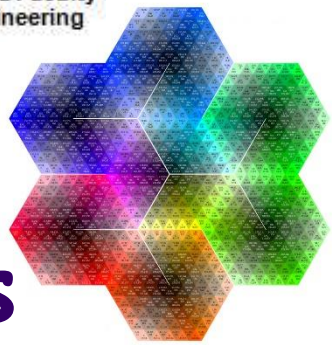
Benha University

Shoubra Faculty of Engineering

Photogrammetry 2B
Lecture 10:
Orthorectification and DEMs



Dr. Eng. Hassan Mohamed Hassan

Hassan.hussein@feng.bu.edu.eg

Geomatics Department

What is Orthorectification?

The process of correcting the image from systematic and non-systematic errors (distortions) that acquired from the image acquisition process is known as image orthorectification and registration

Orthorectification is a process of geometrically correcting an image so that it can be represented on a planar surface, conform to other images or conform to a map. That is, it is the process by which geometry of an image is made planimetric.

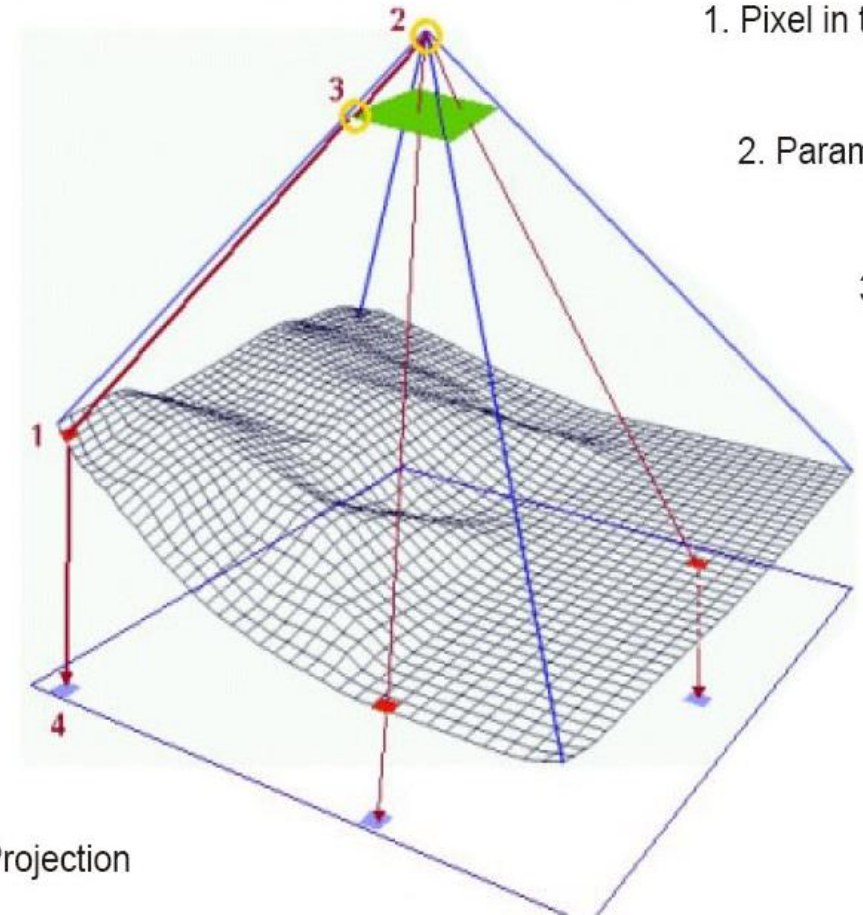
What is Orthorectification?

It is necessary when accurate area, distance and direction measurements are required to be taken from the imagery. It is achieved by transforming the data from one grid system into another grid system using a geometric transformation.

In order to accurately remove the image distortions, a digital elevation model (DEM) is used to perform image orthorectification. The required DEM is generated by feature extraction from high resolution stereo satellite imagery.

What is Orthorectification?

