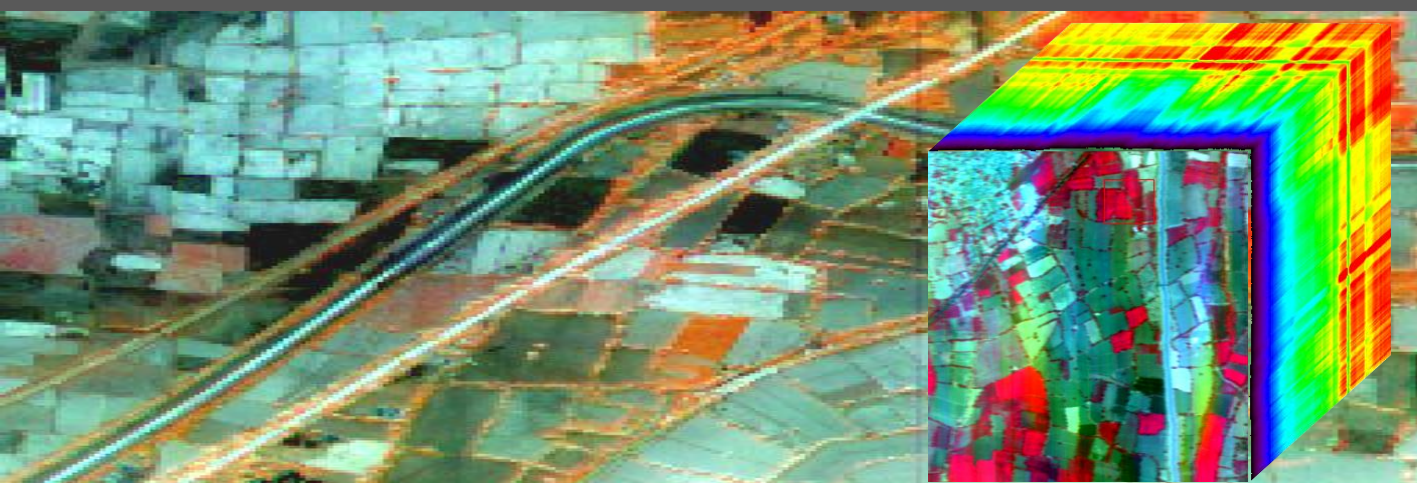


Sensor Electronics Technologies



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SPACE APPLICATIONS CENTRE
INDIAN SPACE RESEARCH ORGANISATION
Ahmedabad

INTRODUCTION

Space Applications Centre, Ahmedabad is a unique centre dealing with a wide variety of activities from payload developments to societal applications, thereby creating a synergy of technology, science and societal applications. SAC is responsible for the development, realization and qualification of communication, navigation, earth observation, planetary observation, meteorological payloads and related data processing and ground systems. It is playing an important role in harnessing space technology for a wide variety of applications for societal benefits.

SAC has also been involving industry, practicing outsourcing, indigenous development of technology and developing vendors. Due to this, the inhouse activities are increasingly being focused on system related aspects, specialised development and fabrication – which are difficult to be done outside. The organizational structure continues to remain dynamic, responding to the needs of the Indian space programme.

Sensors Development Area has designed and developed electro-optical payloads for earth observation and planetary missions for ISRO's satellite program. These include IRS and INSAT series of satellites catering to land and water utilization, vegetation, forestry, oceanography, meteorology, etc. They provide imagery with different resolutions catering to the user needs. Spatial resolution has improved from nearly a kilometer to better than a meter in the current and future systems. Similarly, spectral resolution has increased from few bands in panchromatic/multi-spectral sensors to large number of bands in hyper-spectral sensors. The sensors are custom-designed and optimized for the user applications.

IRS-1C/1D and subsequently Resourcesat-1/2 carried a set of three sensors optimized for agricultural applications. Cartosat-1 carrying fore and aft cameras provides stereoscopic view of the land surface. High resolution imagery for cartography is provided by Cartosat-2. Oceansat-1/2 satellites equipped with high temporal resolution ocean colour sensors are providing data useful for mapping phytoplankton in the oceans. Very High Resolution Radiometers (VHRR) are developed and flown onboard INSAT and METSAT (Kalpana) missions to provide cloud motion vectors and atmospheric parameters. In near future, temperature and humidity sounder payload shall be flown on INSAT-3D. Planetary sensors include optical cameras onboard Chandrayaan-1 and those planned for forthcoming Chandrayaan-2 and Mars missions. Sensors are also flown on airborne platforms for generating site-specific data for scientific studies and generating spectral and spatial signatures of ground features.

These sensor technologies are available for consultancy or these sensors can be custom designed and developed as per the requirement of the user.

