MSI vs HSI Explainer

Exploring the Difference Between Multispectral and Hyperspectral Imagery

Pixxel is a space data company building the world's most advanced constellation of hyperspectral earth-imaging satellites. The constellation is designed to provide global coverage every 24 hours at high spatial resolution. Pixxel's data is captured from a combination of customer tasks and regular monitoring of high-interest areas. In this explainer sheet, we'll dive into the key differences between multispectral and hyperspectral imagery, showcasing how our hyperspectral satellites offer a distinct advantage in capturing and analysing Earth's surface characteristics.

What is Multispectral Imagery?

Multispectral imagery (MSI) is a type of remote sensing technology that captures data across a limited number of discrete spectral bands (typically 3-12), each representing a specific range of the electromagnetic spectrum. These bands are typically chosen to include the visible spectrum (red, green, and blue) as well as the near-infrared (NIR) region. Multispectral sensors (such as Landsat 8 OLI) collect information from a fixed set of bands, providing a basic and generalized view of the Earth's surface that can allow for visible monitoring and basic analysis of things such as vegetation health and land cover classification.

What is Hyperspectral Imagery?

Hyperspectral imagery (HSI) is a more advanced form of remote sensing technology that captures data across a vast number of adjacent spectral bands (typically 37+) offering a detailed and comprehensive view. This high spectral resolution enables a nuanced detection of surface materials through its narrow wavelength bands that allow the identification of objects on Earth's surface giving us information about their physical and chemical properties.

Why is this important? The differences in spectral resolution is key in helping identify objects in remotely sensed imagery. This is because we are able to derive spectral response curves that we wouldn't otherwise be able to generate with multispectral imagery. This is particularly helpful in vegetation monitoring as an example, as vegetation

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has the highest reflectance in the near infrared and reflects more green light in the visible spectrum and with HSI being able to detect the nuance in these portions of the electromagnetic spectrum.

How are MSI and HSI Different?

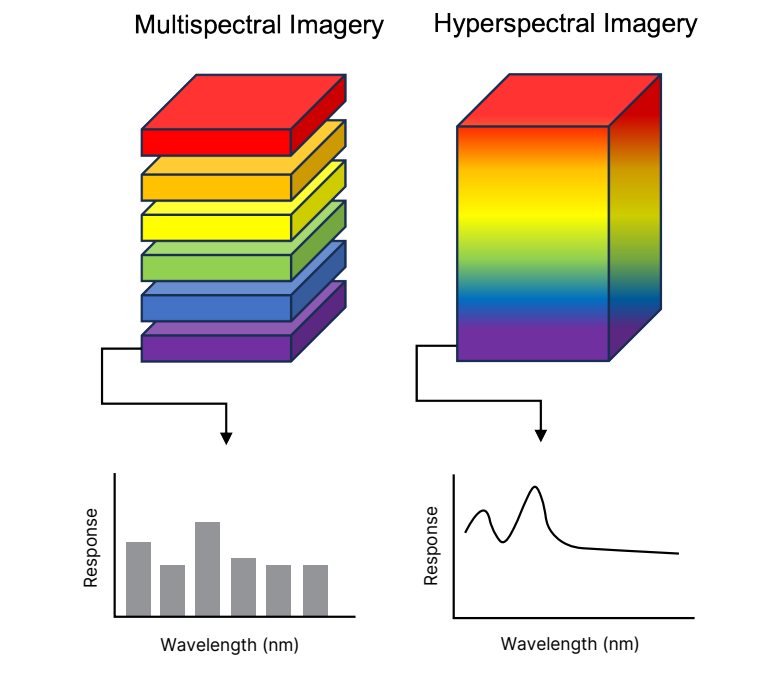
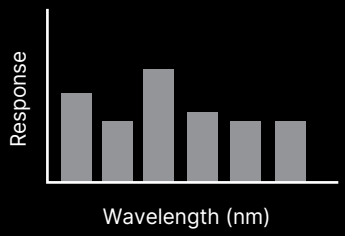
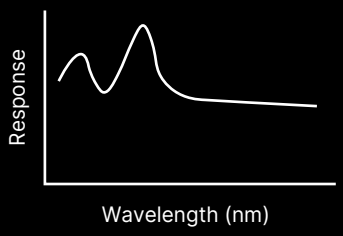


Figure 1: Difference between multispectral and hyperspectral image stacks capturing images across specific spectra, and hyperspectral imaging, encompassing images taken across a broad range of spectra.

	Multispectral Imagery	Hyperspectral Imagery
Number of Bands	Between 5-36, (RGB, NIR)	Typically over 37 (USGS), numerous contiguous spectral bands
Bandwidth	Broad 	Narrow 
Material Discrimination	Limited	Enhanced

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Spectral Signatures

In the realm of remote sensing, spectral signatures are the unique fingerprints of materials and surfaces in response to different wavelengths of light. These signatures are defined by the way objects interact with and reflect light across the electromagnetic spectrum. Each material exhibits distinct absorption and scattering characteristics resulting in a unique spectral signature. By analysing these signatures, remote sensing analysts can identify materials, differentiate surface features, and gain insights into the Earth's surface. The enhanced capability to capture spectral signatures is a fundamental advantage of hyperspectral imagery that enables precise material identification and environmental monitoring.

