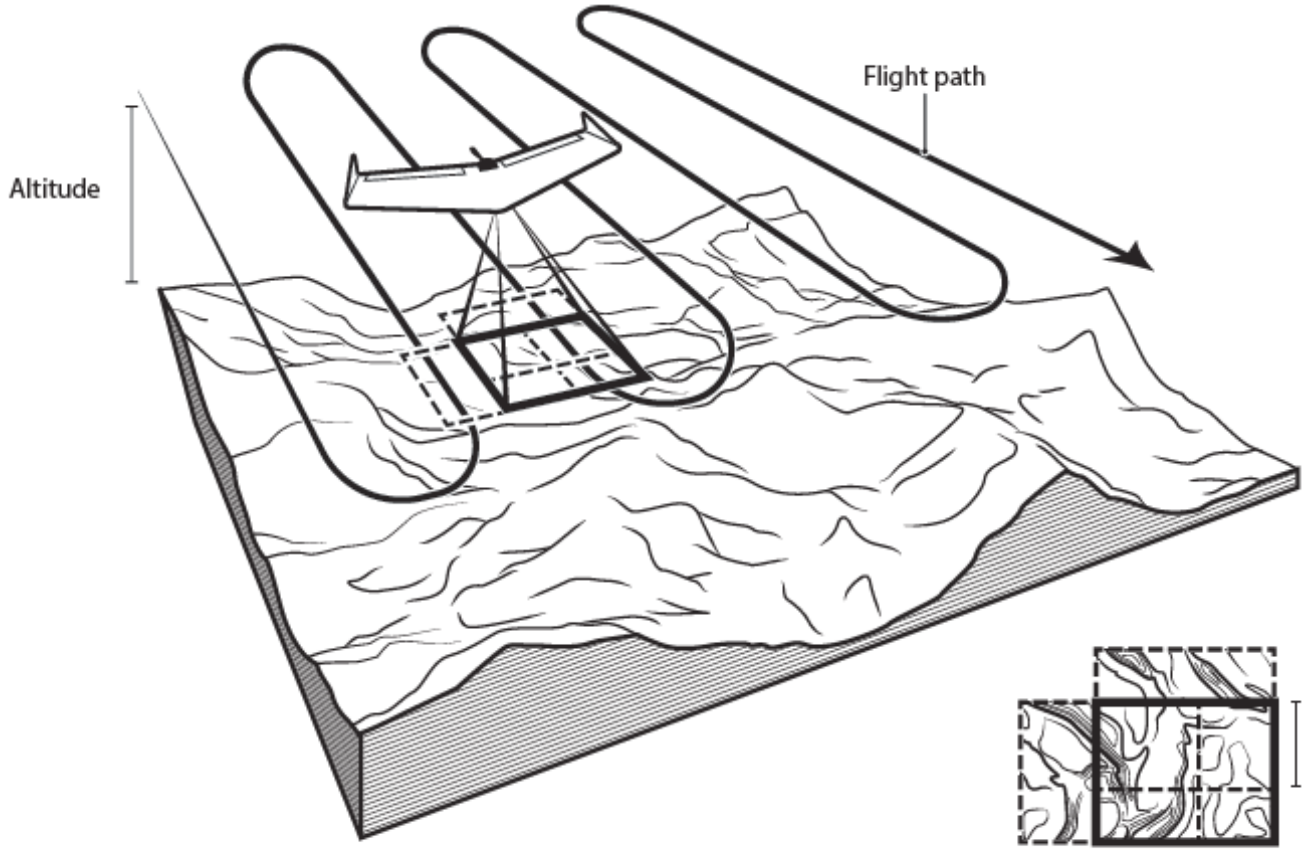
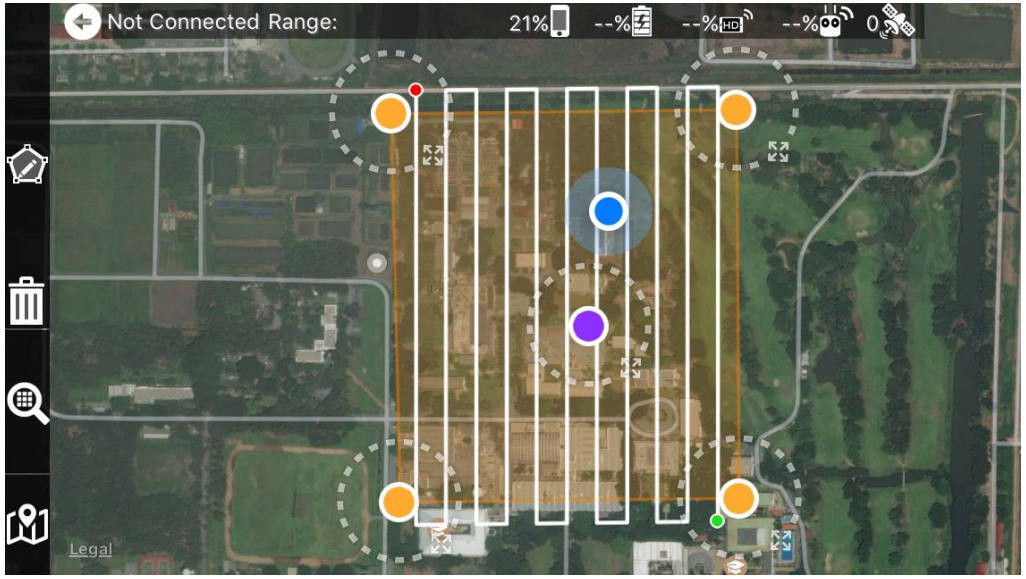
Orthoimage, DSM and 3D Model Generation

