





# AERIAL TRIANGULATION

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## Aerial triangulation

- Aerial triangulation is the term applied to the process of determining x,y and z Ground coordinate of individual points on measurements from the photograph.
- The principal application is in extending Ground control through strip or block of photo for use in subsequent photogrammetric operation.

## Benefits of Aerial Triangulation


- Minimizing delays and hardships due to adverse weather condition.
- Access to much of the property within the project area is not required.
- Field surveying in difficult area, such as Marshes, Extreme slope, hazardous rock formation, etc; can be minimized.

## Method of Aerial Triangulation

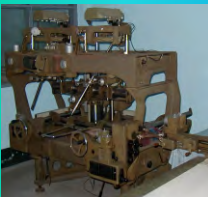
Aerial Triangulation is classified three categories.



- Analogue Aerial Triangulation
- Semi Analytical Aerial Triangulation
- Analytical Aerial Triangulation

## Analytical Aerial Triangulation

Analytical Aerial Triangulation tends to be more accurate than Analogue or semi analytical analogue aerial triangulation.



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## Materials to be performed Aerial Triangulation

- Index map of Aerial photos
- Digital Aerial image data
- Results and Descriptions of Ground control Points
- 3D-airborne position data File of Aerial photo
- Elements of Aerial Camera

Parameter of aerial camera	
Type and Name	Leica RC-30
Focal distance	153.19mm
Mutual Data	Less than 10 μ
Distortion	Less than 0.1 μ
Offset of GPS antenna	Corrected Position



$d$  - offset of antenna

## Aerial Triangulation Index Map

Two block of Aerial Triangulation were performed using the block adjustment program

Zone - 46

Zone - 47

The whole study area composed of 1,100 models.

## Digital Aerial Image Data

## Result and Description of Ground Control Points

Point	UTM Zone 46		UTM Zone 47		Elevation
	Northing	Easting	Northing	Easting	
GC01	1842 822 011	230 810 752			6.630
GC02	1860 071 873	208 247 937			6.619
GC03			1892 271 877	209 244 938	6.649
GC04			1870 768 020	204 243 977	6.560
GC05			1868 765 073	207 243 981	6.520
GC06			1890 740 810	248 240 832	7.066
GC07			1897 242 776	223 241 288	2.874
GC08			1854 807 872	233 240 649	2.217
GC09			1858 806 796	243 240 649	6.889
GC10			1820 070 816	238 240 748	6.207
GC11			1844 874 888	208 241 854	2.816
GC12			1890 743 816	232 241 934	7.958
GC13	1818 184 000	268 248 231			6.231
GC14	1818 275 148	268 268 084			6.200
GC15			1870 825 738	233 241 947	2.833

DESCRIPTION OF PICKING POINT

Point No.	Station No.	Station Name	Station Type	Station Class	Station Date
GC01	47	Station 1	Control	3rd	2010/05/01
GC02	47	Station 2	Control	3rd	2010/05/01
GC03	47	Station 3	Control	3rd	2010/05/01
GC04	47	Station 4	Control	3rd	2010/05/01
GC05	47	Station 5	Control	3rd	2010/05/01
GC06	47	Station 6	Control	3rd	2010/05/01
GC07	47	Station 7	Control	3rd	2010/05/01
GC08	47	Station 8	Control	3rd	2010/05/01
GC09	47	Station 9	Control	3rd	2010/05/01
GC10	47	Station 10	Control	3rd	2010/05/01
GC11	47	Station 11	Control	3rd	2010/05/01
GC12	47	Station 12	Control	3rd	2010/05/01
GC13	47	Station 13	Control	3rd	2010/05/01
GC14	47	Station 14	Control	3rd	2010/05/01
GC15	47	Station 15	Control	3rd	2010/05/01

## Airborne GPS support Aerial triangulation

Airborne GPS support Aerial triangulation was performed in order to get equal precision as usual by less number of ground controls.

## Trails of airplane by GPS observation

3D positions are observed by GPS continuously every 1 second

GPS Antenna

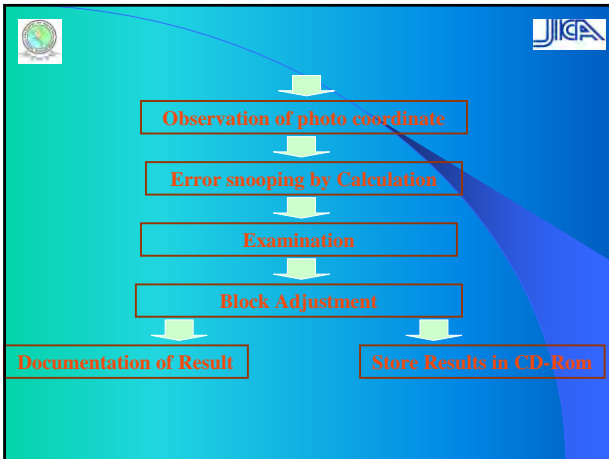
Ground control

GPS loaded airplane for photography

## Procedure of Aerial triangulation

```

    graph TD
      A[Preparation] --> B[Input of Control Points and Exposure station]
      B --> C[Input of Aerial Photo Image]
      C --> D[Execution of Inner Orientation]
  
```



## Orientation Parameters

6 elements  
Position of aerial camera and inclination of axes as  $(l, x, d), (b, \alpha, \gamma)$

## Inner Orientation

Inner orientation is performed to locate the aerial photo by using fiducial mark.

## Relative Orientation


Relative orientation provides a convenient means of checking most point making and photogrammetric measurement.

## Pass-points and Tie-points

Pass-point and Tie-points are used to connect photos or models and strips.

## Block adjustment by bundle adjustment

The block adjustment is performed to transfer from photo coordinate system to object x,y,z coordinate system.





## Accuracy of adjustment of aerial triangulation

**Theoretical error of adjustment**

**Plane position -**  $x, y = 6 \mu$  (on photo)  
 $= 300\text{mm}$  (on ground)

**Elevation -**  $z = 0.006\%$  of altitude  
 $= 450\text{mm}$  (on ground)



## Adjusted errors of Horizontal Position

	Axis	Mean ERROR	Max. ERROR
Zone 46	X	0.602	1.686
	Y	0.628	1.547
Zone 47	X	0.378	0.678
	Y	0.585	1.058

Unit: m

Theoretical estimated error is 0.02% of the flight height.

Theoretical error on ground = 590mm





## Adjusted errors of vertical position

	Mean Error	Max. Error
Zone 46	0.006	0.023
Zone 47	0.007	0.019

Unit: m

The theoretical error of vertical position is 0.006% of flight height.




# THANK YOU VERY MUCH FOR YOUR ATTENTION!

