Orthophoto
Orthorectification
Digital Ortho Mosaic

Course Digital Photogrammetry
Programme: M.Tech Geoinformatics

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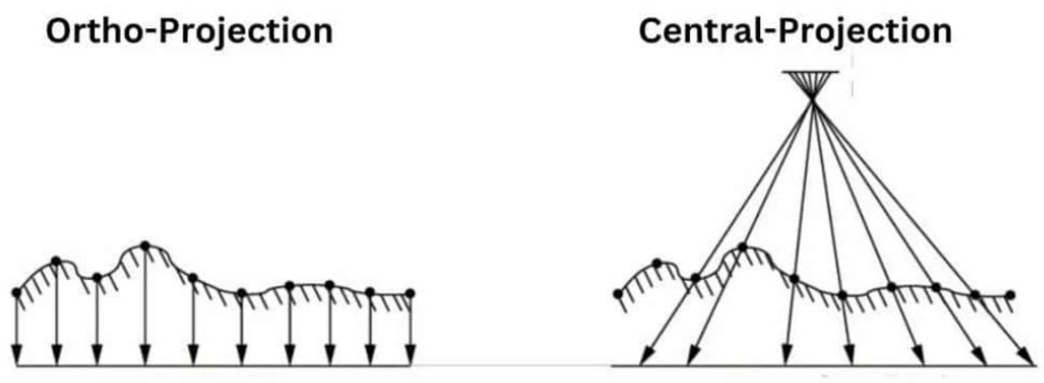
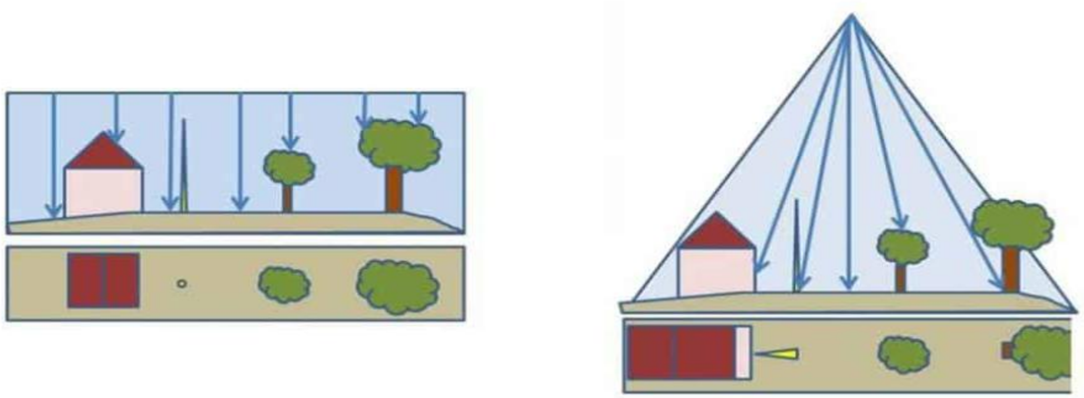
What is Orthophoto (Orthoimagery)?

Orthophoto, also known as orthoimagery, is a high-resolution aerial photograph that has been geometrically corrected to ensure uniform scale. Unlike regular aerial photographs, orthophotos are free from distortions caused by camera tilt or terrain relief, making them accurate for surveying and mapping.





https://www.surveyinggroup.com/what-is-orthophoto/

- Orthophoto or Orthoimage is a photograph showing images of objects in their true orthographic position, and it is equivalent to a planimetric map.
- The difference between maps and orthophotos is that orthophotos are composed of images of features, whereas maps utilize lines and symbols plotted to scale to depict features.
- Orthophotos can be used as a map for making direct measurements of distances, angles, positions, and areas without making corrections for image displacement.
- This cannot be done with perspective photos. It is very widely used in a GIS as a reference for performing Analysis

Data used in Orthophoto Production / Process

Orthoimage is based on perspective photos. The production procedure divides the entire image into small blocks and then rectifies the image block by block. Orthoimage production is also known as **digital differential rectification.**

The essential inputs for the process of differential rectification are a DEM and a digital aerial photo having known exterior orientation parameters (ω, Φ,K, X_1,Y_2, and Z_3), image coordinate (rows and columns) to be used in the transformation to compute digital image coordinates.