Orthorectification process of remote sensed Image data



1. Pixel in the DEM (Height)

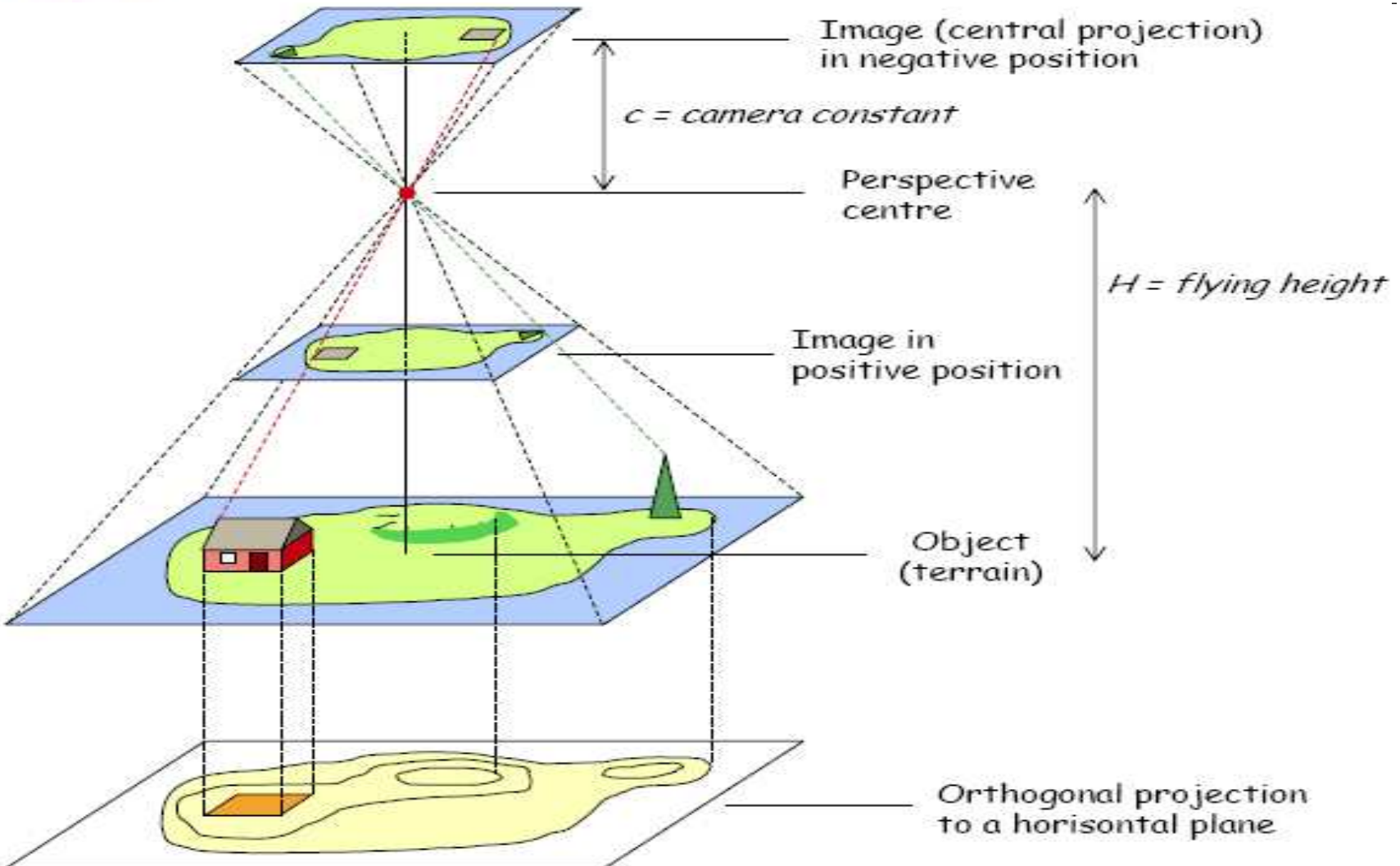
2. Parameters in the Exterior Orientation

3. In the image, a Brightness Value is determined based on the resampling of surrounding pixels

4. Height, Exterior Orientation information and Brightness Value used to calculate equivalent location in the orthoimage

Orthographic Projection

What is Orthorectification?



What is Orthorectification?

- The process of removing geometric error:

1- Camera orientation

2- Systematic error associated with camera/lens distortion etc.

3- Relief displacement

4- Earth curvature

5- Scan Skew

6- Mirror-Scan Velocity Variance.

Orthorectification Methods

- Generated by an elevation model (DEM) and an aerial photo. The elevation model can be generated by the same stereoscopic photographs, so no other source of data is needed.
- Shows photographic detail without errors caused by tilt and relief displacement.
- Orthographic projection rather than central perspective properties.
- An orthophoto combines the advantages of a map (constant scale, orthographic projection) and those of a photo (photographic realism and level of detail).

