Pre-Processing & Correction of Digital Image

Remote sensing system gathered data in many forms and techniques. In all these systems, there are numerous errors associated with gathered data. Therefore, it is usually necessary to preprocess the remotely sensed data in order to remove these errors.

Image preprocessing operations normally precede all other image manipulation and analysis, such as enhancement or classification. The preprocessing of remotely sensed image (image restoration) consists of geometric and radiometric characteristics analysis. by realizing these features, it is possible to correct image distortion and improve the image quality and readability.

Image restoration is usually implemented to correct distortion, to remove degradation, and to reduce noise introduced during the image process. Image restoration produces a corrected image that is as close as possible, both geometrically and radiometrically, to the radiant energy characteristics of the original scene. All the geometric and radiometric distortions are corrected and reduced by the application of appropriate digital techniques.

SATELLITE IMAGE PROCESSING

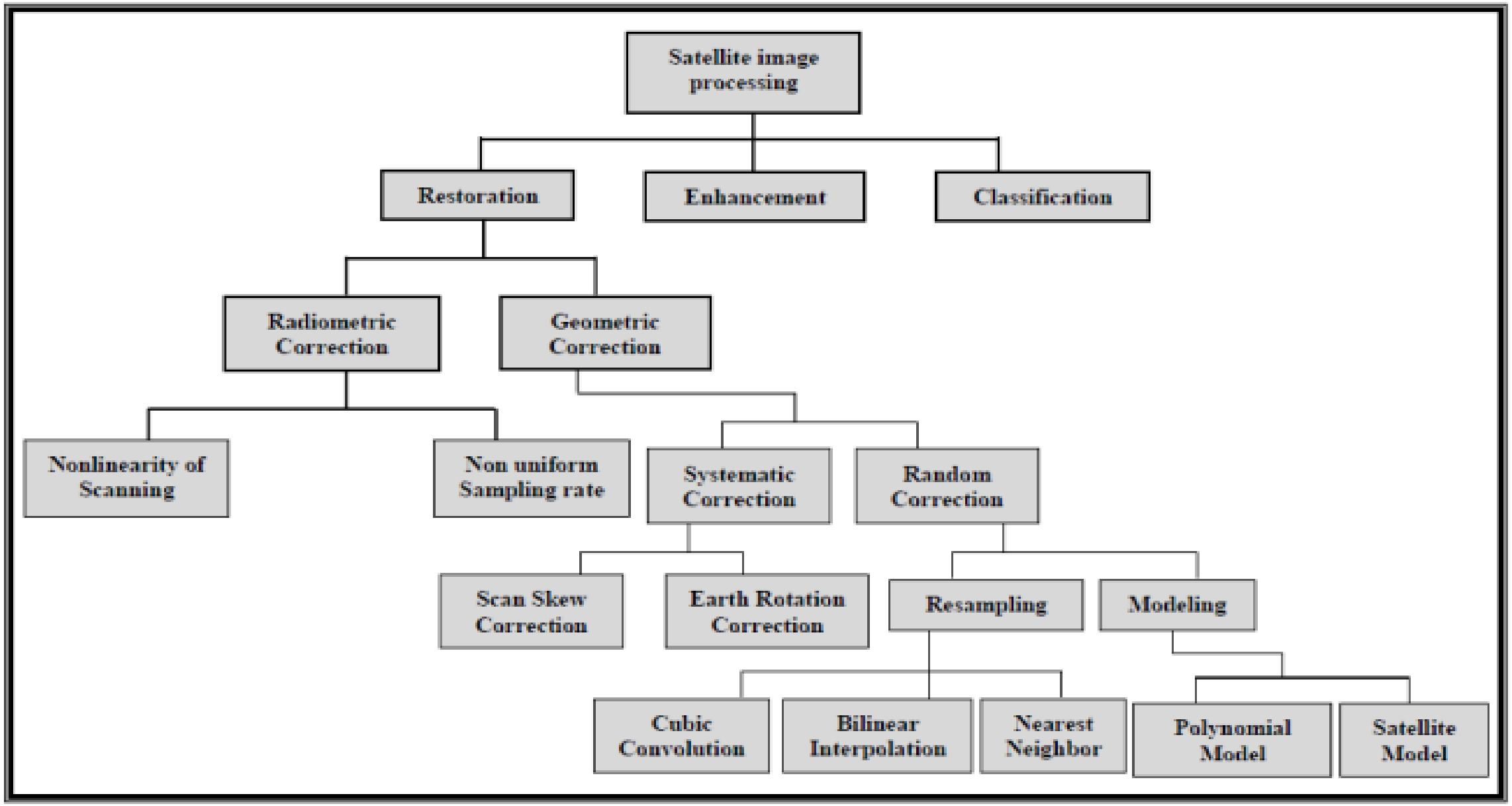


Image Corrections

- Raw remote sensing images always contain significant amount of distortions, therefore, they cannot be used directly for further image analysis. The image correction involves image operations which normally precedes manipulation and analysis of image data to extract specific information. The primary aim of image correction operations is to correct distorted image data to create a more accurate representation of the original scene. Image corrections are also known as a preprocessing of remotely sensed images. It is a preparatory phase that improves quality of images and serves as a basis for further image analysis.
- Radiometric correction attempts to improve the accuracy of measurements made by remote sensors pertaining to the spectral reflectance or emittance or back-scatter from the objects on the Earth surface.
- Geometric correction is the process of correcting geometric distortions and assigning the properties of a map to an image.

Radiometric Correction

- Ideally, the radiant flux recorded by a remote sensing system in various bands is an accurate representation of the radiant flux actually leaving the feature of interest (e.g., soil, vegetation, water, or urban land cover) on earth‘s surface. Unfortunately, noise (error) can enter the data collection system at several points. For example, radiometric error in remotely sensed data may be introduced by the sensor system itself when the individual detectors do not function properly or are improperly calibrated.
- Second, the intervening atmosphere between the terrain of interest and the remote sensing system can contribute so much noise that the energy recorded by the sensor does not resemble that which was reflected or emitted by the terrain.

