OVERVIEW OF THE FOURIER TRANSFORM HYPERSPECTRAL IMAGER (HSI) BOARDED ON HJ-1A SATELLITE

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On September 6, 2008, in Taiyuan Satellite Launch Center, HJ-1A/B satellites (HJ-1A/B), China's first two satellites of Environment & Disasters Monitoring and Predicting Microsatellite Constellations, were successfully launched with the technique of "one rocket, two satellites".

The primary mission of HJ-1A/B is to validate new instrument technologies in flight and to provide remotely sensed data to the user community for Environment and Disaster Monitoring. The three primary instruments boarded on HJ-1A/B are the HyperSpectral Imager(HSI), Charge Coupled Device(CCD) and Infrared multi-Spectral (IRS). The technical specifications of these three instruments are given in Table 1.

Table 1 Instruments boarded on HJ-1A/B

satellite	payload	band	Spectral range (μm)	Spatial resolution (m)	width (km)
HJ-1A	CCD	B1	0.43-0.52	30	360
		B2	0.52-0.60	30	
		B3	0.63-0.69	30	
		B4	0.76-0.90	30	
	HSI		0.45-0.95	100	50
HJ-1B	CCD	The same as that of HJ-1A			
	IRS	B5	0.75-1.10	150	720
		B6	1.55-1.75	150	
		B7	3.50-3.90	150	
		B8	10.5-12.5	300	

The HyperSpectral Imager(HSI) on-board HJ-1A satellite is a Fourier Transform HyperSpectral Imager(FTHSI) built by Xian Institute of Optics and Precision Mechanics(XIOPM) of Chinese Academy of Sciences(CAS). The FTHSI is a kind of Spatially Modulated Imaging Interferometer (SMII) developed in the 1990s[1-3]. Due to its theoretical advantages and its stable capability, this new spectral imaging technology was developed and boarded on a satellite fewer than ten years after its emergence[4-6].

The data from a dispersive imaging spectrometer can normally be processed through relative radiometric correction and absolute radiometric correction, but the data of HSI are Fourier transformed, and they must be processed through a series of special processes which include data preprocessing, FFT, absolute corrections and image combination. There are total of 115 bands between 450nm and 950nm in the hyperspectral level 2 products after they are reconstructed from the HSI raw interferential data. A summary of the payload characteristics is shown in Tables 2.

Table 2 Spectral and radiometric properties of HSI

Parameter	Value
Instrument type	Imaging interferometer
HSI Technique	Fourier transform
Swath Width	≥50 km at 650 km altitude
Spectral Range	459-956 nm
Spectral Resolution	98.5 cm^{-1}
Ground Sampling Distance	100 m
Number of Bands	115
Digitization	12 bit
Spatial Coverage Technique	Pushbroom

The quality of HSI Fourier transformed raw data can be affected by the interferogram sampling, radiometric uniformity, sidelobes and so on. To overcome potential limitations, we have designed the spectrum reconstruction flow for the HSI data. The process of HSI data spectrum reconstruction can be divided into data preprocessing, FFT, absolute correction and image combination. Figure 1 shows the flow chart of spectrum reconstruction.

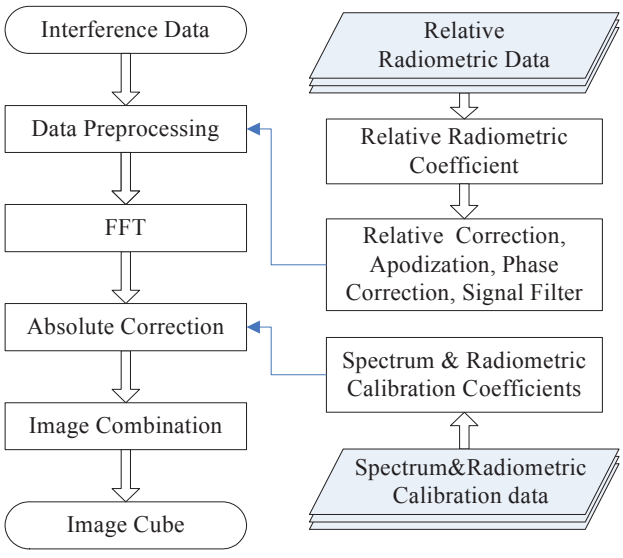

Figure 1 Spectrum reconstruction flow chart

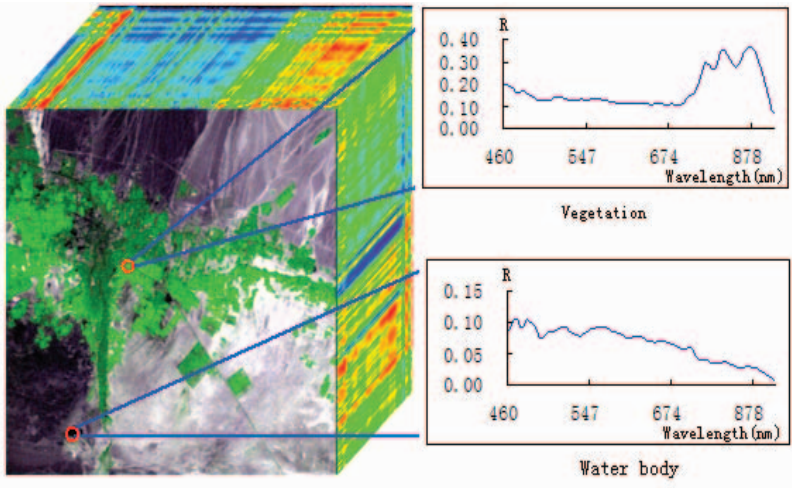

Figure 2 First orbit hyperspectral image of HJ-1A

The Fourier transform HSI on the HJ-1A satellite provides a new opportunity to obtain hyperspectral space observations using a promising new technology. The HSI Fourier transformed data can be reconstructed successfully by GDPS in a timely way every day. The first orbit hyperspectral image was received on Sept. 9, 2008. One part of it, from Hami City in Xinjiang province, is shown in Figure 2. The vertical coordinate represents the top of atmosphere reflectance (TOAR).

HSI products already have been distributed to various users. Due to its fine spectral resolution, hyperspectral imaging can be used to precisely detect, identify, and categorize diversified objects. At present, the HSI is running normally, and it has provided many HSI products since it launched. It has begun play an important role in environmental and disaster monitoring, including the fields of water quality, aerosol pollution, flood, earthquake and so on.

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