

Department: SPACE SCIENCE

Batch: MS -7 (RSGS)

Semester: 2nd Semester

Session Year: SPRING-2019

Section: A

Faculty : WAQAS AHMED QAZI

Submit Date: 15/04/19

Course: 820307 Radar Remote Sensing

Credit Hour: 3

COURSE DESCRIPTION

This is a graduate-level course on remote sensing using active radar. It presents an overview of radar basics, fundame building blocks of radar remote sensing, interaction of radar with targets, and different remote sensing applications.

It is expected that students will develop a quantitative understanding of radar system requirements for remote sensing, how different kind of targets interact with radar signals, and how the analysis of these returned signals can help us in gaining informat

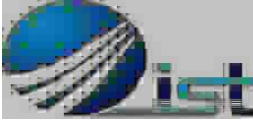
TEXT AND MATERIALS

Textbook: Richards (2009), Remote Sensing with Imaging Radar

References: Woodhouse (2005), Introduction to Microwave Remote Sensing
 Sullivan (2004), Radar Foundations for Imaging & Advanced Concepts
 Mahafza (2009), Radar Signal Analysis & Processing using MATLAB
 Mahafza (2000), Radar Systems Analysis & Design using MATLAB
 Oliver & Quegan (2004), Understanding Synthetic Aperture Radar Images
 Jackson & Apel (2004), SAR Marine User’s Manual
 Lillesand & Kiefer (2007 6th ed. / 2003 5th ed.), Remote Sensing & Image Interpretation
 Relevant papers
 Assigned readings

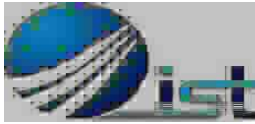
Practical Applications:

Chapter & Topic Detail	
Chapter	Topic
Intro to Radar Remote Sensing	Intro to Remote Sensing
	Intro to Radar Remote Sensing
	History of Radar Remote Sensing
	Radar Basics
Mathematics for Radar	Electromagnetic Waves & Polarization
	Decibels
	Fourier Series & Fourier Transform
	Complex Numbers
Radar Fundamentals	Pulses & Pulsewidth
	Ranging & Range Ambiguity
	Doppler Shift & Doppler Radar
Radar Equation	Power requirements
	Maximum detectable range
	Noise power
	System losses
	SNR



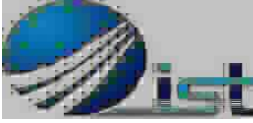
Chapter & Topic Detail

Chapter	Topic
Radar Equation	Radar equation analysis
	Radar equation derivation
	SNRmin
Antennas	Directivity & Gain
	Beamwidth
	Antenna pattern
	Array antennas
	Radar coordinates
	Solid angle
Imaging Radar	Side-looking Radar
	Imaging Geometry
	Slant Range and Ground Range
	Along-Track Resolution
	Ground Range Resolution
Pulse Compression	Disadvantages of Pulsewidth Reduction
	Pulse Compression (Chirping)
	Matched Filtering
	Pulse Compression Ratio
Sources of Error in Imaging Radar	Compressional Distortion
	Layover
	Foreshortening
	Shadow
	Radar Cal/Val
	Passive Calibration Targets
	Active Calibration Targets
	Radiometric Errors
Radar Scattering from Earth Surface Features	RCS
	Rayleigh/Mie/Non-selective Scattering
	Hard Target Scattering: Double / Triple Bounce
	Surface/Volume/Hard Target Scattering
	Relative Permittivity & Dielectric Constant
	Signal Penetration & Absorption
	Surface Scattering: Smooth & Rough Surfaces, Rayleigh Roughness Criterion
	Surface Scattering: Penetration Depth & Impact of Moisture
	Surface Scattering: Polarization Dependence
	Volume Scattering: Backscatter Models
	Volume Scattering: Depolarization
	Hard Target Scattering: Point Targets, Corner Reflectors, Urban Areas, Ships
	Ocean Surface Imaging: Bragg Scattering, Two-scale Model
	Ocean Surface Imaging: Biogenic/Oil Slicks and Bragg Wave Damping
	Hard Target Scattering: Impact of Orientation, Cardinal Effect
Scattering from Other Earth Surface Features: Crops, Sea Ice, etc.	
SAR	Inverse SAR



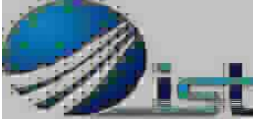
Chapter & Topic Detail

Chapter	Topic
SAR	SAR Image Formation
	Speckle Noise
	Radiometric Calibration
	Doppler History & Synthesizing the Aperture
	SAR imaging geometry
	Data Processing Tools
	Airborne & Spaceborne SAR Instruments
	Multilooking and Spatial Filtering
	dB transformation
	Accessing SAR data
	Synthetic Aperture
SAR Imaging Modes & Data Products	
Altimetry & Scatterometry	Altimetry Basics
	Brown Waveform
	SSH Measurements
	Scatterometry for Ocean Surface Winds
	Issues in Coastal Altimetry
	Radar scatterometry
	Altimetry for inland waters and rivers
	J1 / J2 / S3 / S6 satellites
	QuikSCAT / ASCAT / NSCAT
Radar Meteorology	Precipitation as volume target
	Precipitation Radar
	Radar reflectivity
	Z-R Relationship
	TRMM & GPM
	Radar for meteorology
	Radar equation for weather radar
Project Presentations	Class project presentations
Microwave Spectrum & Atmosphere	Interaction with Dry Atmosphere
	Interaction with Water Vapor
	Interaction with Rain
	Interaction with Clouds & Fog
Hands-on Activities	Opening / importing / Exploring SAR data from different satellites
	Using SAR archives / data systems to search for data
	Speckle Filtering
	dB Conversion & Histogram Analysis
	Analyzing scattering behavior, visual analysis & interpretation
	Intro to ESA SNAP
	Pre-processing: Calibration, Geocoding
	Flood inundation mapping through SAR
	Exploring complex data, S-1 SLC to GRD conversion
	Intro to ASF MapReady
	ALOS-1 PALSAR Terrain Correction



Chapter & Topic Detail

Chapter	Topic
Hands-on Activities	Using SNAP Graphs and Batch Processing
	Pre-processing of Optical / SAR data for Palaeochannel Detection
	Intro to ESA BRAT, Exploring Radar Altimetry Data
	Exploring multi-pol data
	Repeat-pass Interferometry
Angular Resolution & RCS	Cross-range resolution
	Point target
	Surface target
	Volume target
SAR Intensity Data Applications	Oceanography
	Upwelling & biogenic slicks
	Eddies
	Ocean surface currents
	Ocean fronts
	Oil spills
	Ship & wake detection
	Forest AGB
	SAR canopy penetration
	AGB measurement
	AGB thresholding & saturation
	Flood inundation mapping
	Urban areas: Building backscatter
	Urban areas: Damage detection
	Geology / Geophysics: Palaeochannel detection
Geology / Geophysics: Lithology & faults	
Geology / Geophysics: Mineralization	
Archaeology	
Data fusion	
Polarimetric SAR	Dual-pol and quad-pol systems
	Polarimetric decomposition methods
	PolSAR image classification
	PolSAR applications
InSAR	Interferometry
	Types of interferometry
	Phase unwrapping
	Ground subsidence measurement
	TerraSAR-X and TanDEM-X
	Latest techniques: PSI, TomoSAR
Midterm Exam	Midterm Exam



INSTITUTE OF SPACE TECHNOLOGY, ISLAMABAD

Course Outline

Date: 13/05/19

At: 10:40