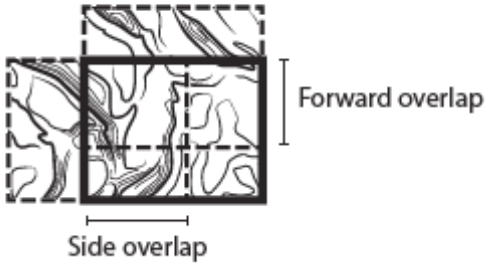
Flight Planning

- Flight Map - where the photographs are to be taken
- Specifications - which outline how to take them

Flight Alignment

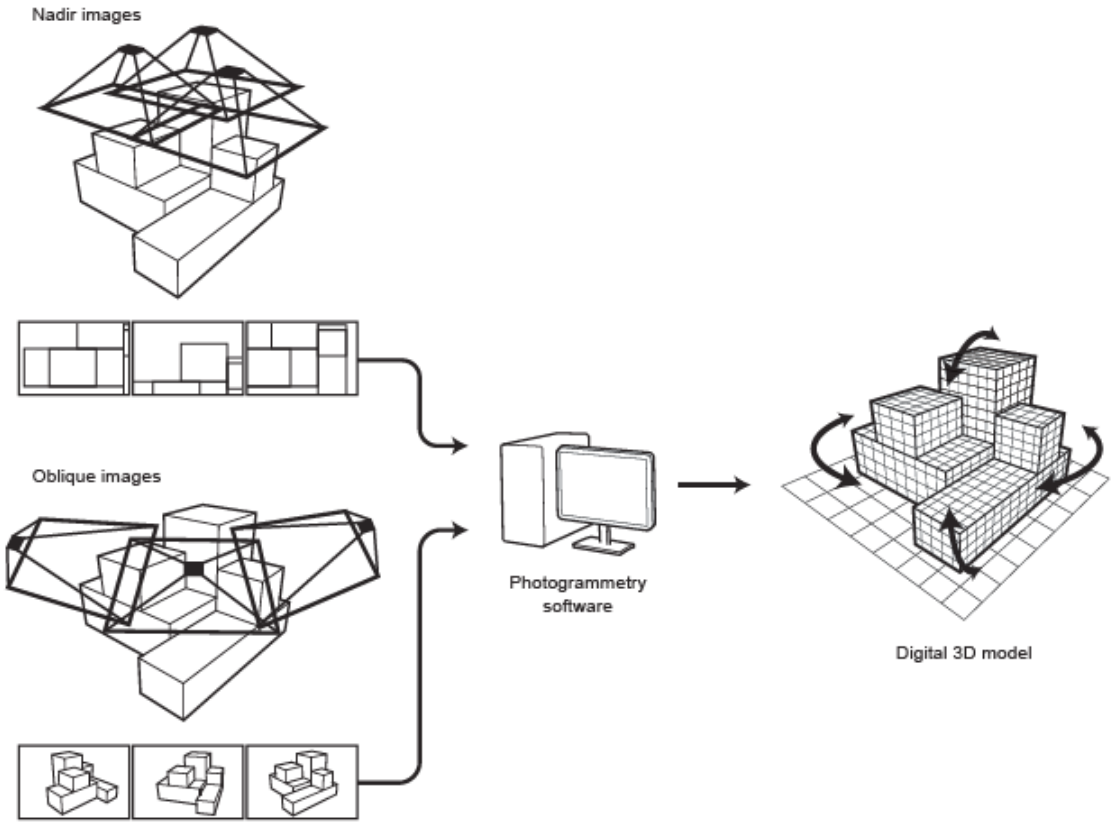






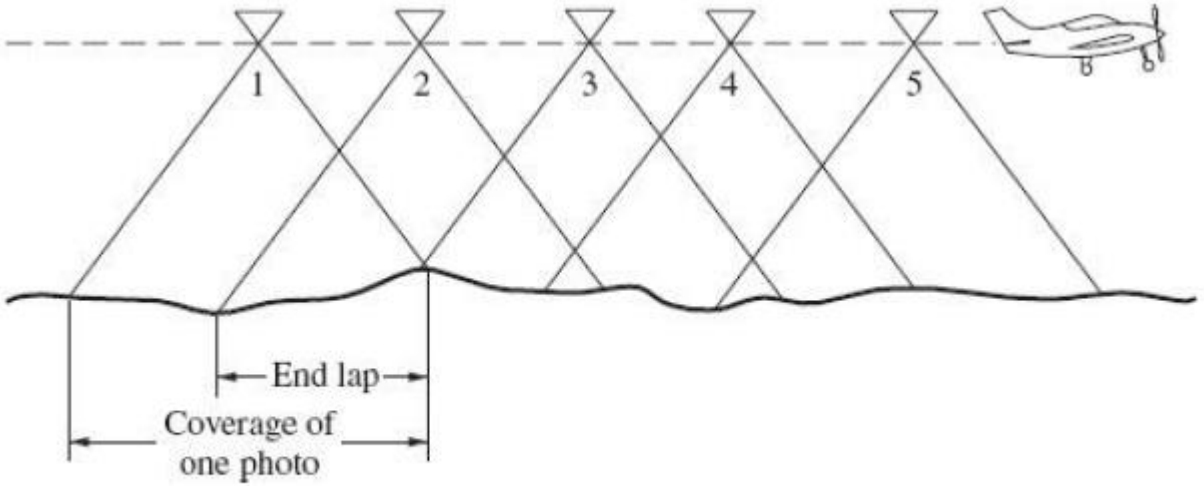
Flight Alignment

- Highly dependent on your application
- Ex: 3D modelling