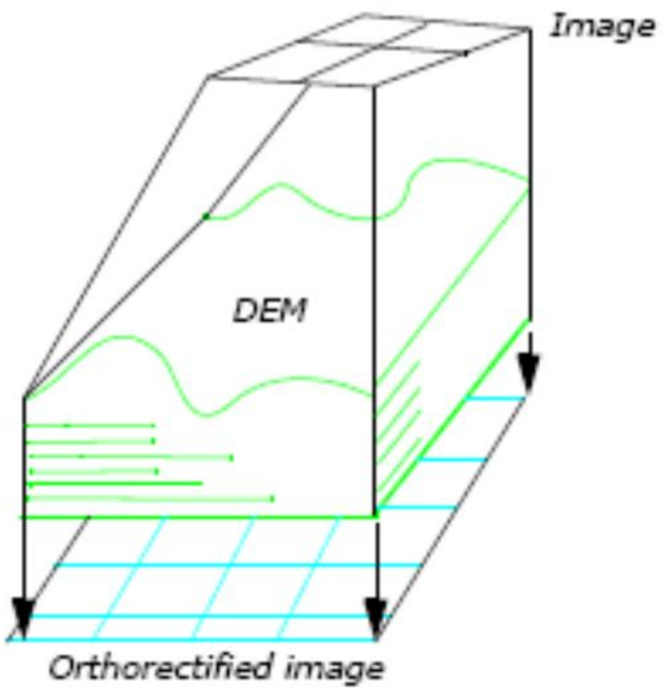
Orthorectification is the process of removing geometric errors inherent within photography and imagery. The variables contributing to geometric errors include, but are not limited to:

- *Camera and sensor orientation*
- *Systematic error associated with the camera or sensor*
- *Topographic relief displacement*
- *Earth curvature*

*By performing block triangulation or single frame resection, the **parameters associated with camera and sensor orientation are defined**. **Utilizing least squares adjustment techniques during block triangulation minimizes the errors associated with camera or sensor instability**. Additionally, the use of self-calibrating bundle adjustment (SCBA) techniques along with Additional Parameter (AP) modeling accounts for the **systematic errors associated with camera interior geometry**. The effects of the **Earth's curvature** are significant if a large photo block or satellite imagery is involved. They are accounted for during the **block triangulation procedure** by setting the relevant option. The effects of topographic relief displacement are accounted for by utilizing a DEM during the orthorectification procedure.*

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 fidelity. Thus, measurements taken off an orthorectified image represent the corresponding measurements as if they were taken on the Earth's surface

Figure II-80: Orthorectification



An image or photograph with an orthographic projection is one for which every point looks as if an **observer were looking straight down** at it, along a line of sight that is orthogonal (**perpendicular**) to the Earth. The resulting orthorectified image is known as a **digital orthoimage**

Relief displacement is corrected by taking each pixel of a DEM and finding the equivalent position in the satellite or aerial image. A brightness value is determined for this location based on resampling of the surrounding pixels. The brightness value, elevation, and exterior orientation information are used to calculate the equivalent location in the orthoimage file.

In contrast to conventional rectification techniques, orthorectification relies on the digital elevation data, unless the terrain is flat. Various sources of elevation data exist such as DEM automatically created from stereo image pairs.

The process of producing a true Orthoimage is illustrated in the below figure. In addition to the differential rectification, the following process is applied first is digitizing the buildings that the removing the relief displacement, as illustrated in the below figures:

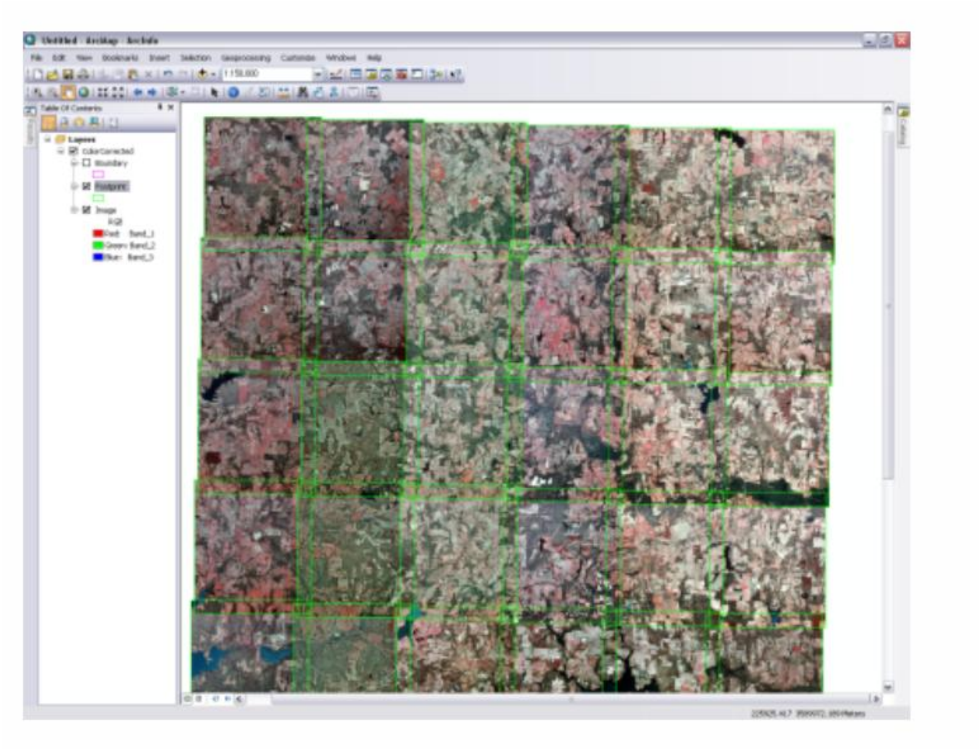
Regular Orthophoto showing the relief of the building.