Airborne Hyper Spectral Imager

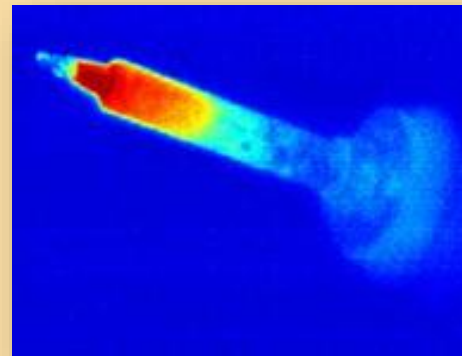
Sub-System	UAV version-1 (available)		UAV version 2 (in near future)	
	Size (Inch ³)	Weight (Kg)	Size (Inch ³)	Weight (Kg)
AHySI Camera, w/o base plate	5.4 x 4.25 x 7.5	2.6	5.4 x 4.25 x 7.5	2.6
PLE + Power Tray	7 x 6 x 2.4	1.5	7 x 6 x 2.4	1.5
Command & Control Unit	15 X 6 X 3	2.0	11.8, 6, 2.16	1.0
PC	10.6 x 6.5 x 3.2	3.0	On card DAQ	--
	Total weight	9.1	Total weight	5.1
	Total Power	39 W	Total Power	10 W



Photograph of Command-Control-DAQ unit for UAV

Thermal Infrared Camera

Microbolometer based Thermal Infrared Camera for Surface Temperature Measurements



Potential Application Areas

- Sea surface temperature
- Land surface temperature
- Laboratory measurements, Biomedical research and Industrial applications

Customization Possible

- Redefinition of spectral bands to suit specific user needs in Thermal-IR
- 230 V operation, PC compatibility, etc.

Payload Features

- Spectral Bands: 3 or more in the region 7 to 14 μm
- IGFOV (Km) from 630 Km Altitude: 1
- Swath (Kms.): > 300
- Quantization (bits): 12
- NEDT (mK): < 500

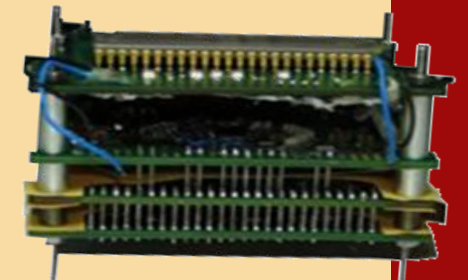


Miniaturization High Resolution Camera

Panchromatic and Multi Spectral

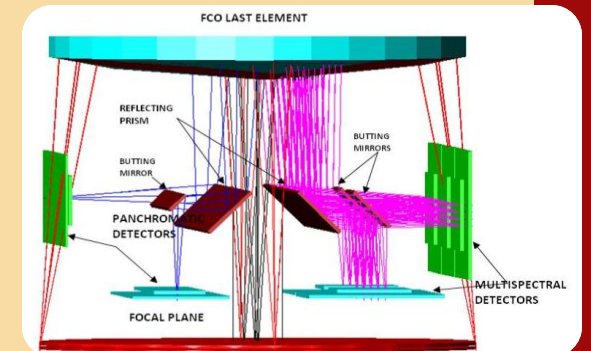
Salient Features

- ✓ Time-Delay-and-Integration mode of imaging
- ✓ Butting of multiple detectors at focal plane
- ✓ State-of-the-art electronics components like SerDes
- ✓ Real-time image compression



Potential Application Areas

- ✓ Cartography
- ✓ Constellations for disaster monitoring
- ✓ Vegetation and forestry
- ✓ Precision farming



Payload Features

- ✓ Spectral Bands: PAN, 4 MX
- ✓ IGFOV (m) from 450 Km Altitude: 1m PAN, 2m MX
- ✓ Swath (Kms.): 05
- ✓ Quantization (bits): 11

Resources Required

- ✓ EOM size (mm^3): $\Phi 370 \times 1000$
- ✓ EOM weight (kg): 30
- ✓ Unregulated power (W): 100
- ✓ Data rate without compression (Gbps): 1



Airborne Terrain Mapping Camera

Panchromatic High Resolution Camera 3 Along-track views for Stereo Triplet



Potential Applications

- Topographic and Cadastral Mapping
- To establish a base map
- Map City services
- 3D City and Urban Modeling
- Electric Transmission lines
- Telecom-Utilities
- Horticulture
- Disaster Management
- Engineering construction and infrastructure
- Defense, Intelligence and national security
- Corridor mapping
- Oil and Gas Pipeline Planning
- High resolution DEM and ortho image

Salient Features

- Stereo triplet
- Programmable gains:4
- Exposure settings : 4
- CameraSize:450 X 255 X 362 mm
- Camera Weight: 6 Kg



30 cm Spatial resolution imagery @ 6 Km altitude



30 cm Spatial resolution imagery @ 6 Km altitude

Specifications

- IFOV: 50 μ rad
- FOV: 11.5°
- Stereo Viewing: +26°, 0°, -26°
- Quantization: 12 bits
- Spectral Range: 500 – 750 nm
- SNR: > 400
- SWR: > 15%
- Data Volume: 30 GB/hr.
- Max. Data Rate: 50 Mbit/sec.