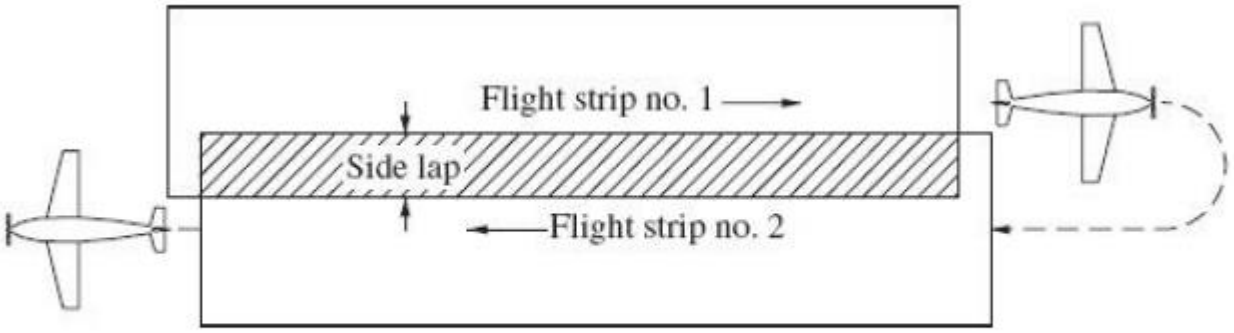


Photogrammetry software combines information from multiple images taken from both overhead and to the side to create 3D models.

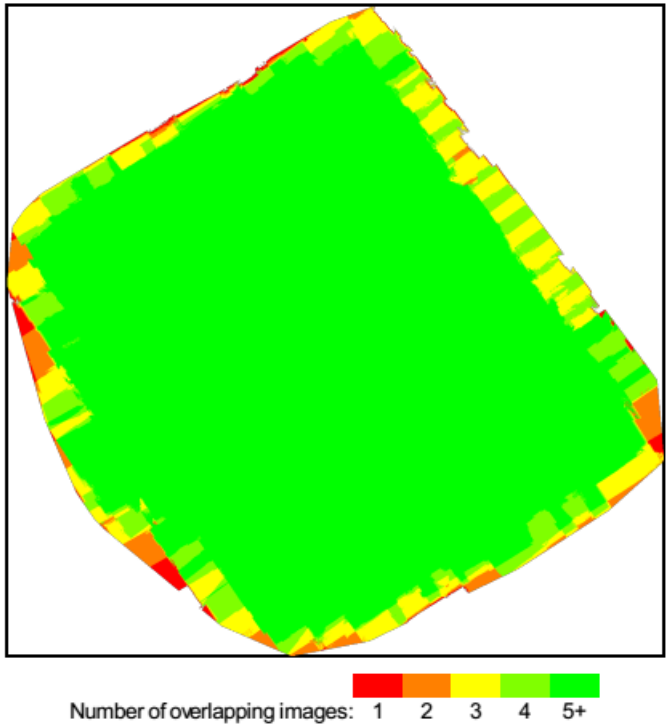
Photographic End & Side lap



End lap of photographs in a flight strip.



Side lap of adjacent flight strips.

