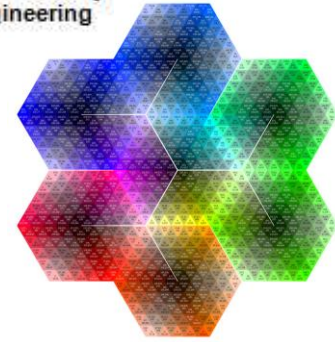# Photogrammetry II
Lecture 5:   Coordinate Systems

Dr. Eng. Hassan Mohamed Hassan

Hassan.hussein@feng.bu.edu.eg

Geomatics Department

What you learn from this lecture

1. Image Coordinate System
2. Pixel Coordinate System
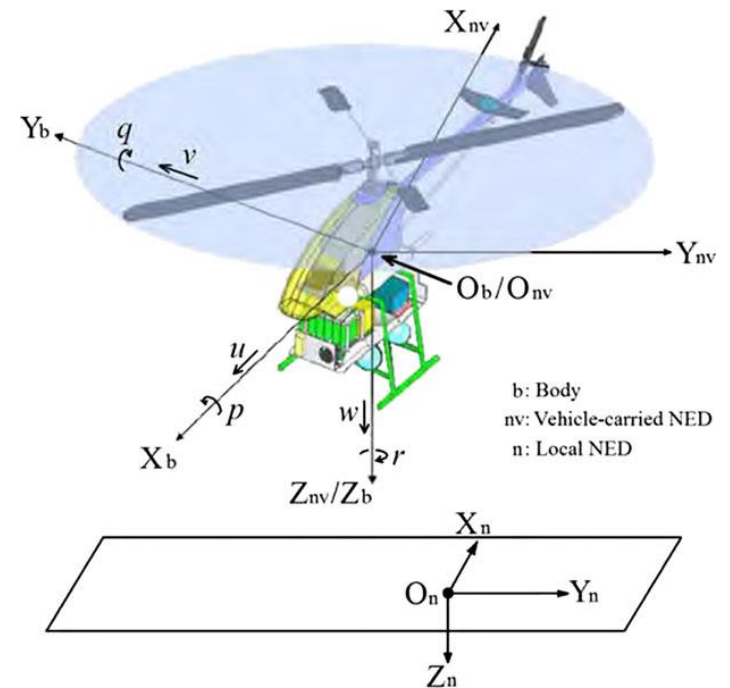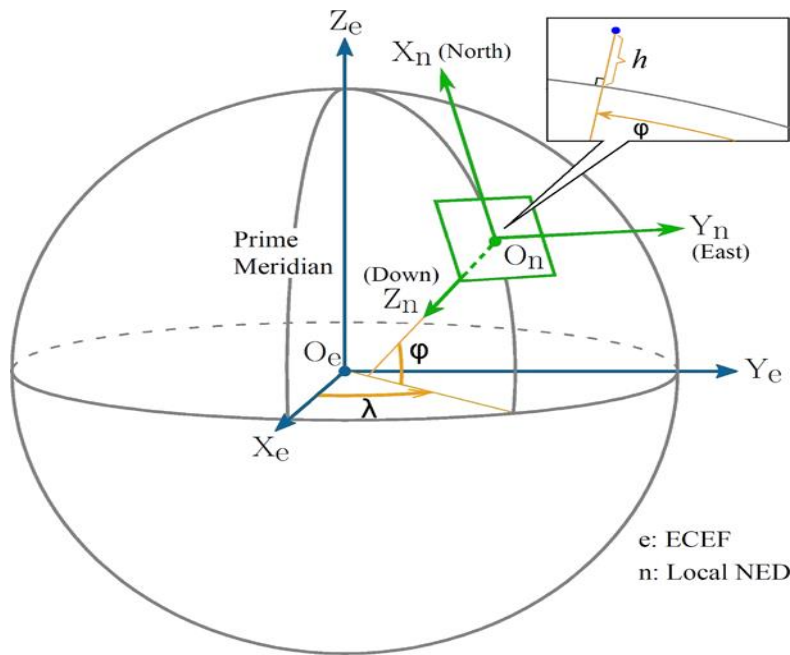3. Model Space Coordinate System
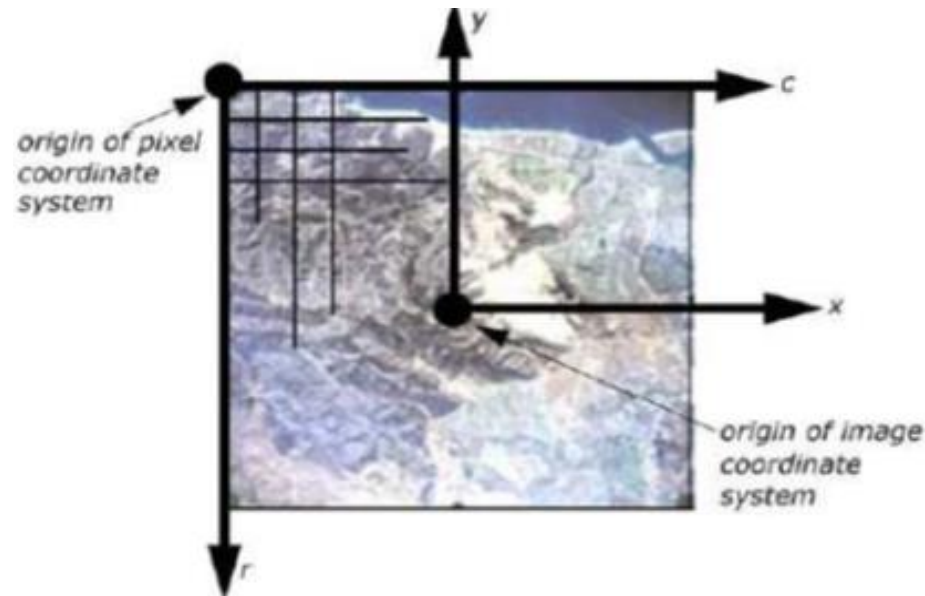4. Ground Coordinate System