Orthorectification Methods

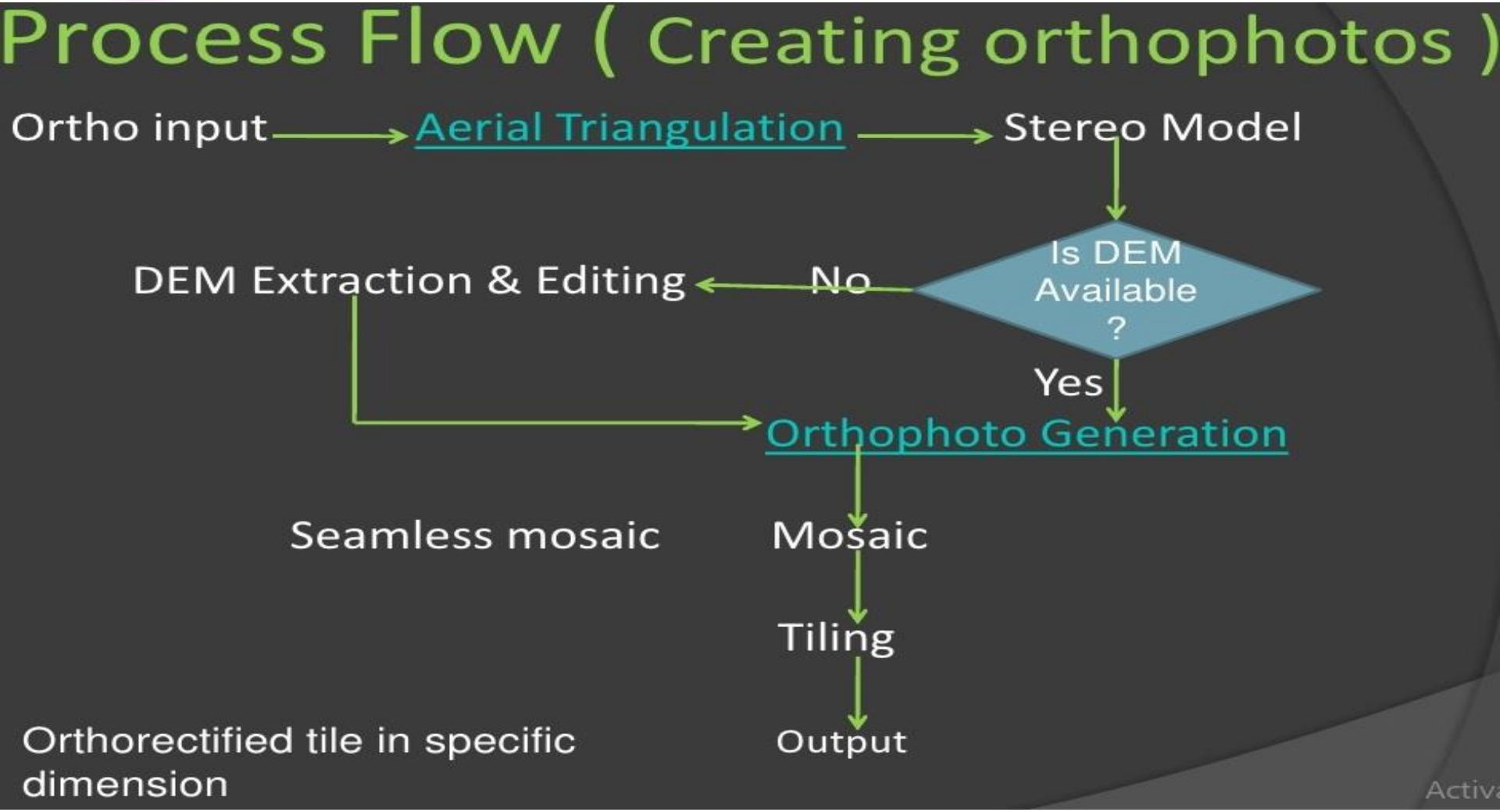
Ortho Input

Stereo Model

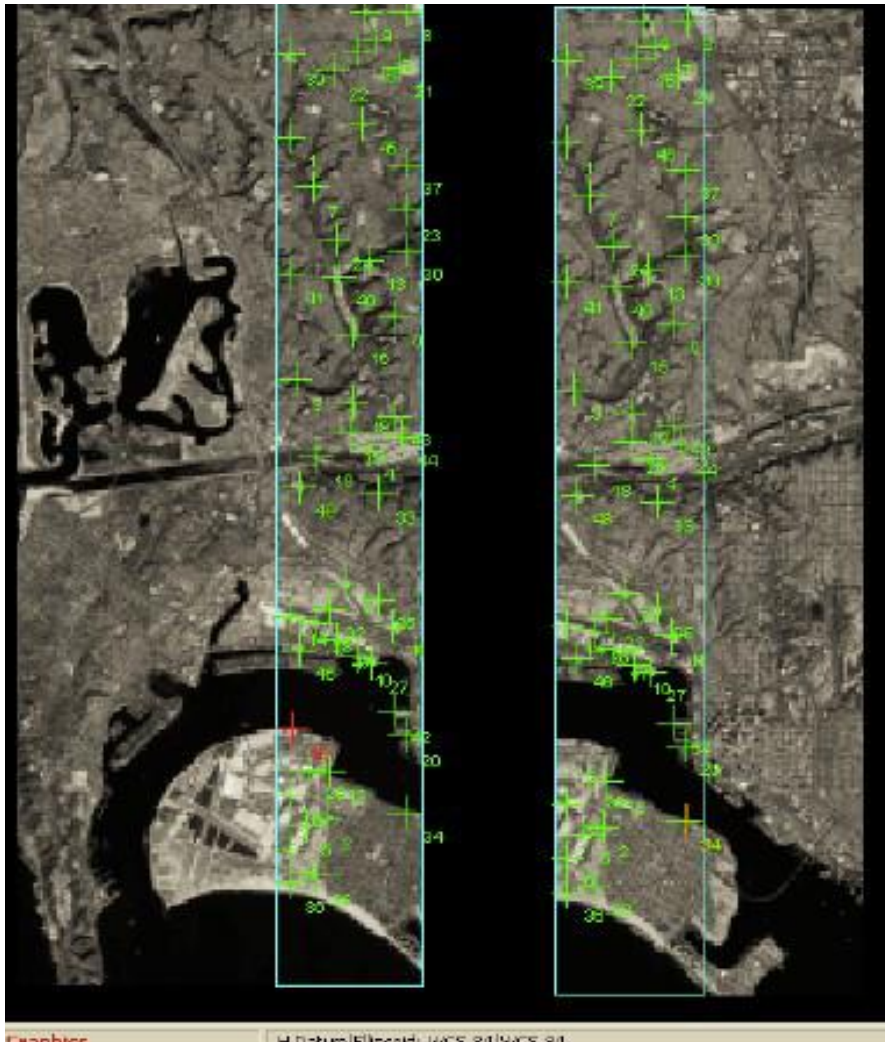
DEM Model

Orthophoto (output)

Orthorectification of Stereo images?



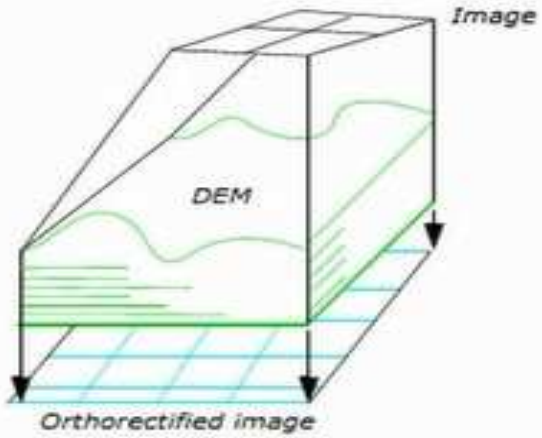
Orthorectification of Stereo images?



Orthorectification of single image?

The input data required for orthorectification process is the original image, an appropriate sensor model, GCPs, and a DTM or DEM.

The orthorectification process takes the raw digital imagery and applies a DEM and triangulation results to create an orthorectified image. Once an orthorectified image is created, each pixel within the image possesses geometric reliability. Thus, measurements taken off an orthorectified image represent the corresponding measurements as if they were taken on the Earth's surface.



Orthorectification of single image?

