Geog 1000 - Lecture 32

Remote Sensing Technology

http://scholar.ulethbridge.ca/chasmer/classes/

Today's Lecture

1. Camera's and aerial photography
2. Multispectral scanning
3. Thermal imaging
4. Hyperspectral remote sensing
5. LiDAR
6. RADAR
7. Ground penetrating RADAR

Some applications

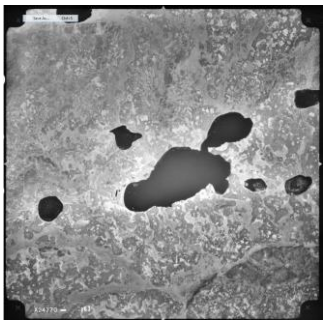
Aerial Photogrammetry

Black and white (often in Near Infrared) or colour photography; thermal infrared.

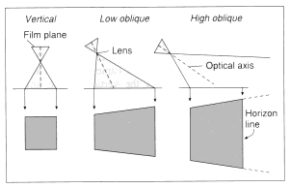
→ Film based in the past
→ Now digital

Acquired from aircraft

→ Has long history starting in the 1800s

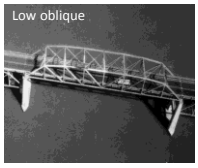


Aerial photography perspectives



Vertical

Low oblique



High Oblique

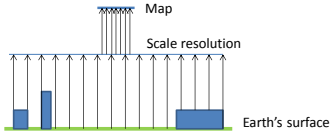
Maps vs. Air Photos

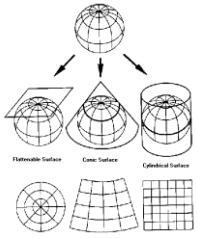
Map: Objects are planimetrically and geometrically accurate.

- As seen from the air, no distortion
- Correct geometric shape, size, and distance from other nearby objects

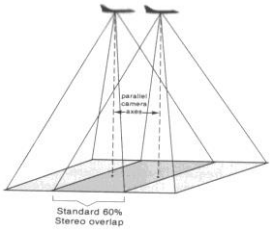
→ Created using an orthographic projection and constant scale

Orthographic → sphere projected onto a plane.

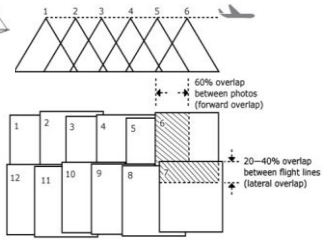




Aerial Photographs: Setting up a Survey



Purpose is for stereoscopy → Looking at things in "Stereo" or 3D

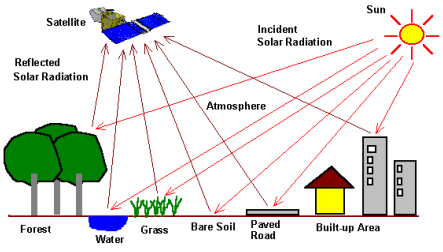


Modern Aerial Photography & LiDAR: UAV's

AIBOTIX: 3D Mapping with Unmanned Airborne Vehicle (UAV) → 2 cm resolution, georeferenced

Multi-spectral scanning

Let's start with passive remote sensing

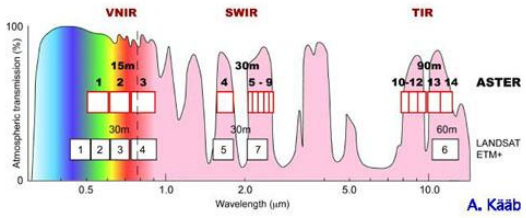


Multispectral Scanning

Bands → Discrete wavelengths that show greatest differences between things on Earth

AND are not scattered by atmosphere

Multi-spectral scanning is interested in a few (4-8 or so) *discrete* wavelength ranges



Each "Band" is assigned a RGB display colour

Example: WorldView-2 Instrument

Launched: October 8, 2009 → operating at full capability by January 4, 2010.

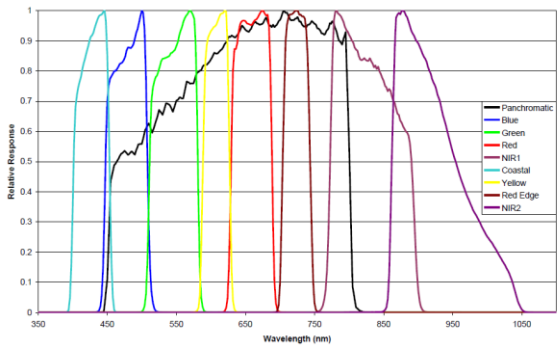
Very high resolution (1.85 m; 0.46 m - resampled), 9-band commercial satellite

Flying altitude = 770 kms

Revisit time: 1.1 days, collects up to 1 million sq kms per day (!)

Bands include:
Panchromatic, coastal, blue, green, yellow, red, red edge, NIR1 and NIR2

WorldView-2 Spectral Bands



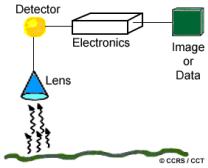
Thermal Imaging

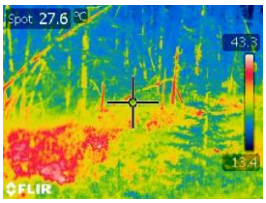
Thermal Remote Sensing→ Emitted thermal infrared (3 to 5 μm and 8 to 14 μm).

