II. Airborne Remote Sensing Data

1. Leica ADS40 Digital Onboard Aerial Photogrammetry System

The ADS40 System was released by Leica Geosystems Inc., Switzerland, in 2001. ADS40 is capable of efficiently obtaining very high-resolution color, NIR, and panchromatic images. The system ensures simultaneous access to five bands (R, G, B, NIR, and Pan images) acquired at the same angle. The ADS40 is mainly used for applications related to photogrammetric and industrial remote sensing (RS) services.

2. UCXp Aerial Camera

This camera collects data in Pan, RGB, and NIR and outputs the largest PAN image footprint available from large format digital cameras available on the commercial market. The data are collected by a separate group of lenses for each image. These lenses share the same geometric accuracy, generating on the focal plane one, two, or four images. The composite image or "master image" is composed of images captured from four angles at the same time. Pixel ground resolution is better than 2 cm from 300 m altitude. The collection rate and geometric accuracy of the UCXp allows users to produce 1) urban maps with minimal occlusions, 2) Digital Elevation Models (DEMs) without spikes or holes, and 3) high quality, large-scale orthophotos.

III. Spectral Characteristics of Ground Objects

1. Spectral Characteristics of Vegetation

The spectral reflectance of green vegetation bears close relevance to the growth, health, and environmental conditions of the vegetation.

Within the visible light bands, all color agents constitute the main cause governing a plant's spectral response, chlorophyll being the most important agent. Within two bands whose central wavelengths are 0.45 μm (blue) and 0.65 μm (red), chlorophyll in the leaves can absorb most of the incident energy. Around the position of 0.54 μm (green) lies a reflection peak, which explains why the vegetation appears green to us. When vegetation is under stress or withers, the mesophyll layer collapses and the effect of the chlorophyll disappears; subsequently erythrophyll and xanthophyll will dominantly influence the spectral response of the leaves. This is the main reason for leaves turning yellow or red in autumn.

For healthy green plants reflecting within the NIR band of the spectrum, their spectral characteristics exhibit high reflectivity (45%~50%) and transmissivity (45%~50%) but low absorptivity (<5%). The reflectivity rises sharply in the area between the visible light band and NIR band, approximately at the position of 0.76 μm, forming what is commonly called the "red edge" and is a distinguishing feature of a plant's spectral curve. This phenomenon is of prime concern with RS observations of the Earth's vegetation.

Within the mid-IR band, the spectral responses of green plants are strongly absorbed and dominated by water at the positions of 1.4 μm, 1.9 μm, and 2.7 μm.

2. Spectral Characteristics of Water Bodies and Snow

Most naturally clear water bodies on the Earth's surface absorb more electromagnetic waves within the band of 0.4~2.5 μm than the majority of other ground objects do. Within the NIR band and Mid-IR bands, water can absorb almost all of the incident energy from the sun; that is to say, the naturally clear water

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bodies within the NIR band border on being a "black body." Therefore, within the band of 1.1~2.5 μm, most naturally clear water bodies have little reflectivity, approaching a zero value.

Water bodies in nature often contain various kinds of inorganic and organic substances. Some impurities within the water remain in suspension and can scatter and absorb part of the incident energy to bring about significant changes in the electromagnetic energy projected through the water body. The turbidity and chlorophyll concentrations of water carrying suspended sediment are major factors influencing the spectral characteristics of various water bodies.

Although snow is a solid state of water, the snow on the Earth's surface is markedly superior to natural water bodies in respect to its spectral reflectance characteristics.

3. Spectral Characteristics of Rock

The spectral curve for rock does not assume a uniform pattern or shape. The curve's shape is subject to influences from differing mineral composition, mineral content, moisture content, grain size, surface roughness, lustre, and other characteristics.

4. Spectral Characteristics of Buildings

In consideration of the fact that the roof is the most visible part of a building on a satellite image, the spectral characteristics of different types of building materials used in roof construction will be a research priority. The reflectivity varies from one building material to another. For example, a grayish white asbestos roof exhibits the highest reflectivity whereas an iron-clad roof that is grayish black, or a roof that is flat and smooth, exhibits low reflectivity.

IV. Terminology

1. Spatial Resolution

Spatial resolution can be defined using various criteria. In respect to the ground, it refers to the identifiable minimum distance between two adjacent ground objects or the minimum size of a ground object. For a remote sensor image, it means the size of the minimum object that can be distinguished in detail; or it reflects the minimum angle or the measurement of the linear distance between two objects that can be detected by the RS data set.

2. Spectral Resolution

Spectral resolution usually defines the multi-band characteristics of RS information. Spectral resolution identifies the number of the bands utilized by the remote sensor, the region of wavelength of each band, and the wavelength interval. In other words, the number of channels at a central wavelength and spectral range of each channel combine to determine spectral resolution. For example, as far as black/white panchromatic aerial photos are concerned, the camera's film or digital detectors will record the spectral reflectance of visible light: red, green, and blue over a comprehensive wide band of visible energy (wavelength: 0.4~0.7 μm; band interval: 0.3 μm). Landsat/TM employs seven spectral bands to ensure a satisfactory range of spectral response characteristics for the same ground object or different ground objects. For example TM Band 3 employs a narrow spectral band (wavelength: 0.63~0.69 μm; band interval: 0.06 μm) to record the spectral reflectance of red light.