Assignment-3

Raju Shrestha
Roll No. 48

Date
Page

1) What are the advantages of hyperspectral imaging? If the spectral range of the 288 channels of the CASI (compact Airborne spectrographic imager) is exactly 0.40 μm to 0.90 μm & each band covers a wavelength of 1.8 nanometers (nm), will there be any overlap between the bands?

⇒ Hyperspectral imaging is a new analytical technique based on spectroscopy. It collects hundreds of images at different wavelengths for the same spatial area.

The advantages of hyperspectral imaging are as follows:

i.) Captures wide range of wavelengths for each pixel.
ii.) Provides better detection & identification in complex environment.
iii.) Capable of real-time assessment of dynamic processes.
iv.) Applicable in various fields such as agriculture, mineralogy, environmental monitoring & medical diagostics.
v.) Enables advanced image processing techniques, such as anomaly detection & pattern recognition.
vi.) Generates high-quality data that can be used for accurate modeling & analysis.

Here,

Total wavelength range variable will be 0.90 - 0.40 μm - 0.50 μm. If there are 288 channels of 1.8 nm each.

Now,

$1.8\text{nm} = 1.8 \times 10^{-9}\text{m}$

$1.8 \times 10^{-9} \times 288 = 0.0000005184\text{m}$

$0.0000005184\text{m} = 0.5184\,\mu\text{m}$

∴ 0.5184 μm is greater than 0.50. So, there will be some overlap between some or all of the 288 bands to fit into this 0.50 μm range.

2.) Differentiate between SAR & RAR. Explain why the use of synthetic aperture radar (SAR) is the only practi-cal option for radar remote sensing from space.

⇒ The difference between SAR & RAR are:-

SAR	RAR
i.) It stands for synthetic Aperture Radar.	i.) It stands for Real Aperature Radar.
ii.) It provides higher resolu-tion.	ii.) It provides lower resolution.
iii.) Capable of wide area coverage with detail.	iii.) Limited coverage are for high resolution.
iv.) Complex in data processing & interpretation.	iv.) Simple processing & interpretation.
v.) more expensive due to complex technology.	v.) Less expensive.
vi.) Used in satellites & aircrafts.	vi.) Used in some aircraft & ground based system.

SAR is only practical option for radar remote sensing from space because of the following reasons:-

i.) It can achive high spatial resolution with relatively small antenna.

ii.) SAR operates in microwave spectrum that helps to ensure data acquistion regardless of weather

condition.

iii.) SAR can cover large area efficiently.

iv.) SAR doesn't rely on sunlight & can operate in both day & night.

3.) What are the advantages of microwave remote sensing? Why is microwave remote sensing better suited for monitoring tropical rain forests than optial remote sensing?

⇒ The advantages of microwave remote sensing are:-

i.) All weather capability as it allows data collection in any weather.

ii.) Can operate independent of sunlight, enabling 24/7 data acquistion.

iii.) Effective in identifying & monitoring the extent & changes of water bodies.

iv.) Effective in creating high resolution 3D image of the Earth's surface using SAR.

v.) Useful in monitoring natural disasters & providing timely information of emergency response.

vi.) Sub surface penetration.

Microwave remote sensing is better suited for monitoring tropical rain forest that optical remote sensing because it can penetrate through the dense cloud cover & heavy rainfall which is common in these regions. This all-weather capability ensures continuous data collection regardless of atmospheric conditions.

4.) Outline the steps how RADAR works? Differentiate between range resolution & azimuthal resolution of radar systems?

⇒ RADAR stands for radio detection & ranging. The steps of how RADAR works as;

i.) Transmission :-
The RADAR system generates & sends a radio frequency (RF) pulse through an antenna.

ii.) Propagation :-
The RF pulse travels through the air at the speed of light, spreading out over a wide area.

iii.) Reflection :-
The pulse encounter an object (target) & part of the energy is reflected back toward the RADAR system.

iv.) Reception :-
The reflected RF signal (echo) is received by RADAR antenna & directed to a receiver.

v.) Detection :-
The receiver processes the signal to detect the echo & measures the time delay to determine the target's distance (range).

VI.) Processing :-
The received signal is amplified & converted for analysis, using signal processing to extract target information.

VII.) Display :-
The processed data is displayed on a screen where it is interpreted to identify & track objects.

Differences between Range Resolution & Azimuthal Resolution are :-

	Range Resolution	Azimuthal Resolution
I.)	It is dependent on the wavelength & pulse width.	It is dependent on beam width, which is function of the antenna size & design.
II.)	can distinguish between two targets at different distances along the same line of sight.	can distinguish between two targets at same distance but at different angles from the radar.
III.)	Equation, $R_r = \frac{\tau \cdot c}{\cos r}$ where, τ = pulse length, c = speed of light, r = depression angle	Equation, $R_a = \frac{S \cdot \lambda}{L}$ where, S = short range, L = antenna length, λ = wavelength