Usually, orthorectification is the conversion of data file coordinates to some other grid and coordinate system, called a reference system. Rectifying or registering image data on disk involves the following general steps, regardless of the application:

A) Locate GCPs

B) Compute and test a transformation

C) Create an output image file with the new coordinate information in the header. The pixels must be resampled to conform to the new grid

Orthorectification of single image?

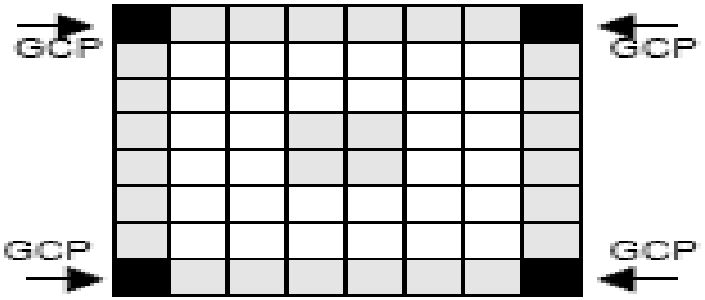
1- Three aspects are essential in the selection of GCPs (number, location and distribution).

2- Transformation may be one of the following types:

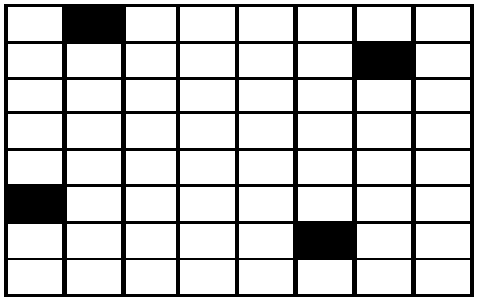
A. Polynomial Transformation.
B. Affine Transformation.
C. Projective Transformation.
D. Piecewise Transformation.
E. Digital Differential Rectification.
F. Direct Linear Transformation.

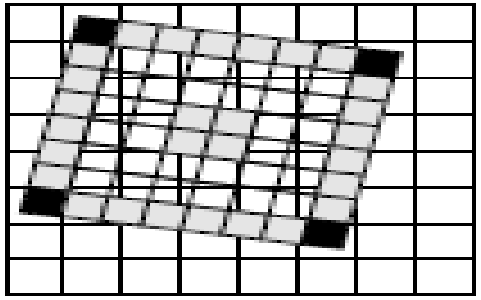
Orthorectification of single image?

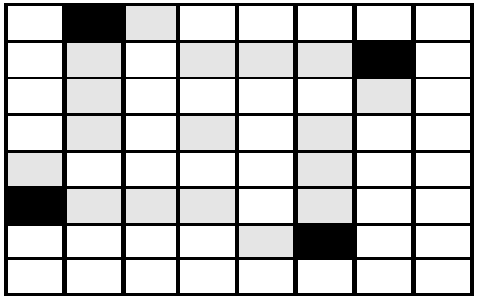
3- The Resampling Process: Nearest Neighbor or Bilinear or Cubic



1. The input image with source GCPs.


2. The output grid, with reference GCPs shown.


3. To compare the two grids, the input image is laid over the output grid, so that the GCPs of the two grids fit together.


4. Using a resampling method, the pixel values of the input image are assigned to pixels in the output grid.

Orthophotos examples

Regular orthophoto

True orthophoto

Regular orthophoto

True Orthophoto

True orthophoto often have problem with blind spots and missing data.