Image Coordinate System

➢ An image coordinate system or an image plane coordinate system is usually defined as a two-dimensional (2D) coordinate system occurring on the image plane with its origin at the image center. The origin of the image coordinate system is also referred to as the principal point. Image coordinate units are usually millimeters or microns.
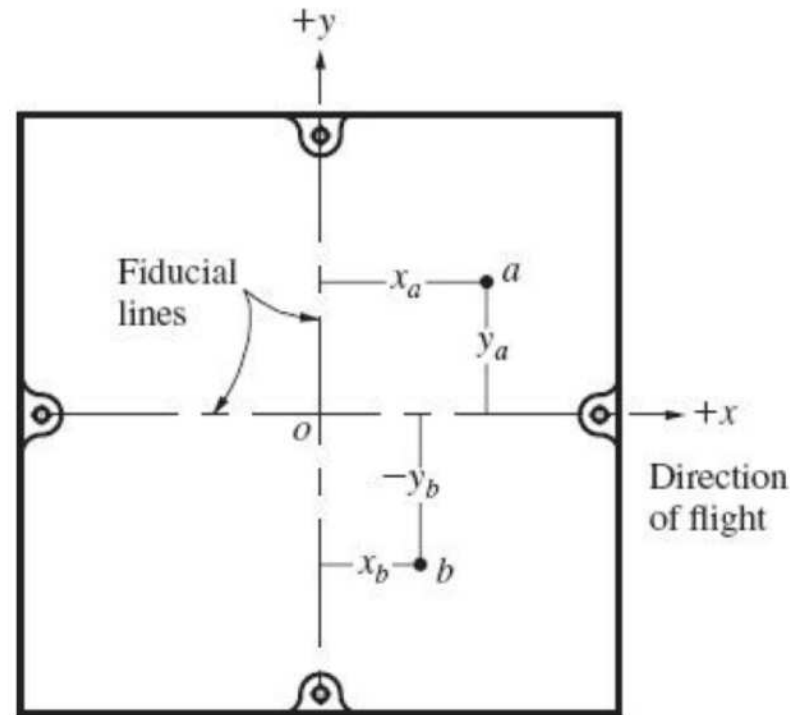
Pixel Coordinate System

