PROPOSAL TO DEVELOP A CONCEPTUAL DESIGN FOR A HIGH SPECTRAL AND SPATIAL RESOLUTION REMOSE SENSING INSTRUMENT (HSSRRSI)

Introduction

This is an unsolicited proposal to develop a conceptual design for the next generation LANDSAT/SPOT type remote sensing instrument. This instrument would provide data that will replicate the current LANDSAT data set, and also provide data for advanced remote sensing applications development. The proposal does not make use of any "beyond the state-of-the-art" technologies. The distinctive features of the proposal are innovative uses of currently available technologies.

Significant features of the HSSRRSI:

- Full spectral imaging
- 10-meter VIS-NIR full spectral spatial resolution
- 2-meter 3-color spatial resolution
- 20-meter SWIR full spectral spatial resolution
- 30-meter IR spatial resolution
- No on-board calibration
- "Bow-tie" correction optics
- Simplified instrument characterization
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Instrument technologies to be employed:

- All reflective optical system
- Full "pushbroom" system, (no scanner)
- Multiple, registered focal planes
- Multiple spectrometers for full spectral coverage
- Duplicated spectrometers for full spatial coverage
- Non-linear digitization
- Real time spectral curve generation
- "Spectro-spatial" data compression
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General System Description

Full Spectral Imaging: The HSSRRSI would employ full spectral imaging. Some of the advantages of full spectral imaging are:

- No need to select spectral bands
- Minimized need for absolute radiometric calibration
- Reduction in data volume
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Even though the HSSRRSI would use a detector with many pixels, essentially collecting the spectrally dispersed light in many bands, the multi-band readout of the detector would be converted, in real time, to spectral curves. Instead of representing every spatial pixel as a series of narrow bands, as is currently done with "hyperspectral" instruments, a curve would be fitted to a histogram of the bands. This curve would contain all of the information of the multiple bands, but could be represented with many fewer bits of data.

The full spectral data could be converted, on the ground, to match any currently available data set, such as LANDSAT. The full spectral data could also be used directly, requiring only small variations on the existing data processing procedures, to produce data products directly.

Even though it is expected that the HSSRRSI instrument would be radiometrically calibrated, this calibration would not be as critical as in multi-band systems as complete spectral curves would be available rather than just selected bands. The radiometric calibration of the HSSRRSI would be accomplished vicariously, by using well-calibrated ground truth sites.

Characterization of the HSSRRSI would be simpler than current multi-band instruments. This is primarily because there is no need to accurately characterize the spectral bandpass of every band. The HSSRRSI collects all the light across the spectrum. This light is simply divided up into bins and then a spectral curve fitted. This feature, along with the reflective optical system, greatly simplifies instrument characterization.

<u>All reflective optical system:</u> The HSSRRSI would use all-reflective, wide field-of-view, low stray light, fore optics. Some advantages of reflective fore optics are:

- Good blue through IR spectral transmission
- No chromatic aberration
- "Bow-tie" correction
- Thermal stability
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Though the terms "reflective", "wide FOV", and "low stray light" are traditionally considered to be mutually exclusive, there is no reason that such optics cannot be built. One must keep in mind that the optical system is intended to image a slit; a long row of many pixels (or several rows of many pixels, as will be discussed later). The fore optics can be thought of as a merged array of reflective optics. An additional feature of the fore optics would be the capability to project the
Earth's curved surface onto the flat focal plane. This would eliminate the annoying "bow-tie" effect typically seen in scanning systems.

<u>Multiple, registered focal planes:</u> In order to cover the desired spectral ranges (VIS, NIS, SWIR, and IR), multiple, registered focal planes feeding multiple spectrometers will be used. The multiple focal planes may be split out from the primary focal plane using fiber optic arrays, or a combination of mirrors and beam splitters. This approach will assure that all focal planes are

spatially co-aligned and only slightly temporally mis-registered. The multiple spectrometers will use common replicated reflective optics to assure spatial registration.

Non-linear digitization: To minimize digitization requirements and maximize the signal-to-noise ratio, non-linear digitization will be used. The square root algorithm would be most effective. The non-linear digitization would be applied immediately after detector readout and before real-time conversion to full spectral curves.

Spectro-spatial compression: By taking advantage of the normally small differences between adjacent pixels, both spatially and spectrally, significant compression of the data may be accomplished. The full spectral imaging system inherently spectrally compresses the information. Spatial compression can be accomplished using another method.