Orthophotos advantages

Alternative to line mapping

Larger flexibility

Shorter production time

Eye pleasing document

Huge amount of information

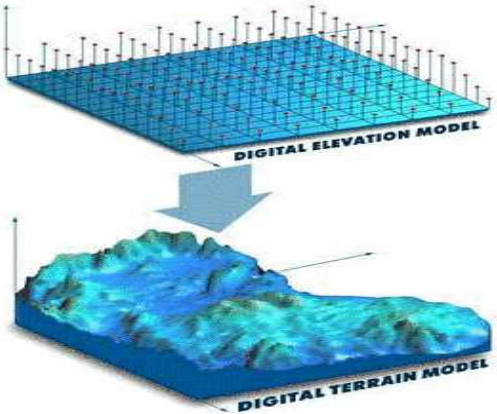
Less expensive than line mapping

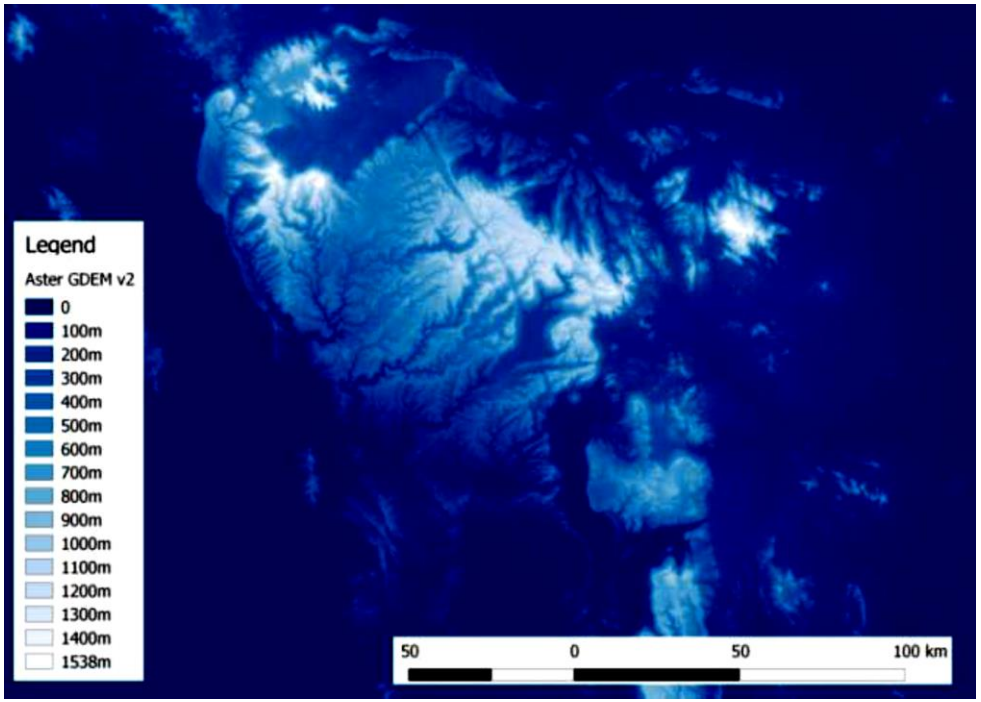
Gaining more importance with digital techniques and development of GI

What is a DEM?

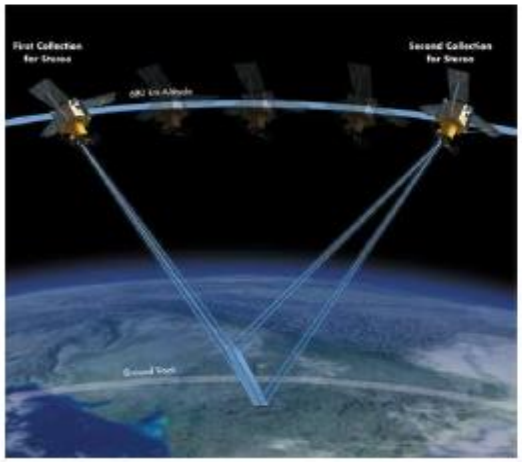
A digital elevation model (DEM) is defined as "any digital representation of the continuous variation of relief over space
“a digital model or 3D representation of a terrain's surface”

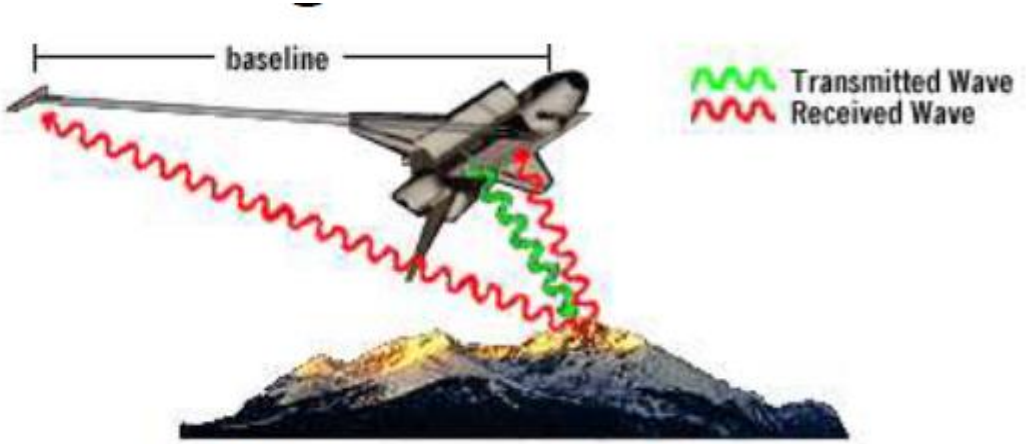
13	14	16	20	23
14	14	16	19	24
18	16	16	18	22
24	22	19	19	21
30	27	23	20	20