➢ pixel coordinate system is usually a coordinate system with its origin in the upper-left corner of the image, the x-axis pointing to the right, the y-axis pointing downward, and the units in pixels, as shown by axes c and r .These coordinates (c, r) can also be thought of as the pixel column and row number, respectively.

origin of pixel coordinate system

origin of image coordinate system

Model Space Coordinate System
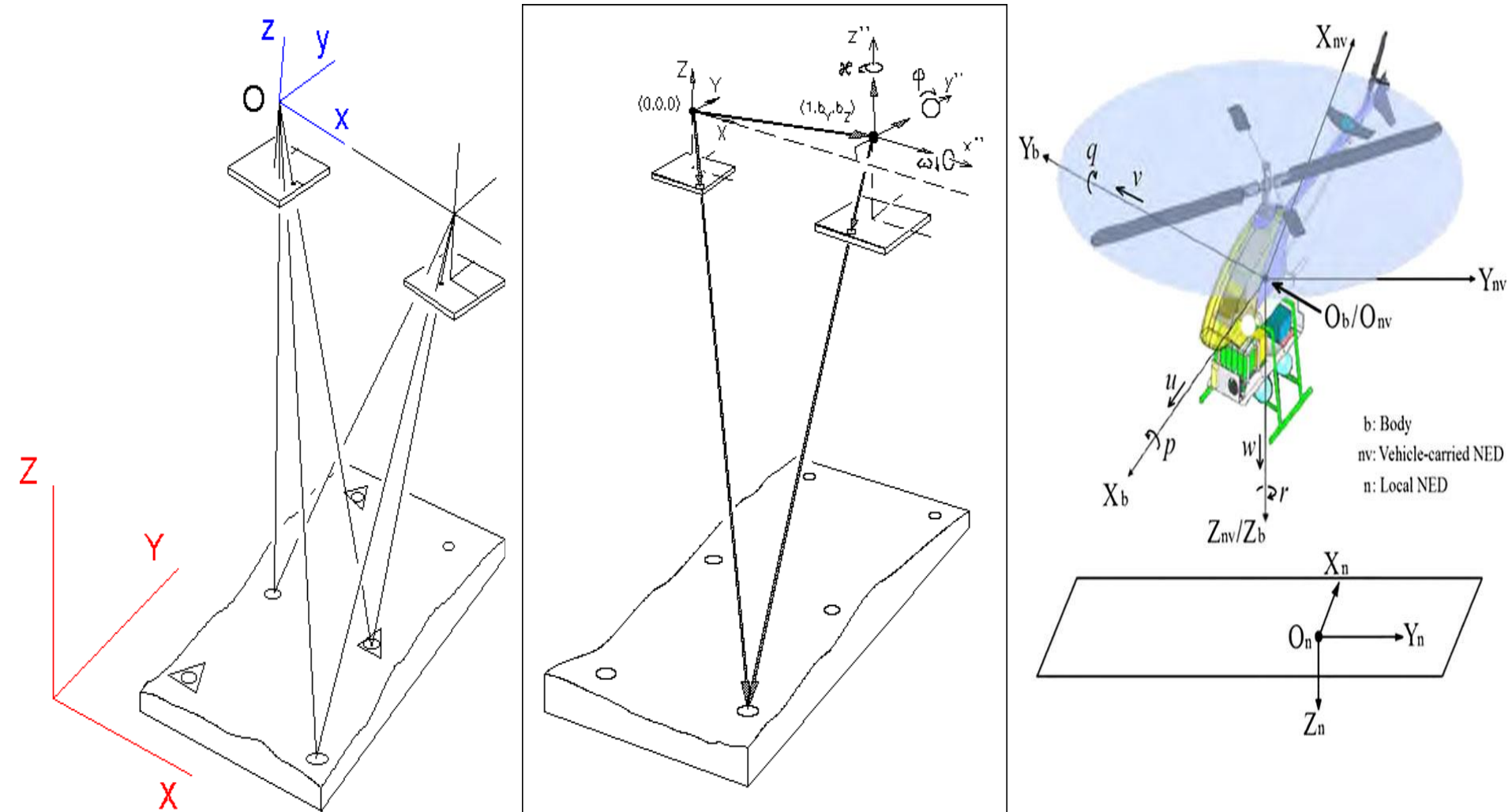
Model Space Coordinate System

