# Bharathidasan University

Tiruchirappalli – 620 023, Tamil Nadu

6 Yr. Int. M.Tech. Geological Technology and Geoinformatics

*Course Code :* **MTIGT0902**

# Thermal and Microwave Remote Sensing

*Unit-4 :* Space Borne Radar Sensing

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# *Course Objectives*

- To study the principles thermal remote sensing
- To learn the interpretations and applications of thermal band
- To study the principles of microwave remote sensing
- To study about space borne radar remote sensing and the sensors
- To learn about the applications of microwave remote sensing.

# MTIGT0902 - Syllabus

**Unit:1. Thermal Remote Sensing:** Principles - Definition - Radiant temperature - Black body radiation - Thermal Emissivity of materials - Thermal energy interaction with atmosphere and terrain elements - Kinetic and radiant temperature - Thermal energy detectors - Thermal radiometers - Thermal scanners and data collection. **16 hrs.**

**Unit:2. Interpretation and Application of Thermal data:** Day time and night time thermal data behaviour and manifestation of objects - Thermal inertia - thermography and heat loss - geometric characteristics of thermal scanner imagery (scale distortion, relief displacement, flight parameters distortion) - Radiometric calibrations- SST and LST mapping- application of thermal remote sensing in urban climate, soil moisture and environmental studies. **12 hrs.**

**Unit:3. Microwave Remote Sensing:** Basic principles - RADAR systems - SLAR operations - Antennas (receivers), Spatial resolution - geometric characters of SLAR imagery (Slant Range and distortion, relief displacement, parallax) - influence of earth surface features over Radar energy (geometry, electrical property, soils, vegetation, water, etc.) - interpretation of Radar imagery. **12 hrs.**

**Unit:4. Space Borne Radar Sensing:** Seasat - SIR - ERS-I - Radarsat - JERS - Elements of passive microwave remote sensing (sensors) - applications of LIDAR and ALTM. **12 hrs.**

**Unit:5. Applications of Microwave Remote Sensing:** Applications of Microwave remote sensing in Earthquake study; Din-SAR, Surface and subsurface Lithological Mapping - Paleo channel mapping. SAR Interferometry and its applications. **12 hrs.**

**Unit:6. Current Contours: (Not for Final Exam; only for Discussion):** Change Detection Analysis: Urban Heat Island, Sea surface Temperature Mapping, Land Surface Temperature Mapping- Mapping of hard rock fracture system. Microwave Remote Sensing: Mapping of subsurface lithology.

## References:


1. American Society of Photogrammetry, Manual of Remote Sensing (2nd Edition), ASP Falls Church, Virginia, 1983.
2. Curran, P. Principles of Remote Sensing, Longman, London.1985.
3. Barrett, E.C. and L.R. Curits, introduction To Environmental Remote Sensing, Halstged Press, Wiley, New York.1976.
4. Lillisand, T.M. and Kiefer, P.W, Remote Sensing and Image interpretation, John Wiley&Sons, New York.1986.
5. Lintz, J. and Simonett L.S. (Eds.), Remote Sensing of Environment, Addition-Wesley, Readings, Mass.1976.
6. Lo. C.P. Applied Remote Sensing, Longman, London.1986.
7. Richadson, B.F.Jr.(Ed), Introduction To Remote Sensing of The Environment, Kendall / Hunt, Dubuque, Iowa.1978.
8. Sabins, F.F.Jr., Remote Sensing Principles and interpretation, Freeman, Sanfrancisco.1978.
9. Schanda,E. (Ed), Remote Sensing for Environmental Science, Springerverlag.1976.
10. Burney, S.S Application of Thermal Imaging, Adam Hilger Publications.1988.
11. Hord R.Michel, Remote Sensing Methods and Application, John Wiley and Sons.1986.
12. Drury S.A, A Guide to Remote Sensing - interpreting Images of Earth, Oxford Science Publications, Oxford.1990.
13. Floyd M. Henderson; Principles & Applications of Imaging Radar, John Wiley & Sons, New York, 1998.
14. Alexay Bunkin& Konstantin Volia. K, - Laser Remote Sensing of the Ocean Methods & Publications. John & Wiley & Sons, New York, 2001.