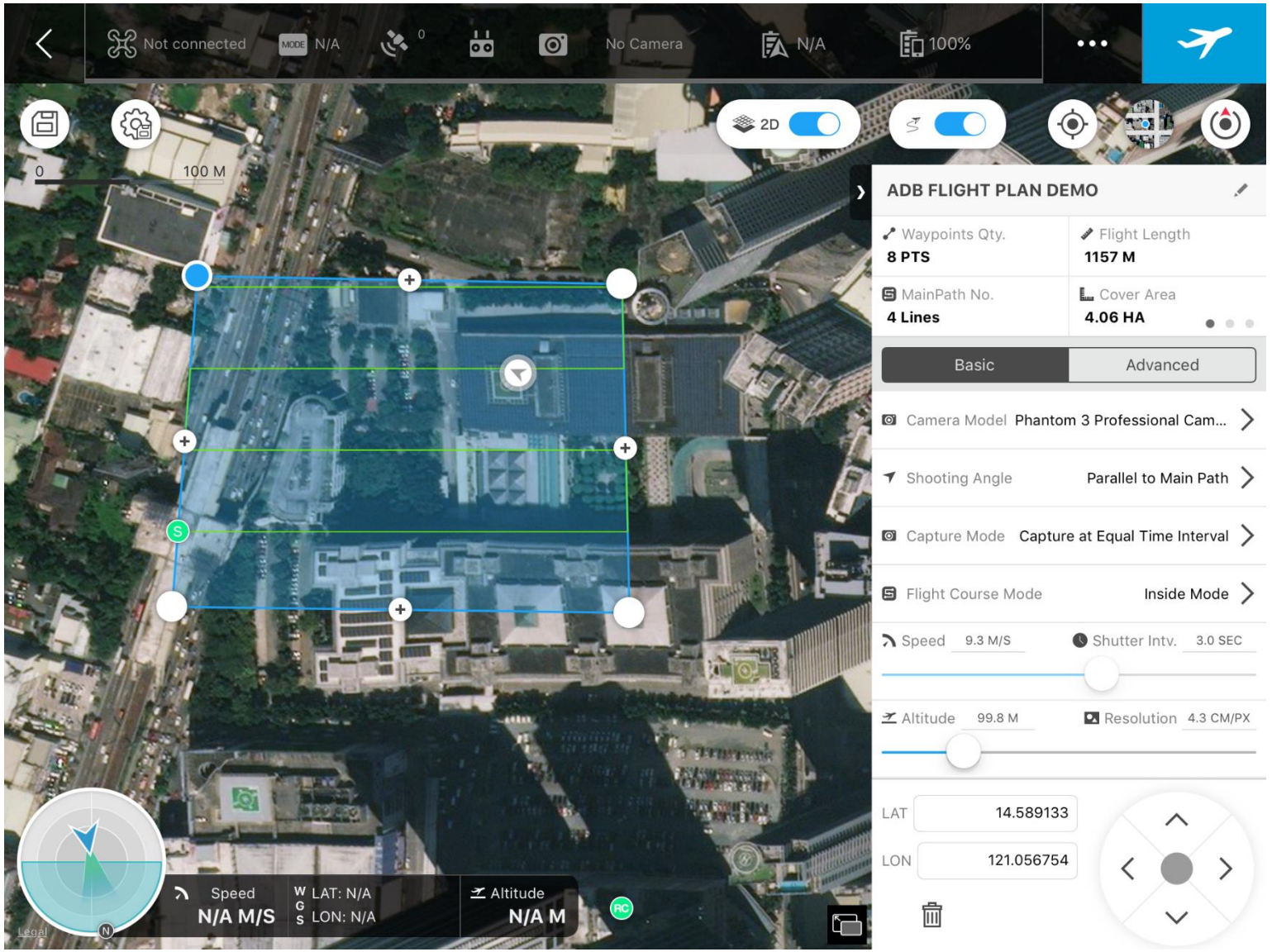


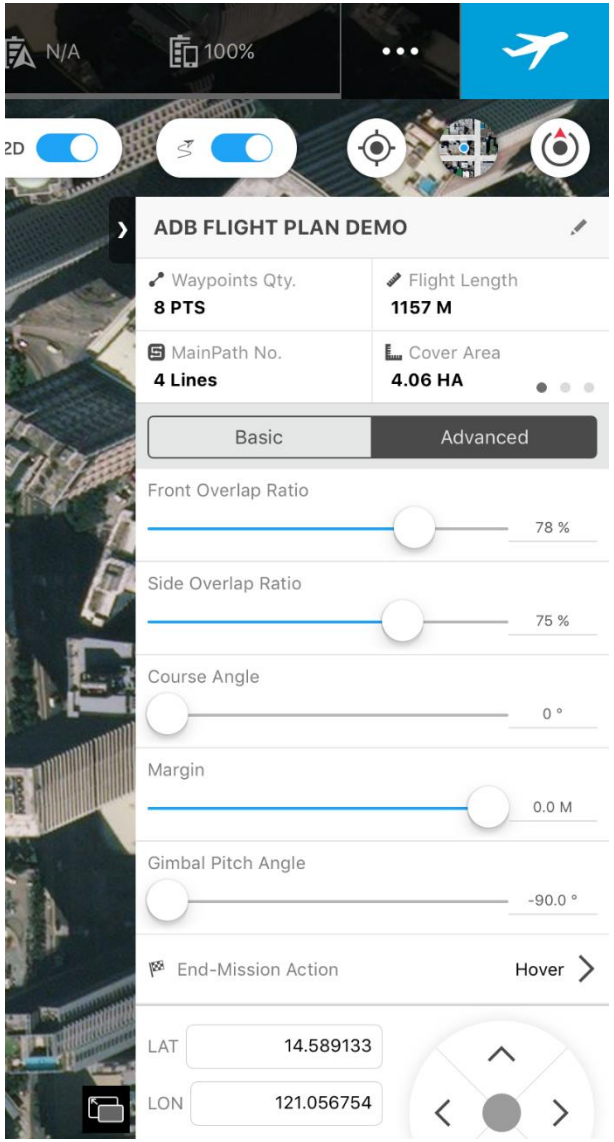
80% Fw Overlap and 70% Side Overlap of Phantom 3 images @100m AGL