Geometric Correction

- All remote sensing imagery are inherently subject to geometric distortions. These distortions may be due to several factors, including: the perspective of the sensor optics; the motion of the scanning system; the motion of the platform; the platform altitude, attitude, and velocity; the terrain relief; and, the curvature and rotation of the Earth. Geometric corrections are intended to compensate for these distortions so that the geometric representation of the imagery will be as close as possible to the real world.
- The geometric distortions may be divided into two classes:
- 1. Systematic distortion: those that can be corrected using data from platform ephemeris and knowledge of internal sensor distortion.
- 2. Nonsystematic distortion: those that cannot be corrected with acceptable accuracy without a sufficient number of ground control points, which are used to establish a relationship between the ground and image.

Nature of Radiometric Errors

- Internal errors are introduced by the electronics themselves. These kinds of errors are also known as systematic errors because of their systematic nature. These errors can be modelled, identified and corrected based on laboratory calibration or in-flight measurements. For example, if a single detector has become uncalibrated, the concerned row (in older satellites such as Landsat) or the column (in pushbroom scanners like SPOT, IRS, IKONOS, WorldView1) would appear like a constant intensity stripe, that does not reflect the terrain changes on the ground.
- External errors are a result of phenomena that vary in nature through space and time and hence are also known as non-systematic errors. External variables such as atmospheric disturbances, steep terrain undulations can cause remote sensor data to exhibit radiometric and geometric errors.

Nature of Geometric Errors

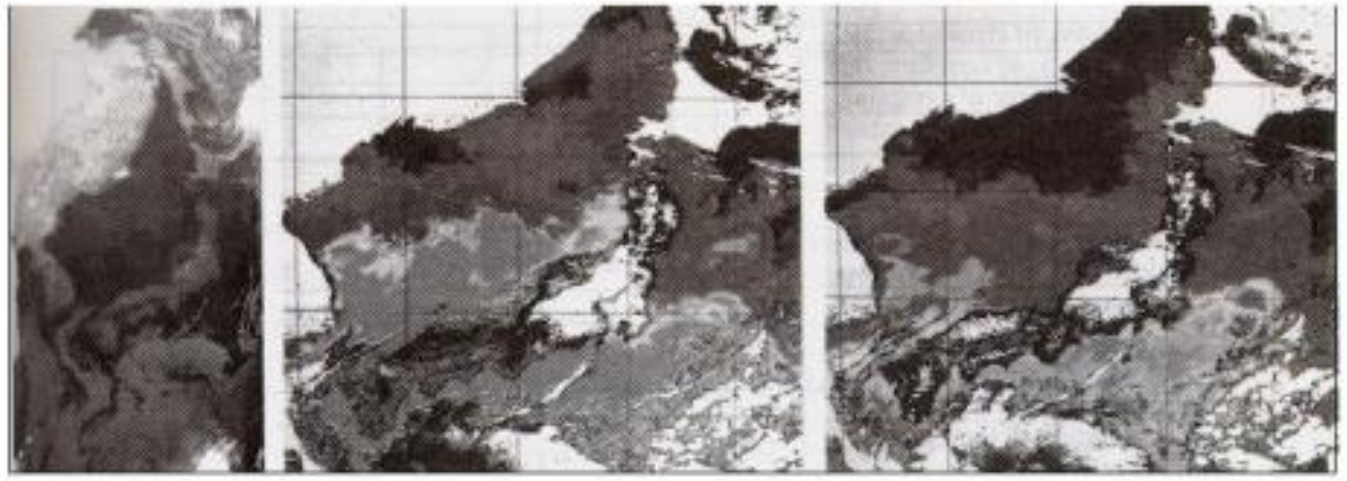
- Geometric errors present in remote sensing images can be categorised into the following two types: • internal geometric errors, and • external geometric errors.
- Internal geometric errors are introduced by the sensor system itself and/or by the effects of Earth's rotation and curvature. These errors are predictable or computable and often referred to as systematic that can be identified and corrected using pre-launch or platform ephemeris.
- External geometric errors are usually introduced by phenomena that vary in Image Corrections nature through space and time. The most important external variables that can cause geometric error in remote sensor data are random movements by the spacecraft at exact time of data collection, which usually involve: • altitude changes and/or • attitude changes (yaw, roll and pitch).