## *Course Outcomes:*

1. Students will learn about the difference among reflection, scattering and emission from earth materials.
2. Students will understand the principles of thermal and microwave remote sensing.
3. Students will come to know the applications of thermal and microwave remote sensing.
4. Students will learn about application of microwave remote sensing in earthquake field.
5. Students will understand the LIDAR and ALTM applications
6. Students will also learn about application of microwave data in subsurface lithological mapping.

# UNIT - 4

# AIRBORNE AND SPACEBORNE RADAR SYSTEMS

**Unit:4. Space Borne Radar Sensing:** Seasat - SIR - ERS-I - Radarsat - JERS - Elements of passive microwave remote sensing (sensors) - applications of LIDAR and ALTM.

**12 hrs.**

**Interferometric systems** use two antennas, separated in the range dimension by a small distance, both recording the returns from each resolution cell.

The two antennas can be on the same platform (as with some airborne SARs), or the data can be acquired from two different passes with the same sensor, such has been done with both airborne and satellite radars.

By measuring the exact phase difference between the two returns (A), the path length difference can be calculated to an accuracy that is on the order of the wavelength (i.e centimetres). Knowing the position of the antennas with respect to the Earth's surface, the position of the resolution cell, including its elevation, can be determined.

**The Sea Ice and Terrain Assessment (STAR)**

**Intera Technologies Limited of Calgary, Alberta, Canada,**

# Convair-580 C/X SAR system


Developed and operated by the Canada Centre for Remote Sensing.

The system was transferred to Environment Canada in 1996 for use in oil spill research and other environmental applications.

This system operates at two radar bands, C- (5.66 cm) and X- (3.24 cm).

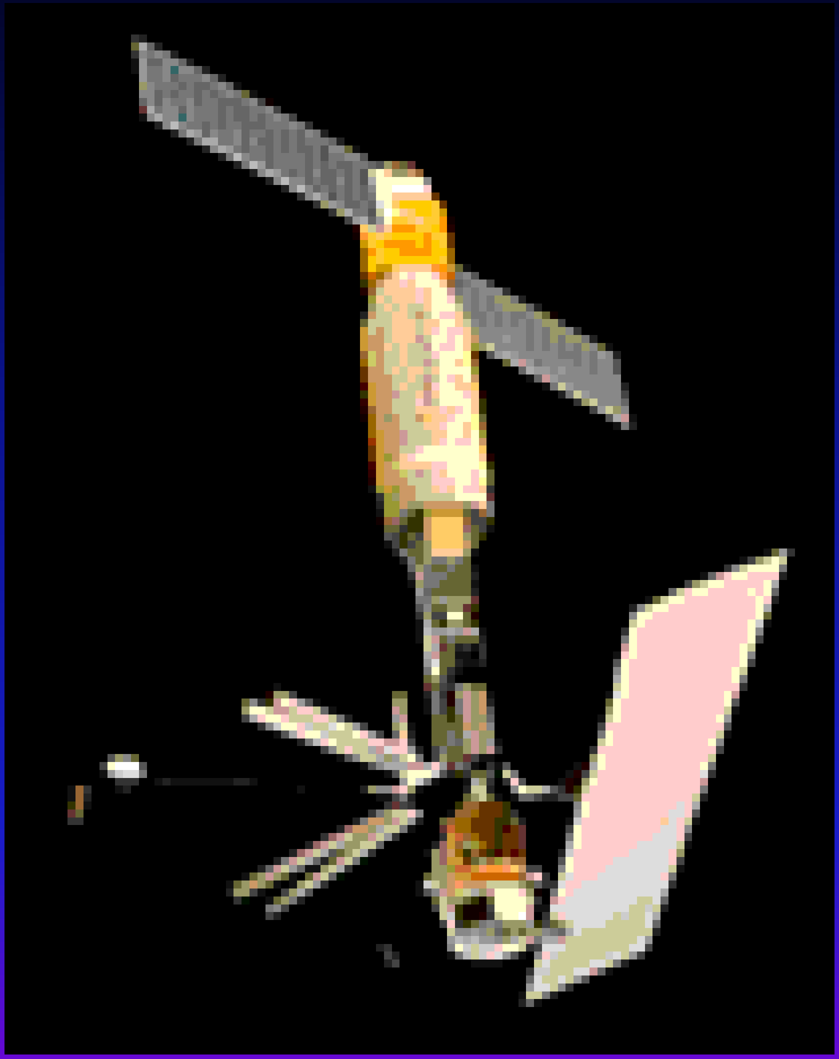
Cross-polarization data can be recorded simultaneously for both the C- and X-band channels, and the C-band system can be operated as a fully polarimetric radar.