UAV Flight Planning

- As drones combines with GNSS and IMU devices; UAV Flight can be automated
- Todays flight planning software attempts to do as much of the computation heavy lifting as possible so you can worry about the on-site issues and not worry about the tech.
- Combine Features As
  - **Automatic Flight Path Generation and Execution** via waypoints
  - **Terrain Awareness**: Ensure Safe Flight and Constant Overlap
  - Base maps
  - Auto Take-off / Auto Land

UAV Flight Planning - Features





UAV Flight Planning

- Factors To Be Considered
  - UAVs are fling Low; Beware of Obstacles
  - Very Limited Flight Time

  - Understand the project goals clearly; Plan the mission accordingly
    - Flying Height
    - Image Overlap
    - Camera Selection
    - Flight Grid Placement
  - Clear idea of the area to be surveyed
    - Existing satellite images (Google earth) or aerial images can be used for reconnaissance

Flight Planning Software for DJI Drones

- Map Pilot for DJI: https://support.dronesmadeeasy.com/hc/en-us/categories/200739936-Map-Pilot-for-iOS
- Pix4D Capture: https://pix4d.com/product/pix4dcapture/
- DJI Ground Station Pro: http://www.dji.com/ground-station-pro

General Workflow of UAV Mapping

Flight Planning

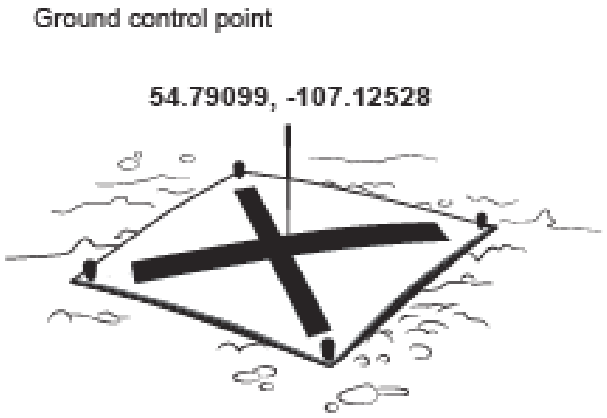
Image Acquisition + GCPs

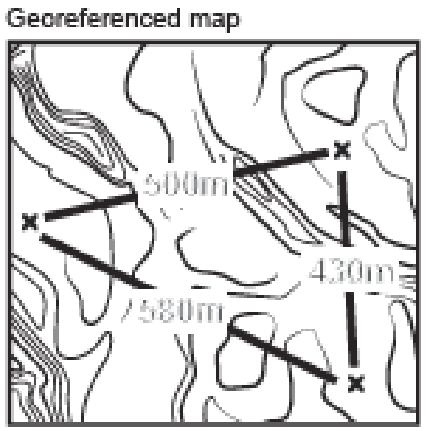
Photogrammetric Processing

Orthoimage, DSM and 3D Model Generation

Image Acquisition

GCPs

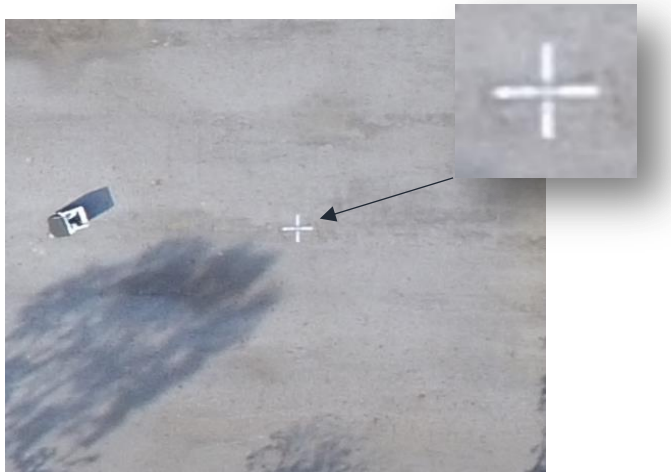




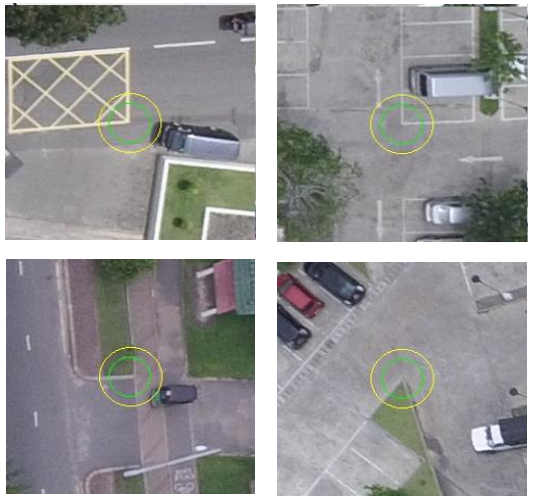
Accurately surveyed ground control points are used to georeference ortho-mosiac maps produced from UAV imagery.

GCP Design

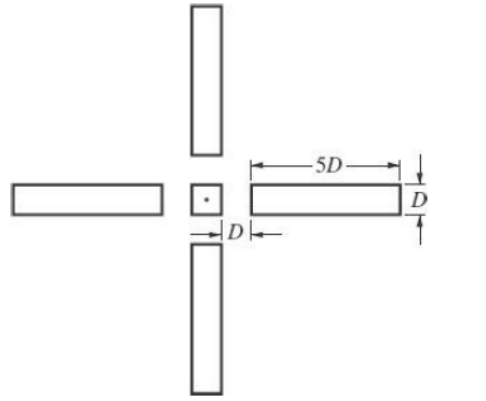
- GCP is any point whose positions are known in an object-space reference coordinate system and whose images can be positively identified in the photographs.
- GCPs must be
  - sharp, well defined, and positively identified on all photos
  - must lie in favourable locations in the photographs



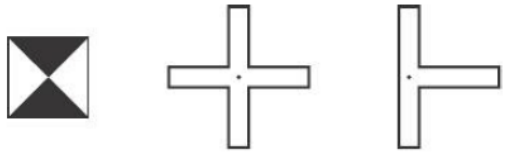
Artificial GCPs



Natural GCPs



Artificial photogrammetric target.



Other common artificial targets.