➢ The spatial coordinates of points imaged in a stereoscopic model.

➢ The position of this system is defined with reference to the direction of flight or instrument axes.

➢ The origin is at the projection center of the left photo.

➢ The X direction coincides with flight direction (Camera base).

➢ The Z direction coincides with the optical axis of the camera.

Geodetic Coordinate System

➢ Origin is the center of ellipsoid (WGS84: Earth's center of mass)

➢ x and y axes are perpendicular to each other in the equatorial plane

➢ Z axis is at right angles to the x,y plane and coincides with the Ellipsoid rotational axis (WGS84: Earth's rotational axis).

● **Geodetic Curvilinear Coordinates**

● Latitude ø, Longitude λ, Ellipsoid height h

● **Geocentric Cartesian Coordinates**

● x, y, z
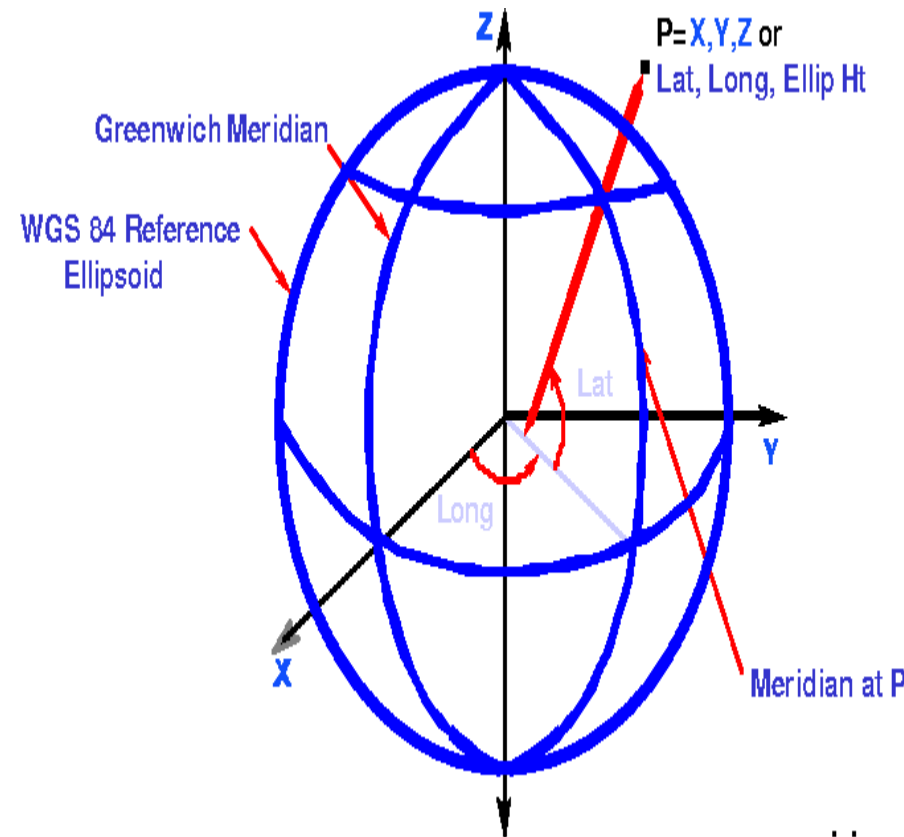
Geodetic Coordinate System

➢ <u>Geodetic Latitude (ø)</u>

Angle between ellipsoid normal from the point (observer) and the equatorial plane measured in the observer meridional plane