The **AirSAR** system is a C-, L-, and P-band advanced (NASA) polarimetric SAR which can collect data for each of these bands at all possible combinations of horizontal and vertical transmit and receive polarizations (i.e. HH, HV, VH, and VV).

Spatial resolution of the AirSAR system is on the order of 12 metres in both range and azimuth. Incidence angle ranges from zero degrees at nadir to about 70 degrees at the far range.

## SEASAT

**Launched in 1978, was the first civilian remote sensing satellite to carry a space borne SAR sensor.**



**The SAR operated at L-band (23.5 cm) with HH polarization. The viewing geometry was fixed between nine and 15 degrees with a swath width of 100 km and a spatial resolution of 25 metres.**

The **Sea Ice and Terrain Assessment (STAR)** systems operated by Intera Technologies Limited of Calgary, Alberta, Canada, (later Intermap Technologies ) were among the first SAR systems used commercially around the world.

Both STAR-1 and STAR-2 operate at X-band (3.2 cm) with HH polarization in two different resolution modes.

The swath coverage varies from 19 to 50 km, and the resolution from 5 to 18 m.

They were primarily designed for monitoring sea ice (one of the key applications for radar, in Canada) and for terrain analysis.

Radar's all-weather, day or night imaging capabilities are well-suited to monitoring ice in Canada's northern and coastal waters.

STAR-1 was also the first SAR system to use on-board data processing and to offer real-time downlinking of data to surface stations.

# Difference between Airborne & Space borne radar systems

| Airborne Radars | Space borne Radars |
|---|---|
| Obtained from 7-12 km altitude | Obtained from 200-800 km altitude |
| Moderate to low depression angle ($20^0$ or more across the swath) | High to moderate depression angles ($2^0$-$6^0$ across the swath) |
| High to moderate look angles | Low to moderate look angles |
| Swath width 5-45 km | Swath width 25-100 km |
| Subject to atmospheric disturbances because of low altitude | No atmospheric disturbances because of high altitude |

# LIDAR SENSING

**( LIGHT  DETECTION AND RANGING )**

- LIDAR is an Active Remote Sensing
- Instead of Micro Wave (mm to cm), Laser Beam (approx. 1000 nm) is Used
- Can be used both in Profiling & Scanning Modes
- Uses less power to generate
- Can go for a larger ranges than microwave as pointed targets
- But the performance of Laser is affected by atmospheric phenomena such as clouds, rain, vapour, etc.