Hyper Spectral Sensor

Salient Features

- ✓ Hyper-spectral sensors are designed for studies of vegetation, mineralogy, atmosphere, trace gases, etc.
- ✓ Compact hyper-spectral sensors are flown onboard IMS-1, Chandrayaan-1, Youthsat and on aircraft systems.
- ✓ Systems can be configured for high spatial/spectral resolution suitable for the intended application.

Applications

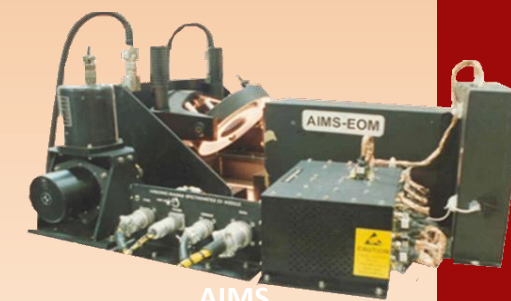
- ✓ Spectral signatures of earth resources
- ✓ Industrial and Field applications

Customization Possible

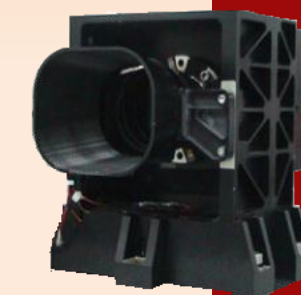
- ✓ Custom spectral / spatial resolution



Youthsat LiVHySI



AIMS



IMS-1 HySI-T



A- HySI

Parameter	HySI-T	New
Payload Features		
Satellite Altitude (km)	632	630
Spectral Bands	64	220
IGFOV (m)	505	30
Swath (km)	129	10
Quantization (bits)	16	10
Resources Required		
EOM Size (mm ³)	160 x 180 x 200	Φ200 x 500
EOM Weight (kg)	3.2	20
Unregulated Power (W)	2.6	70
Data Rate (Mbps)	4	1200

Ocean Colour Sensor

High Radiometric Accuracy Sensors for Oceanographic Applications

Salient Features

- Medium spatial resolution, wide swath payloads
- High radiometric accuracy for oceanographic applications
- Eight-band ocean colour sensors are flown onboard Oceansat-1 (1999) and Oceansat-2 (2010)
- New Ocean Colour Sensor to cater to oceanographic requirements with improved radiometric performance



8 band Ocean Colour Monitor

Customization Possible

- Redefinition of spectral bands for specific R&D (e.g., chlorophyll fluorescence, coastal applications, etc.)
- 230 V operation, PC compatibility, etc.

Parameter	OCM-2	Miniature Ocean Colour Sensor
Payload Features		
Spectral bands	8 bands in the range 0.4 to 0.9 μ m with $\Delta\lambda \cong 20$ nm	3 bands in the range 0.4 to 0.9 μ m with $\Delta\lambda \cong 10$ nm
IGFOV (m) from 720km altitude	360	360
Swath (km)	1440	360
SNR at ocean reference radiance	> 300	> 1000
Quantization (bits)	12	16
Resources Required		
EOM size (mm ³)	701 x 650 x 420	200 x 100 x 200
EOM weight (kg)	78	3
Unregulated power (W)	132	9
Data rate after binning (Mbps)	17	1.5

Sub - Kg Camera

4 Band Highly Miniaturized Multi Spectral VNIR Camera

Salient Features

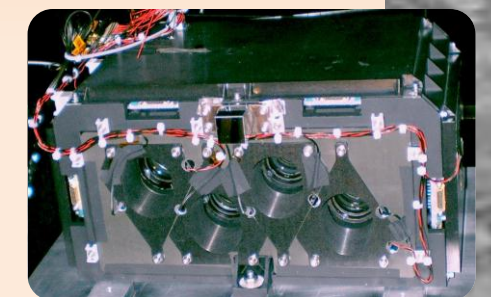
- ✓ Multi-spectral payload for vegetation studies
- ✓ Electro-optical module mass <1 kg
- ✓ Four spectral bands B1/B2/B3/B4 with IRS heritage for vegetation studies
- ✓ Each spectral band housed in separate refractive optical head

Potential Application Areas

- ✓ Vegetation indices
- ✓ Vegetation vigour
- ✓ Forestry

Customization Possible

- ✓ Additional spectral bands can be incorporated for improving user applications
 - ✓ Red-edge studies
 - ✓ Coastal blue applications, Data correction
- ✓ Improved near-IR performance using CCDs
- ✓ 230 V operation, PC compatibility, etc.