➢ <u>Geodetic Longitude (λ)</u>

Angle between Greenwich meridian and observer meridian measured in equatorial plane anticlockwise direction

➢ <u>Geodetic Height (h)</u>

Distance from point to ellipsoid measured along ellipsoid normal
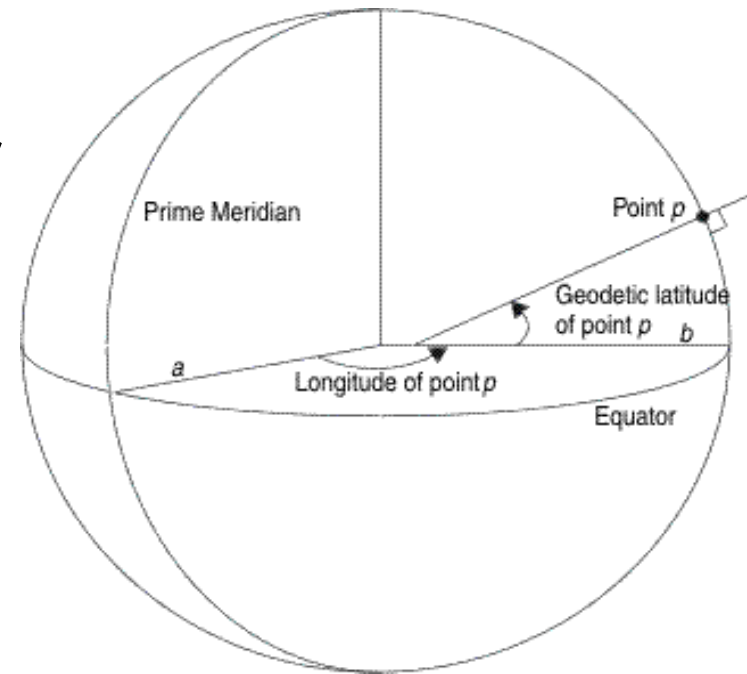
Astronomic Coordinate System

➢ Φ :the angle between the plane of the earth's equator and the plumb line (direction of gravity) at a given point o the earth's surface.

➢ Λ :the angular distance of a point on th celestial sphere from the great circle that is perpendicular to the ecliptic at the point of the vernal equinox, measured throug $360°$ eastward parallel to the ecliptic.

➢ Φ, Λ : Observed through Astronomy

➢ H: Observed through Leveling

➢ Φ – ø = ξ & (Λ – λ) cos ø = η & h – H = N
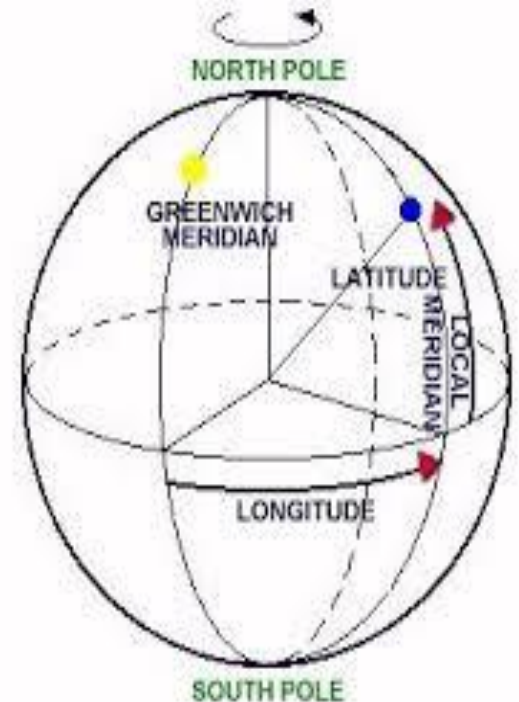
Local Space Coordinate System

➢ The N axis coincides with the North direction.

➢ The Z axis is taken parallel to the local vertical which simplifies the work.