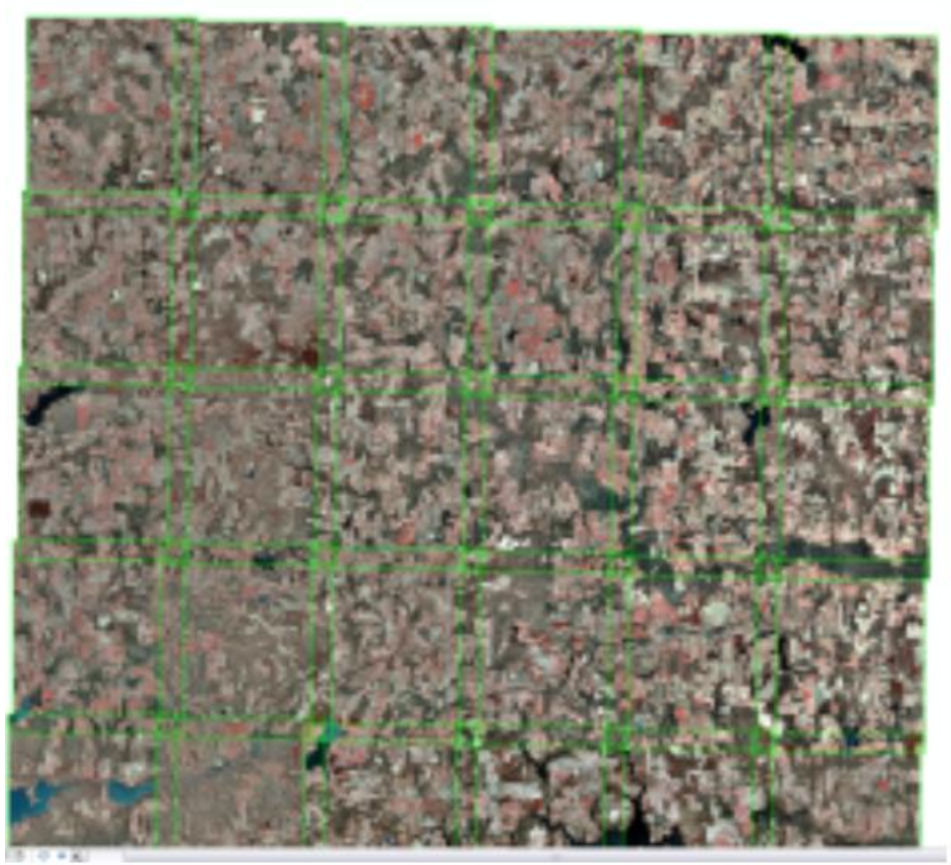
The vector map of the buildings

True Orthophoto produced by removing relief displacement by applying the

Color balancing

Colour correction to achieve a more consistent balance between the images