GCP Innovations

- Smart GCPs : https://www.propelleraero.com/aeropoints

Introducing AeroPoints

The world's first smart ground control points

WIRELESS CONNECTIVITY

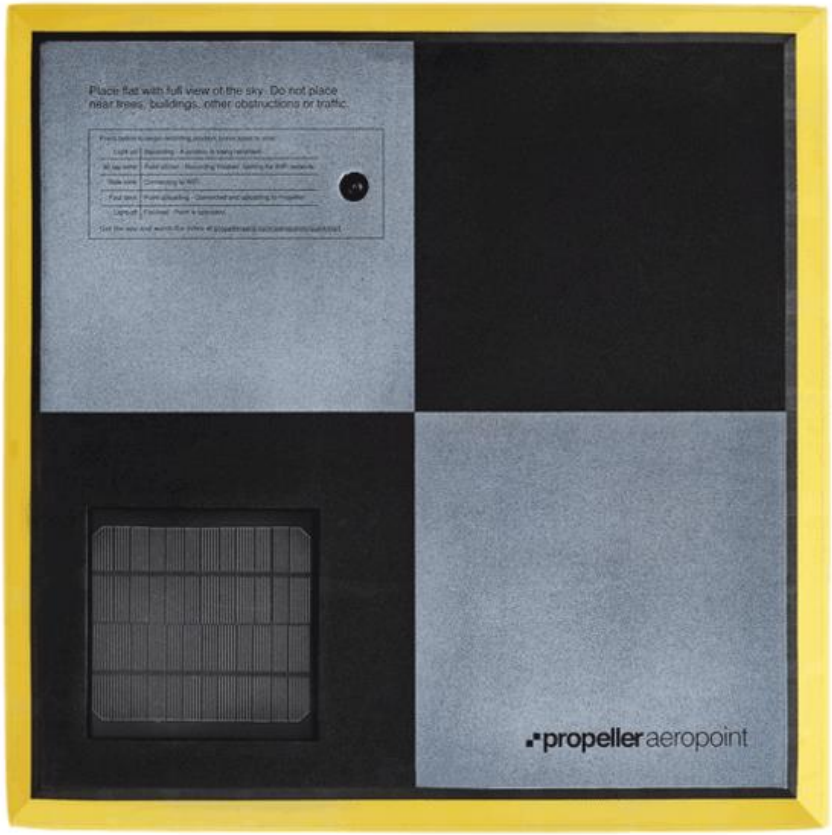
One-button activation lets you use a wifi connection or a mobile hotspot to upload position data.

FULLY SOLAR POWERED

With a powerful solar panel, AeroPoints will never run out of batteries while capturing position data.

EXCEPTIONAL DURABILITY

AeroPoints are waterproof, shock and weather resistant. Their $LiFePO_4$ batteries are high temperature, impact, puncture and aviation safe.



INCREDIBLE ACCURACY

Inbuilt PPK gives you global/absolute accuracy down to 2cm.

VISUAL GROUND CONTROL

Our tested checkerboard pattern is visible from the air and won't blow out on overexposed photos

SPEED & INTEGRATION

Our processing servers will have precision points ready - usually just minutes after uploading.

Methodology

Flight Planning

Image Acquisition + GCPs

Photogrammetric Processing

- Camera Calibration
- Sparse Cloud Generation
- Dense Cloud Generation
- Mesh
- Texture

Orthoimage, DSM and 3D Model Generation

Photogrammetric Processing

Done by Pix4D

Initial Processing

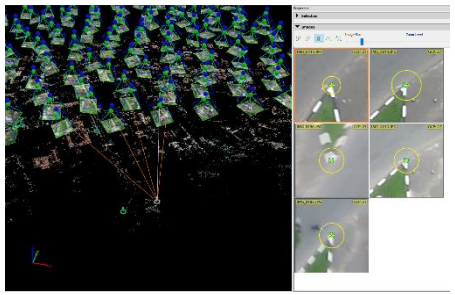
- Camera Intrinsics + Extrinsics
- AAT + BBA
- Undistorted Images

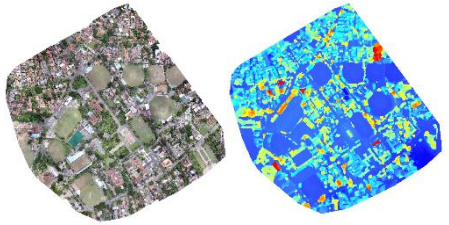
Point Cloud and Mesh

- Densified Point Cloud
- 3D Textured Mesh

DSM and Orthophoto

- Raster DSM
  - Contours
- Orthophoto
  - Google maps Tiles
  - Mapbox Tiles





General Workflow of UAV Mapping


Thank You


ADB
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Results
3D Model