➢ Local coordinates are easily obtainable from geocentric coordinates by a 3D transformation which contains a translation, rotation, and a scale factor.
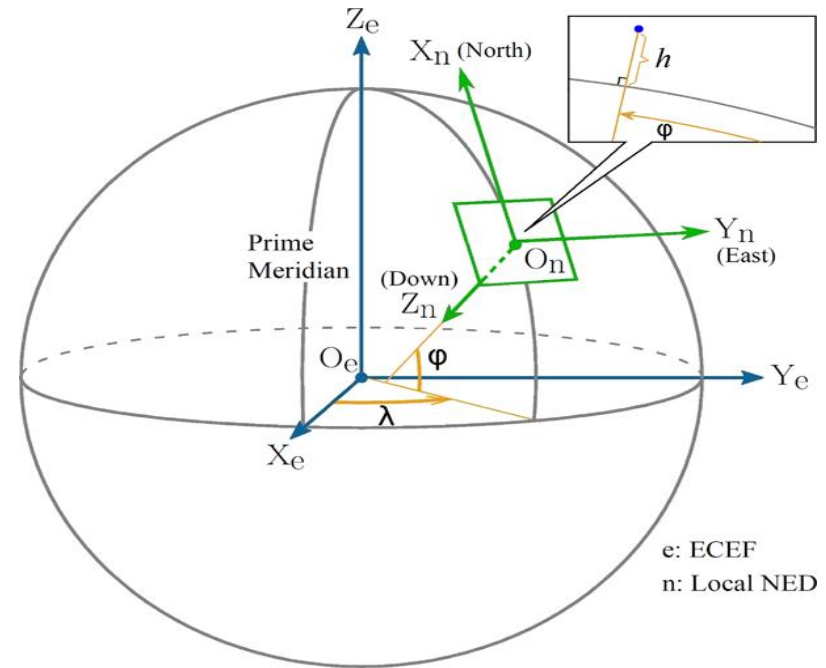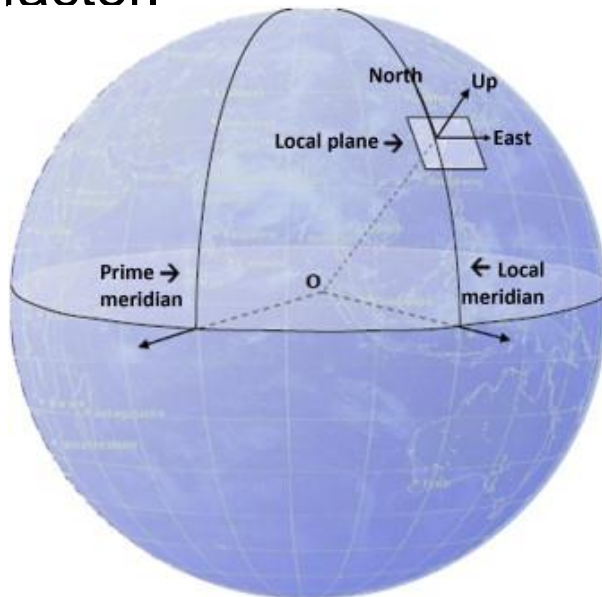
Summary of the most important relationships between image and object space

relationship between	procedure	mathematical model
measuring system and photo-coordinate system	interior orientation	2-D transformation
photo-coordinate system and object coordinate system	exterior orientation	collinearity eq.
photo-coordinate systems of a stereopair	relative orientation	collinearity eq. coplanarity condition
model coordinate system and object coordinate system	absolute orientation	7-parameter transformation
several photo-coordinate systems and object coordinate system	bundle block adjustment	collinearity eq.
several model coordinate systems and object coordinate system	independent model block adjustment	7 parameter transformation

Supplementary files:

➢ Unmanned Rotorcraft Systems. Guowei Cai, Ben M. Chen, Tong Heng Lee, 2011, Springer London Dordrecht Heidelberg.

➢ Elements of Photogrammetry with Applications in GIS, Fourth Edition. Paul R. Wolf, Bon A. Dewitt, Benjamin E. Wilkinson, 2014 McGraw-Hill Education

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Thanks

Dr.Eng. Hassan Mohamed