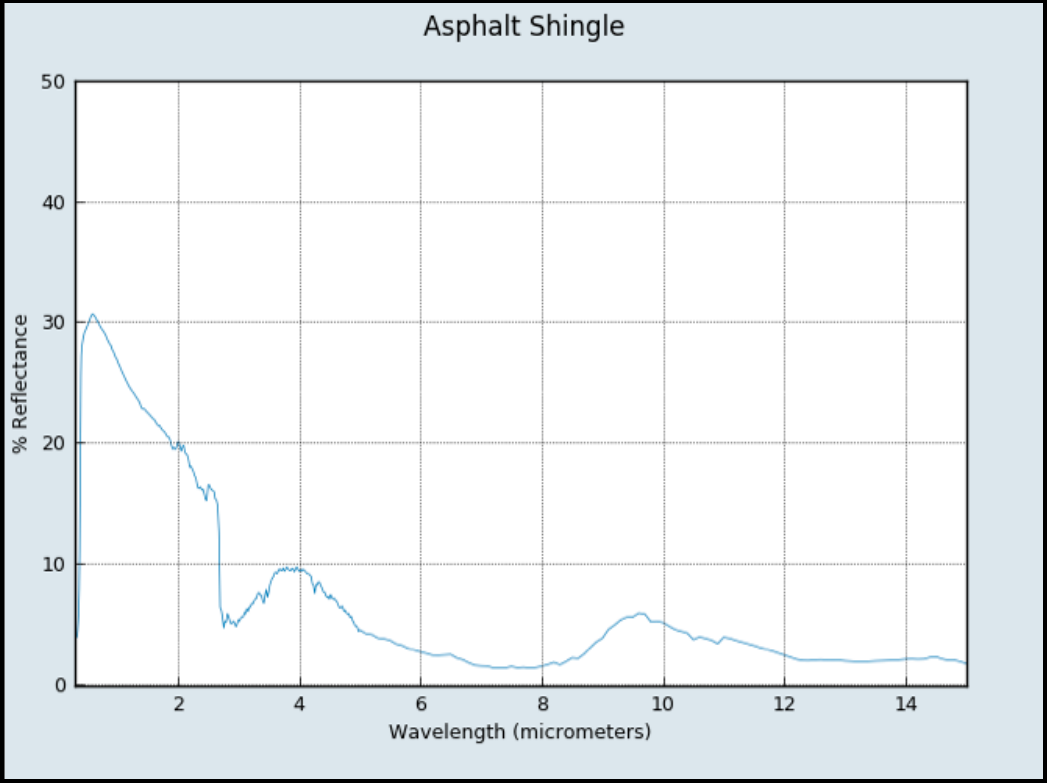

Figure 2: Sample spectral response curve highlighting the spectral signature of an asphalt shingle. Credit: NASA JPL

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Applications

Application Area	MSI Use Cases	HSI Use Cases
Agriculture	Crop health assessment	Disease detection, pest monitoring, nutrient detection
	Land cover classification	Crop type identification
	Irrigation Management	Water stress assessment
Geology and Mining	Geological mapping	Mineral identification, resource exploration
	Soil composition analysis	Mineral prospecting
Urban Planning	Urban expansion monitoring	Building material identification, impervious surface mapping
Environmental Monitoring	Land use change detection	Material and surface identification
	Vegetation analysis	Biodiversity assessment, specific habitat assessment, health monitoring, carbon stock monitoring
	Water quality assessment	Identification of water pollutants, algal bloom detection

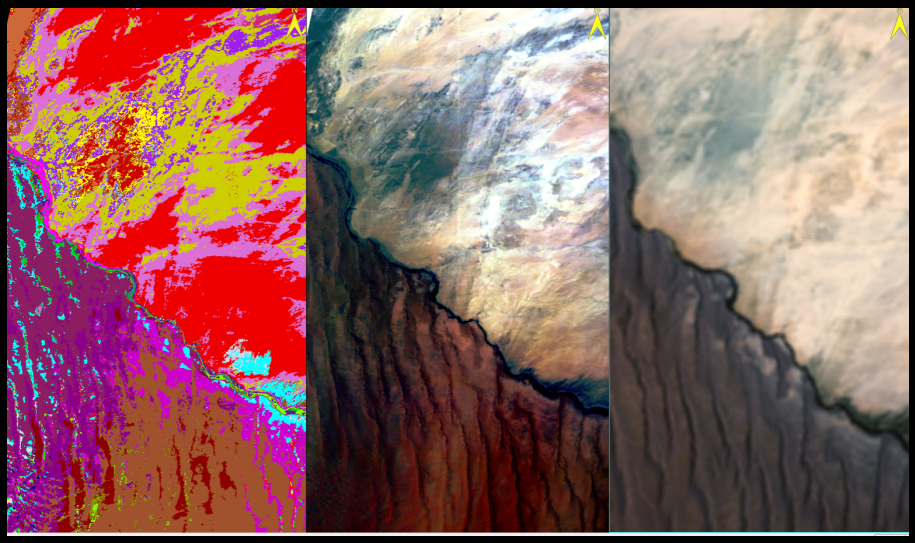

Figure 3: Comparison between the derived classification of 30m Pixxel Tech Demonstrator imagery (left), Pixxel visible imagery (centre), and 30m Landsat 8 OLI imagery (right) over Gobabeb, Namibia.