VARIOUS TERMS USE IN GEOMETRIC CORRECTION

- Geometric correction is the process of correction of raw remotely sensed data for errors of skew, rotation and perspective.
- Rectification is the process of alignment of an image to a map (map projection system). In many cases, the image must also be oriented so that the north direction corresponds to the top of the image. It is also known as georeferencing.
- Registration is the process of alignment of one image to another image of the same area not necessarily involving a map coordinate system.
- Geocoding is a special case of rectification that includes geographical registration or coding of pixels in an image. Geocoded data are images that have been rectified to a particular map projection and pixel size. The use of standard pixel sizes and coordinates permits convenient overlaying of images from different sensors and maps in a GIS.
- Orthorectification is the process of pixel-by-pixel correction of an image for topographic distortion. Every pixel in an orthorectified image appears to view the Earth from directly above, i.e., the image is in an orthographic projection.

TERMS USE IN RADIOMETRIC CORRECTION

- Atmospheric Correction The solar radiation is absorbed or scattered by the atmosphere during transmission to the ground surface, while the reflected or emitted radiation from the target is also absorbed or scattered by the atmosphere before it reaches a sensor. The ground surface receive not only the direct solar radiation but also sky light, or scattered radiation from the atmosphere. A sensor will receive not only the direct reflected or emitted radiation from a target, but also the scattered radiation from a target and the scattered radiation from the atmosphere, which is called path radiance. Atmospheric correction is used to remove these effects.



PROCEDURE OF GEOMETRIC CORRECTION

- There are following two common geometric correction procedures which are often used: • image-to-map rectification • image-to-image registration
- Image-to-map rectification is the process by which the geometry of an image is made planimetric. Whenever accurate area, direction and distance measurements are required, image-to-map geometric rectification should be performed. It may not, however, remove all distortions caused by highly undulating terrain heights, leading to what are known as relief displacement in images. This process normally involves selecting some image pixel coordinates (both row and column) with their map coordinate counterparts (e.g., meters northing and easting in a UTM map projection).
- Image-to-image registration is the translation and rotation alignment process by which one image is aligned to be coincident with respect to another image, thereby allowing the user to select a pixel (i.e. Ground control point - GCP) in one image and its positionally exact counterpart from the other image. The same general image processing principles are used in both image rectification and image registration. In case, an image that is already rectified to a map reference system is used as base image and second image also retains all geometric errors present in the base image. However, this approach is more appropriate when images of multiple dates are used for observing changes on the ground. This is because if two images are separately rectified to the map reference system each may have the same overall error but may be of a different nature, resulting in twice the individual errors when two rectified images are used together.

steps in geometric correction process

- Step 1: Collection of Ground Control Points (GCPs)
- Step 2: Solving a Polynomial Equation Using GCPs
- Step 3: Transformation of the Image to the Geometry of the Reference Map/Image (Spatial Interpolation)
- Step 4: Assessment of Error
- Step 5: Resampling (Intensity Interpolation)

Reference:-

- https://www.sciencedirect.com/topics/earth-and-planetary-sciences/geometric-correction
- https://eo.belspo.be/en/geometric-and-radiometric-corrections
- Remote Sensing & GIS by B. Bhatta.

THANK YOU

SOMA MUKHOPADHYAY,RKSMVV