Aerial Triangulation

Aerial triangulation (AT) is the task of estimating 3D location of points using aerial images as well as the camera parameters.

AT is a method for producing maps by overlapping aerial images.

AT establish precise and accurate relationship between the individual image coordinate systems and a defined projection.

For each block , the flight is done taking GSD & GCP into account.

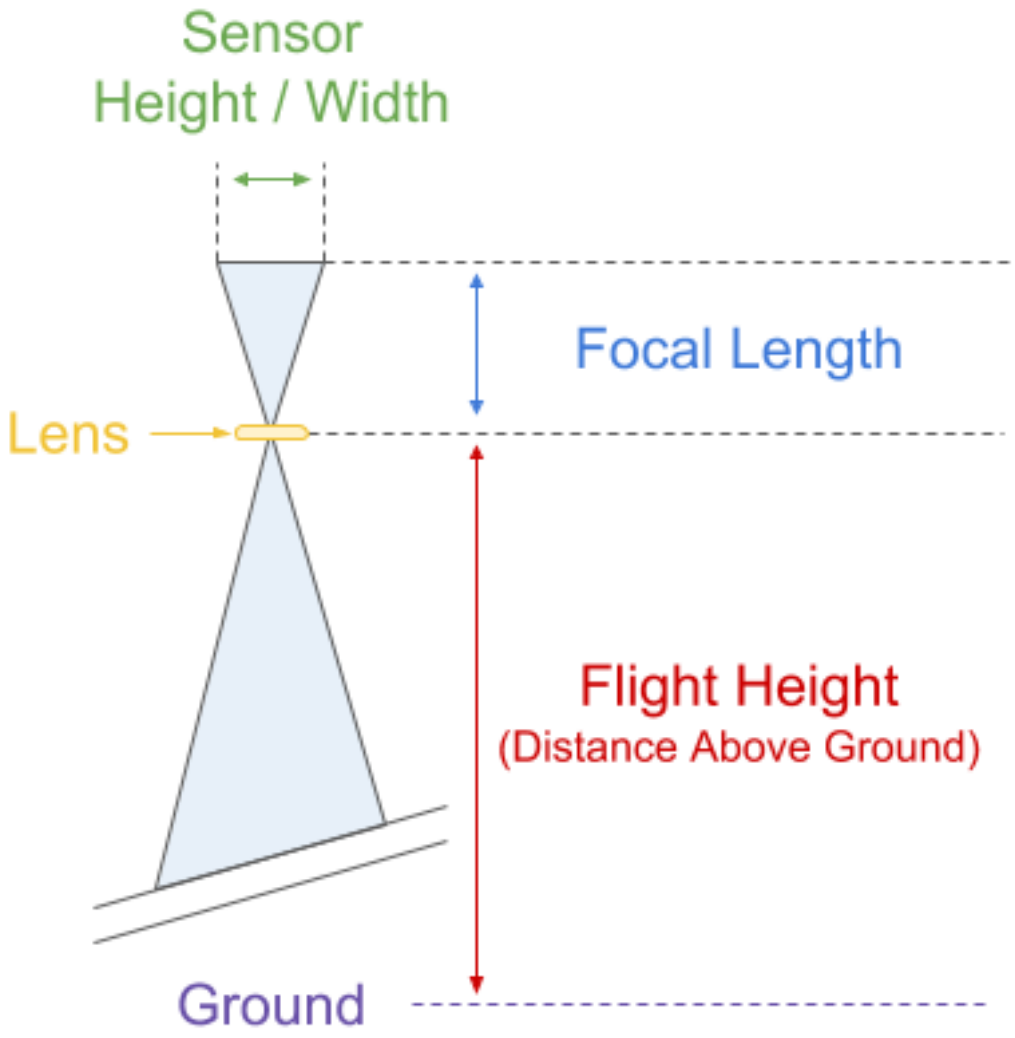
- GSD : The Ground Sample Distance (GSD) is the distance between the center points of each sample taken of the ground. In simple terms , the GSD is how big each pixel on the ground .