# LIDAR APPLICATIONS

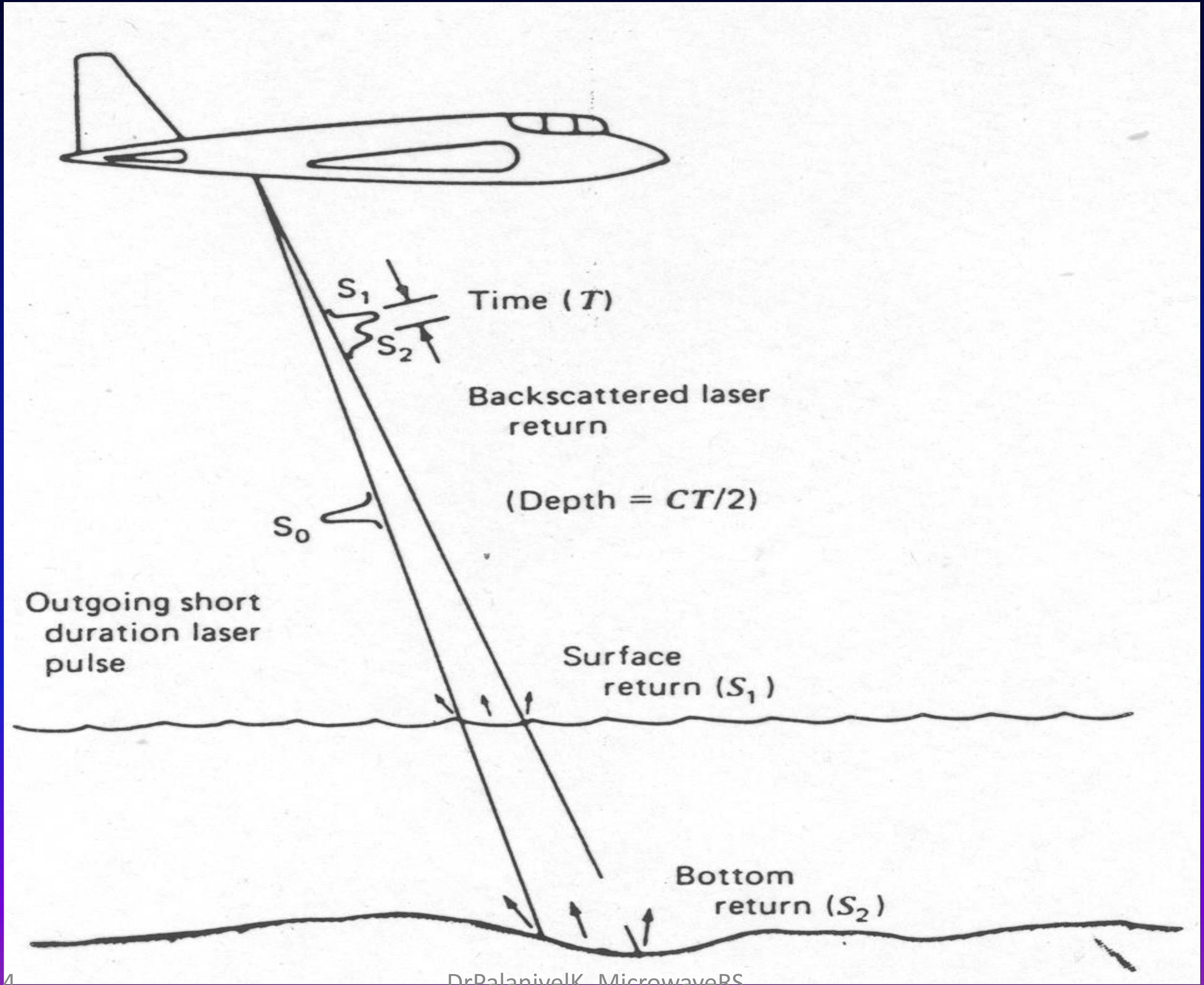
→ Measurement Of Water Depth

# On sending pulsed coherent laser energized strongly reflected

# Weakly reflected one returns from the lake bottom next

# From the difference the depth of the water Column is worked out

# Principle of LIDAR Bathymetry



# Thank you