Calibrating Remote Sensing Cameras

Most remote sensing cameras are, essentially, high quality electronic digital cameras with complex software built in. Many also have spectral imaging capabilities that allow them to image a scene in multiple spectral bands simultaneously. The capability of these cameras can be verified and even enhanced by optical calibration while they are still on the ground. Integrating sphere uniform sources are used for this calibration by supplying:

- uniform radiance
- temporal stability
- known radiance
- known, stable spectral characteristics
- radiance adjustability without altering spectral characteristics

Uniform Radiance

A well-designed integrating sphere uniform source, when viewed from outside the sphere, presents a nearly perfectly uniform radiance - uniform to better than 1%. When such a source is presented to a camera, the camera's output will generally not be as uniform primarily because of the pixel-to-pixel non-uniformity of the detector array. However, these effects are constant and can be corrected by software.

Temporal Stability

By choosing stable tungsten halogen lamps and stable current-controlled power supplies, the radiance of a uniform source sphere is extremely constant. Additionally, it is easy to fit a detector on the sphere which monitors the same radiance that the camera "sees" so any changes in radiance, such as those caused by optical back-reflections from the camera, are readily apparent and quantified.

A Labsphere uniform source with a one meter aperture used for large remote sensing calibration applications.

Labsphere's unique system utilizes precision measurement technology to meet the demanding requirements of remote sensing camera calibration.

Known Radiance

Camera designers are aware of the illumination conditions on the ground and the range of expected reflectance factors of the viewed scenes. Accordingly, they design the cameras to view a specific range of radiance levels. A uniform source can verify that the cameras are responding as designed to a specific radiance level.

Known, Stable Spectral Characteristics

Since many remote sensing cameras have spectral imaging capabilities, and all have spectral variations in response, it's important that the spectral distribution of the calibration source be well known. Using stable lamps and power supplies means that the sphere output can be measured in a laboratory and be counted on to hold that spectral characteristic for a significant period of time. Also, multiple filtered monitor detectors, or even a monitoring spectrometer, can be used to continuously verify the spectral characteristics.

Radiance Adjustability

By fitting multiple lamps in the sphere, it's possible to achieve multiple levels of uniform, stable radiance. Actually, by using an external lamp with a variable aperture along with properly selected sizes of interior lamps, the sphere can be adjusted to any radiance level from zero to maximum, if desired. A monitor detector can continuously check and report the radiance. With this arrangement, a camera can be tested over its complete dynamic range.

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PB-16015-000 Rev.00