- Digital images are grids of colored squares (pixels) , much like chess boards.
- Way you can strike balance between :
- 1) Flying low enough to keep the GSD smaller
- 2) Flying high enough to keep photo count reasonably low

- Calculate GSD :

- GSD(h) = (Flight Height * Sensor Height) / (Focal length * Image Height)

- For width replace image Height with image width , we get GSD(w)



- GCP : Ground Control Points(GCPs) can be an invaluable tool for aerial mapping . When used correctly can give high degree of global accuracy

  They are used 1) When high accuracy required 2) if want to provide measurement in certain area of range.

- Minimum 4 GCPs are requires , but 8 GCPs for 50 acres would be a correct choice. GCPs should distributed entirely even on the map. Each GCPs must be visible in atleast 4 images.

- **To Construct a GCP :** There is no right way to construct GCP. One thig must be sure that it should be visible so use high contrast color. Generally recommended flying at 300 feet with frontlap and 70/75 with sidelap when using GCP

The quality control of aerial traingulation is done by assuring the working steps completeness and the final result accuracy:

- The relative orientation is satisfactory for all images in a block.
- The residual of AT compensation are smaller than 1.2*pixel image size
- RMS value are less than 0.8* pixel image size
- The Sigma0 value is situated in the interval of 1/3 and ¾*pixel image size
- RMSxy and RMSz for GCPs are smaller than the final GSD of the block.

BUNDLE ADJUSTEMENT

- Bundle adjustement is state estimation of object in the environment(3D points) has been estimated from camera images, along where the camera was while taking images(6DOF camera orientation)
- It boils down to minimum reprojection error between image of locations of observed and predicted image points, which is expressed as the sum of squares of a large number of non-linear, real valued functions. Thus, the minimization is achieved using nonlinear least-squares algorithms
- Lavenberg-Marquardt algorithm also known as damped least square problems is most successful in explaning it.

Multi View Stereo reconstruction : Multi frame stereo consist of reconstructing the 3D shape of a scene from collection of images from different points.

Reconstruction from Silhouettes :

(Silhouettes ---> image usually black with its edges matching the outline of the subject)

Approach

- Backproject each silhouettes
- Intersect backprojected volumes

Pros

- Easy to implement,, fast

Cons

- Require identification of silhouettes
- Not photo consistent

NCC(Normalized Cross Correlation)

SSD(Sum Squared Distance)

PIDAL is Point Data Abstraction Library .It is a C/C++ open source library and applications for translating and processing point cloud data. It is not limited not LIDAR data(method for determining ranges by targeting an object with laser and measuring the time for reflected light to the receiver).

- PDA allows you to compose operations on point clouds into pipeline of stages. These pipelines can be written in a declarative JSON Syntax or constructed using the available API
- Python supports PDAL, allow geospatial practitioners in a more comfortable and familiar language environment.
- PDAL doesn't provide a friendly GUI interface

GIDAL Geospatial Data Abstraction Library is a translator library for raster and vector geospatial data formats. As a library iit presents a single abstract data model and single vector abstract data model. It also comes with a useful variety of commands for data processing and translation.

Installing GDAL in already running CONDA:
conda install –c conda forgegdal=2.1.3

Structure from Motion

- Structure from Motion(SFM) is to determine the spatial and geometric relationship of the target through the movement of the camera , which is a common method of 3D reconstruction .
- It needs an RGB Camera so the cost is lower and the environment is less restricted.
- SFM is based on same principle of stereophotogrammetry, traingulation is used to calculate the relative 3D positions(x,y,z) of objects from stereo pairs

- To create 3D reconstruction one simply needs many images of an area or an object with a high degree overlap, taken from different angles. Specialized software packages automatically identify matching features. These features are tracked from image to image and are used to produce estimates of the camera positions and orientations and the coordinates of the features. This produces a point cloud of x,y,z coordinates for features.
- The 3d points clouds are often generated in a relative "image space" coordinate system but can be aligned to a real world coordinates system using GCPs and geo-refrenced imagery.