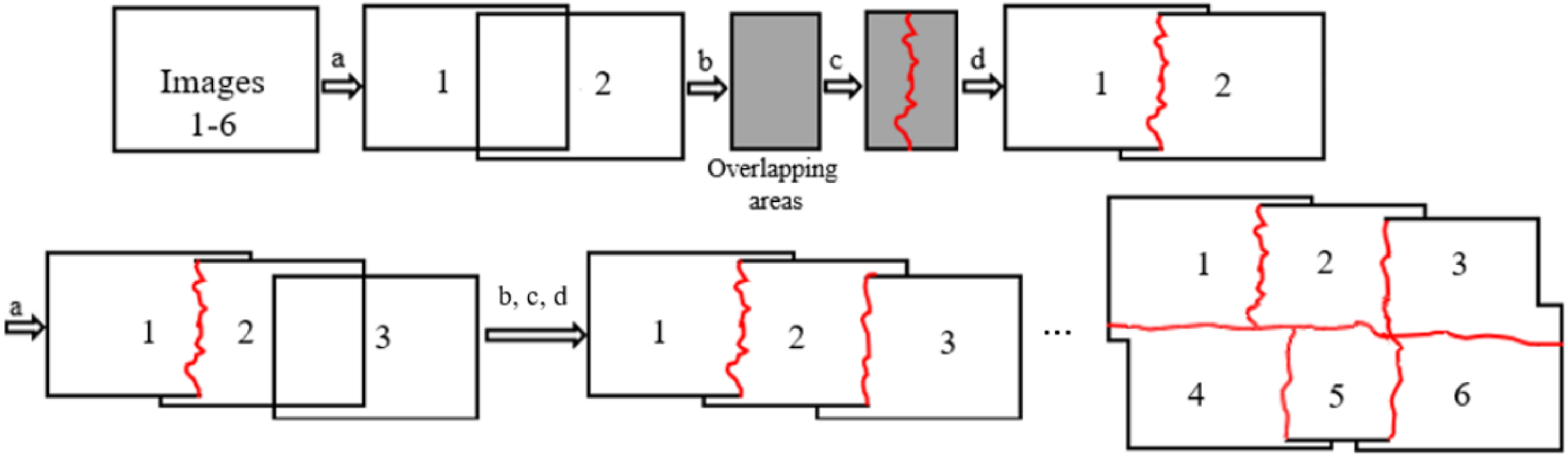




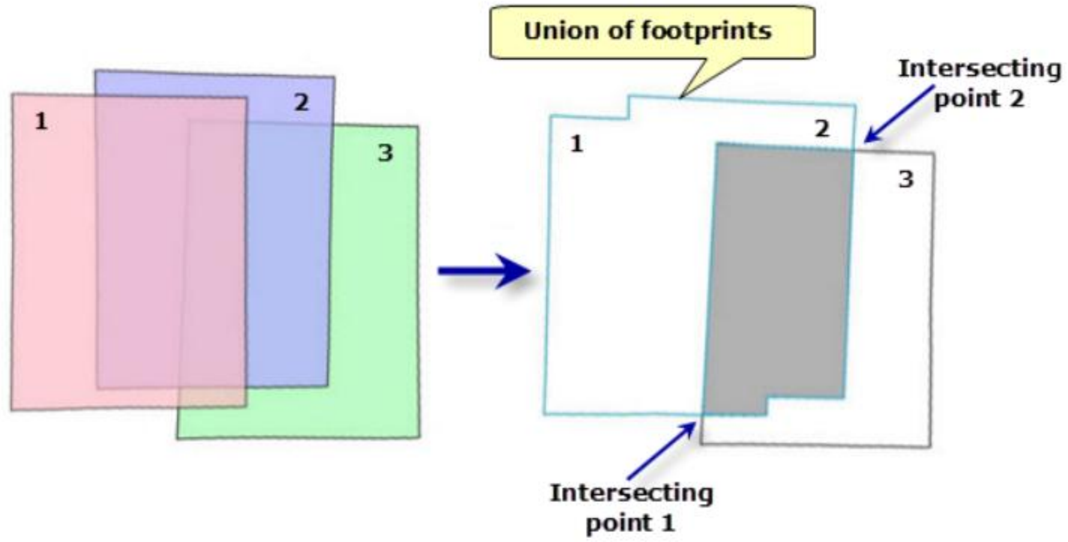
https://desktop.arcgis.com/en/arcmap/latest/manage-data/raster-and-images/ex-5-color-balancing-a-mosiac-dataset.htm

