The Potential of Very High Resolution SAR Data for Land Applications

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Radar characteristics



- → All weather observation capability
- → Active system
- → Receives echoes
- ✓ Visualization of radar echoes



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What does the radar measure?

Brightness of features in radar imagery depends on portion of energy that is backscattered to the SAR system



Radar transmits a pulse (traveling velocity is equal to speed of light)

Some of the energy is reflected back to the sensor. The radar measures the radar backscatter σ_0 (sigma naught or sigma zero)

Backscatter properties

- → Surface roughness
- → Dielectric properties
- ✓ Imaging and surface geometry

Image properties: Target interaction

- Surface roughness
 Smooth: height variation much smaller than signal wavelength: specular
 Rough: height variations approach size of wavelength: diffuse
- ✓ Function of wavelength and incidence angle



- A: double bounce (specular)
- **B:** direct reflection (specular)
- **C:** specular reflection
- D: diffuse scattering with dominating direction

E: diffuse scattering (volume)

- F: combination D & A
- G: multiple double bounce
- (H: shadow)

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Spotlight Image: Teotihuacán







Flooding of White River Area, Arkansas March 2008



Augusta (Arkansas, USA), Source: Google Earth



Flooding of White River Area, Arkansas March 2008



TerraSAR-X StripMap Image HH pol, March 27, 2008



Flooding of White River Area, Arkansas March 2008



TerraSAR-X StripMap Image HH pol - water bodies



Flooding of White River National Wildlife Refuge, Arkansas - March 2008



Source: http://www.fws.gov/whiteriver/flood%20waters%20page.htm



Flooding of White River Area, Arkansas March 2008



TerraSAR-X StripMap Image HH pol - inundated forest areas



Flooding of White River Area, Arkansas March 2008



TerraSAR-X StripMap Image HH pol - water bodies & inundated forest areas



Flooding of White River Area, Arkansas March 2008



DEM from SRTM

TSX-Spotlight: Ebro River Delta, Spain January 2, 2008





TSX-HR-Spotlight: Malaysia December 30, 2007





TSX-HR-Spotlight: Munich February 6, 2008





Speckle-Analysis and Filtering



Generation of color composites



SAR-intensity (TerraSAR-X)

Speckle-divergence

composite intensity - divergence

Image Classification

Generation of built-up area mask



Built-up area

Image Classification: Istanbul

Basic land use classes





TerraSAR-X StripMap image



Tokyo @ 300 MHz High Resolution Spotlight B=158 m, 43.8 m/fringe



Stripmap Mode: Salar de Uyuni & Mt. Tunupa, Bolivia





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First Processed TSX Scene – First Moving Objects





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Imaging and Velocity Estimation of a Moving Ship



Azimuth displacement	∆az	260 m
Beam velocity on ground	V _b	7010 m/s
Slant range distance	R_0	796 km
Radar Look angle	θ	52 deg
Ship heading angle	α	7 deg

$$v_{ship} = -\frac{\Delta az \cdot v_b}{R_0 \cdot \sin \theta \cdot \cos \alpha}$$

 $v_{ship} = 10.5 \ km / h$

Positive azimuth displacement \rightarrow Ship moved towards Radar

Illumination ------

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft Data: L1B_MGD_RE_DT00013

Imaging and Velocity Estimation of a Moving Train



Azimuth displacement	∆az	-779 m
Beam velocity on ground	V _b	7010 m/s
Slant range distance	R_0	791 km
Radar Look angle	θ	52 deg
Train heading angle	α	38 deg

$$v_{train} = 40.6 \ km / h$$

Negative azimuth displacement \rightarrow Train moved away from Radar



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Data: L1B_MGD_RE_DT00013

Automatically Detected Vehicles in TSX AS Mode Data



Ground range approx. 14 km

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Total number of detections:	38
Detected vehicles driving away from Radar (West):	23
Detected vehicles driving towards Radar (East):	15

Comparison of Results with Ground Truth Observations



Flight direction

Illumination —

B: Comparison with floating car measurement

Floating car average velocity:

86 km/h

82 km/h

Highest incidence of detected velocities for direction of floating car:

→

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A: Comparison with traffic at SAR imaging time of camera bridge



C2



TSX-Spotlight: Tehachapi Loop, California December 30, 2007 & November 16, 2007





Thank you for your kind attention



Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft Scattering mechanisms from vegetation, soil and ice



scattering from canopy

Courtesy: NASA

volume scattering

surface scattering

VEGETATION



surface scattering

volume scattering

scattering from subsurface horizon

surface scattering