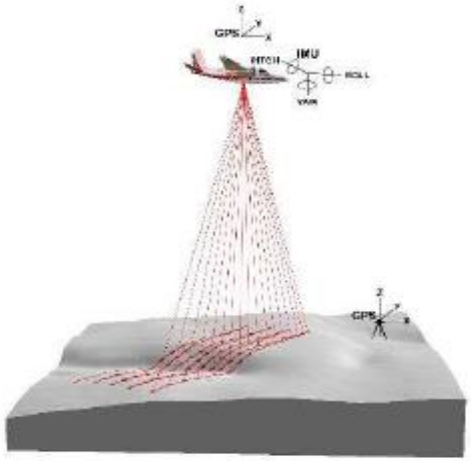


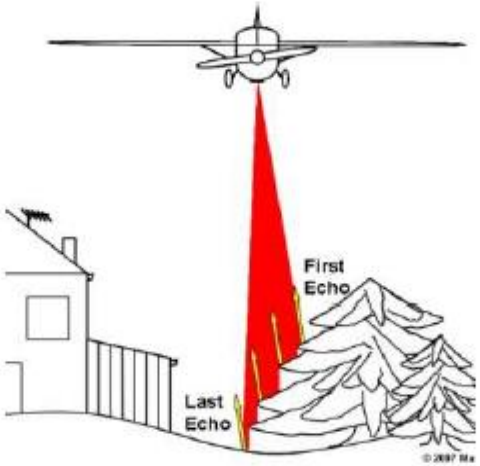
How is a DEM generated?





RADAR Interferometry with 2 receivers, 60m apart





Airborne Laserscanning or LIDAR

A) From airborne or satellite remote sensing: Stereo images, RADAR or LIDAR data are used in a semi-automated process to create a DEM.

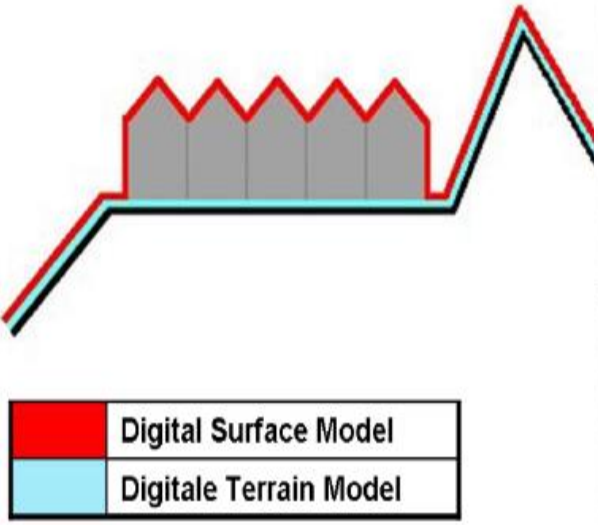
How is a DEM generated?

B) From terrestrial measurements with precise land survey instruments. These spot measurements are then interpolated into an elevation surface. With this method, it is costly and time consuming to cover bigger areas.

Comparison of Various DEM Acquisition Techniques:

Acquisition Method	Accuracy of data	Speed	Cost
Traditional surveying	High	Very slow	Very high
GPS survey	Relatively high	Slow	Relatively high
SAR	Low	Very fast	Low
LIDAR	High	Fast	High
Existing Topographic Maps	Relatively low	Slow	Low

DEMs Types:



Digital Surface Model

Digital Terrain Model

Supplementary files:

- https://slideplayer.com/slide/7526048/
- https://www.youtube.com/watch?v=KrzuMDpH9d0
- https://www.youtube.com/watch?v=kbeGJRZzmB8
- https://remote-sensing-portal.com/courses/geometric-correction/?AspxAutoDetectCookieSupport=1

Thanks

Dr.Eng. Hassan Mohamed