Seamline Generation

Seamlines are used when mosaicking images in a mosaic dataset. Use seamlines instead of footprints to define the edges along which the images in the mosaic dataset are mosaicked together. A mosaic dataset using seamlines removes overlap between the images in the mosaic dataset



https://doi.org/10.3390/rs16050903



RADIOMETRY—Build seamlines by examining the values and patterns in the intersecting area and compute a path between the intersecting points.
COPY_FOOTPRINT—Build seamlines by copying the footprints in which each seamline is the copy of the corresponding footprint.
COPY_TO_SIBLING—Commonly used with satellite imagery when the panchromatic band does not always share the same extent as the multispectral band. This option ensures that they share the same seamline.
EDGE DETECTION—Generate seamlines over intersecting areas based on the edges of the features in the overlap area. Use this option when you want to use the edge of the feature to make the transition less apparent.
VORONOI—Incorporate the polygons in a Voronoi diagram to create the seamlines.
DISPARITY—Create seamlines based on the disparity between images of stereo pairs. This option avoids splitting features between stereo images that may lean in different direction

Orthophoto

Ture-Orthophoto

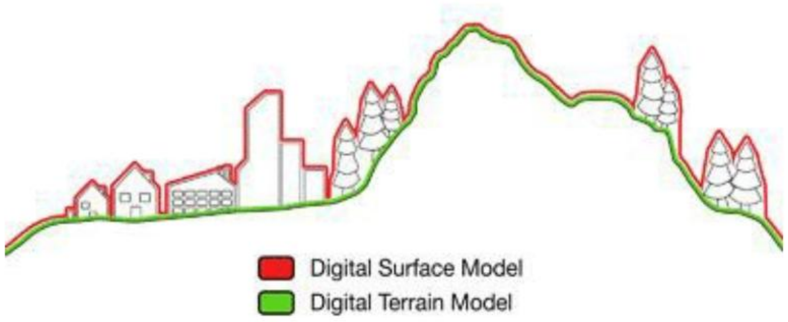
https://geoawesome.com/eo-hub/what-is-the-difference-between-orthophotos-orthophotomaps-orthomosaics-and-true-orthophotos/

Orthophoto:

Firstly, **Orthophotos** are an effect of photogrammetry processing that uses the Digital Terrain Model (DTM), typically seen in traditional airborne photogrammetry. In orthophotos, you will often see an effect where the terrain representation is very accurate, but you will see a tilt in the buildings and other tall structures, which is an effect of using DTM that only maps the natural shape of the earth (excluding vegetation and all man-made objects and structures).

True Orthophoto:

True Orthophoto, on the other hand, is processed using Digital Surface Model that maps every shape and object visible on the ground (including vegetation and man-made objects). True Orthophoto gives a vertical view of the earth's surface, eliminating building tilting and allowing a view of nearly any point on the ground.



https://geoawesome.com/eo-hub/what-is-the-difference-between-orthophotos-orthophotomaps-orthomosaics-and-true-orthophotos/

Advantages of Digital Orthophotos Despite these limitations, an orthophoto is a very useful mapping tool. It has the interpretative qualities inherent in an image and the geometric properties of a map. This means that the features on the image can be accurately measured, just like one might want to do with a conventional line map. Because of this, orthophotographs form an excellent base or control layer for a GIS. It is also relatively inexpensive, especially when one considers the costs incurred in conventional line mapping.

Disadvantages of Orthophotography It is important for the user community to understand that orthophotography is just a tool and as such is not applicable in all situations. Disadvantages include: The data are an image that needs interpretation by the user. While features can be depicted on the image, there is still a wealth of information missing such as feature classification and specific feature identification. An example of the latter is that it may be impossible to differentiate between buildings used for commercial or residential purposes. All the view sees is a building. There are hidden areas where no data exist Data shown on the image only represents that data above ground, and even this may sometimes be hidden. There are no spatial analysis capabilities. For example, a line could be identified within a vector map and an attribute table can be displayed. But, clicking on that same feature on a rasterized image will result in displaying pixel location.

Digital Orthophoto The creation of a digital orthophoto brings with it competing issues.

- These include accuracy, quality, cost, and the hardware/software display and manipulation capabilities.
- Image quality is dependent upon a number of production components such as camera quality diapositive/negative
- sharpness photo to orthophoto map scale magnification orthophoto diapositive
- density range or bits in the scanner scan pixel (radiometric resolution) sample scan rate in micrometers or dots per inch (dpi) and the photo scale rectification procedures final pixel size in ground units (pixel ground resolution)
- electronic auto-dodging or radiometric image smoothing after the rectification process selection of control points
- DEM data density Modulation Transfer Function Pixel output being proportion to density or to the “transmissivity” of the medium Assuming that the correct inputs are used, the accuracy that can be achieved in orthophotography is comparable to that found in line maps. Accuracy of a digital orthophoto is a function of:
- Magnification, geometric accuracy of the scanner, quality of the DEM, control, focal length of the taking camera