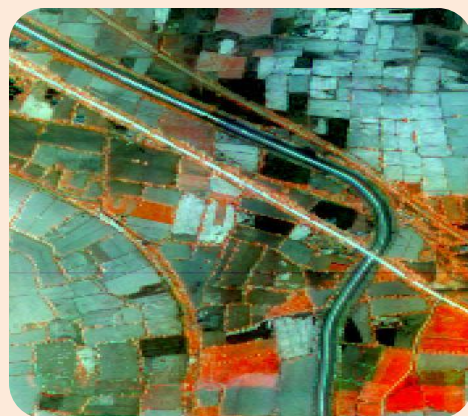
Parameter	MX-T Payload flown in IMS-1 Satellite	New
Payload Features		
Spectral bands	Four spectral bands between 0.45 to 0.86 μ m	Four spectral bands between 0.45 to 0.86 μ m
IGFOV (m)	35	35
Swath (km)	150	150
Quantization (bits)	10	10
Resources Required for Six Bands		
EOM size (mm ³)	300 x 150 x 230	200 x 120 x 200
EOM weight (kg)	5.5	1
Unregulated power (W)	19	6
Data rate (Mbps)	32	60

Airborne Hyper Spectral Imager

Airborne Hyperspectral Imager (HySI-A) is a Wedge Filter based small form factor, compact sensor well suited for Light Aircraft or UAV. Programmability for different illumination conditions and very high spectral sampling allow a wide range of possibilities for optimized imaging.

Salient Features

- ✓ Programmable Gains: 2
- ✓ Programmable exposures: 4
- ✓ Camera weight: 2.6 kg
- ✓ Camera size : 5.4 x 4.25 x 7.5 in 3



4.8 m spatial resolution @ 6 Km

Potential Applications

- ✓ Agriculture: Precision Farming, Vegetation Classification
- ✓ Forest Monitoring
- ✓ Fisheries
- ✓ Water Quality Monitoring
- ✓ Coastal Water Management
- ✓ Environment Monitoring

Specifications

- ✓ IFOV: 800 μ rad
- ✓ FOV: 11.7°
- ✓ No. of Bands: 512
- ✓ Spectral Range: 465 – 995 nm
- ✓ Spectral Width: 10.0 nm
- ✓ Spectral Sampling: 1.02 nm
- ✓ Quantization: 12 bits
- ✓ SNR: > 100
- ✓ SWR: 40%
- ✓ Data Volume: 20GB/hr.
- ✓ Data Rate: 35 Mbps

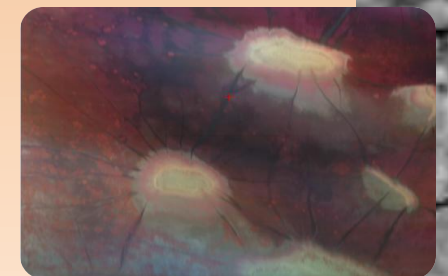
Airborne Imaging Spectrometer

High Resolution – Wide Coverage

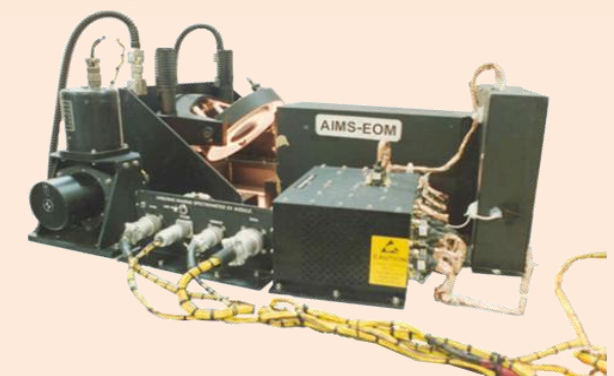
Airborne Imaging Spectrometer (AIMS), a Grating based VNIR Hyperspectral instrument with 2-axis Platform Motion Compensation, is specially developed by SAC-ISRO for generating library of spectral signatures. Variable Integration Time feature incorporated in AIMS facilitates operations at different platform altitude and speed.

Potential Applications

- ✓ Agriculture: Vegetation Classification, Precision Farming
- ✓ Forest Monitoring
- ✓ Fisheries
- ✓ Water Quality Monitoring
- ✓ Coastal Water Management
- ✓ Environment Monitoring



3.96 m spatial resolution @6 Km



Specifications

- ✓ IFOV: 660 μ rad
- ✓ FOV: 14.5°
- ✓ No. of Bands: 143
- ✓ Spectral Range: 450 – 900 nm
- ✓ Spectral Width: 3.0 nm
- ✓ Quantization: 10 bits
- ✓ SNR: > 256
- ✓ SWR: > 20%
- ✓ Data Volume: 18 GB/hr.
- ✓ Data Rate: 24 Mbps