→ Measure the surface temperature

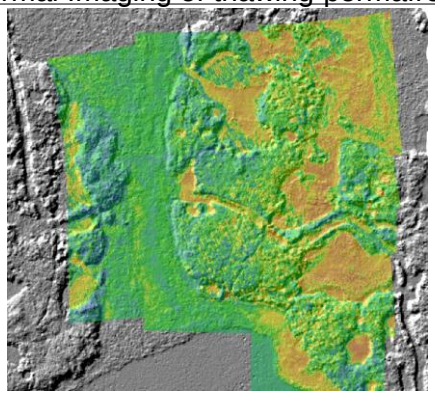
→ Have an internal temperature reference

→ Thermal IR cameras have large view area because there isn't much energy from longer wavelengths.





Thermal Imaging of thawing permafrost



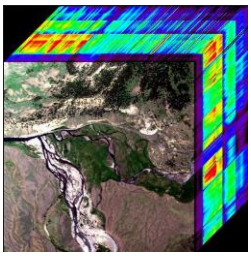
Alyssia Paluck

Hyperspectral Imaging

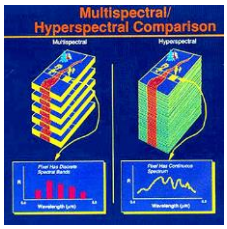
Similar to multi-spectral, but instead of discrete bands collects data across the electromagnetic spectrum.

→ Does not collect within discrete bands – may have hundreds of bands

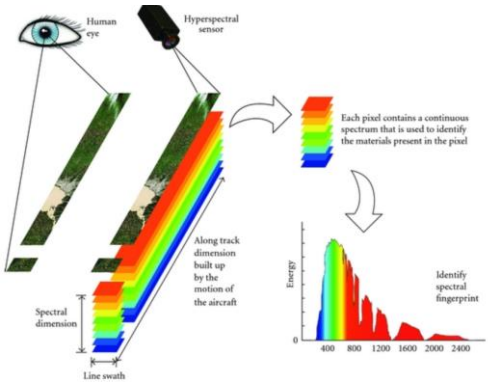
→ Data are viewed in an 'image cube'



Each feature has a "fingerprint" → spectra that characterises that object.



Hyperspectral Imaging



LiDAR

LiDAR = Light Detection And Ranging. Dr. Chris Hopkinson will present on LiDAR applications on Friday.

Can be Terrestrial, Airborne, Spaceborne

Airborne LiDAR → Active laser scanning

Airborne LiDAR: Example of Earthquake Zone

Use of LiDAR for examining earthquake behaviour.

→ Before and after picture of earthquake zone (via change detection), Mexicali, northern Mexico, April 10th.

→ Example: 5 foot escarpment created when part of hill moved up and sideways.

→ Further warping

→ 7 small faults came together to create a major earthquake.

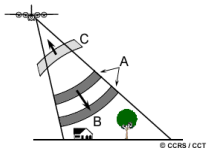
Radar

RADAR = RAdio Detection And Ranging,

→ Active sensor that pulses microwave radiation.

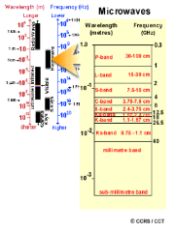
→ Antenna emits radiation, some is reflected back

→ Energy is timed (speed) and measured = 2D image



RADAR has a transmitter, receiver, antenna and recording electronics

Used often for terrain mapping:
Various wavelengths are used (code letters from WWII)



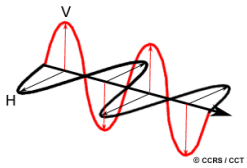
X-band → airborne reconnaissance
C-band → research systems, including RADARSAT
S-band → used on Russian ALMAZ satellite
L-band → American, Japanese satellites
P-band → longest wavelengths, experimental, NASA

Radar

Two RADAR images of same field using a C-band radar (top) and L-band radar (bottom)

→ Very different due to ways in which radar energy interacts with crops depending on wavelength.

Radar also emits in different polarization:



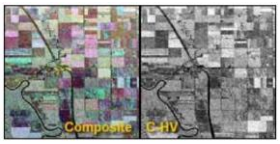
Transmit radiation either horizontally polarized (H) or vertically polarized (V)

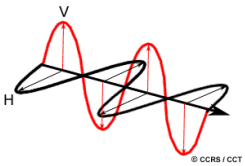
Radar

Transmit radiation either horizontally polarized (H) or vertically polarized (V)

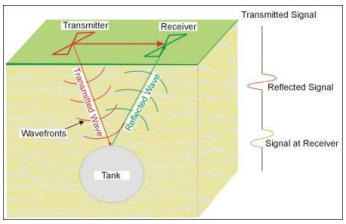
Receives in one or the other or both:

HH = horizontal transmit, horizontal receive
VV = vertical transmit, vertical receive
HV = horizontal transmit, vertical receive
VH = vertical transmit, horizontal receive





Ground Penetrating Radar



Emits electromagnetic energy in microwave wavelengths.

→ Reflected signal detected from various objects below ground

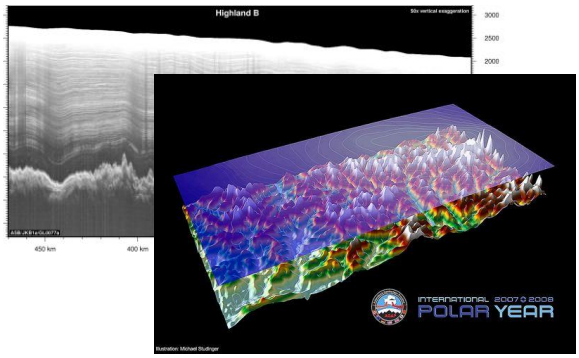
→ Dependent on *dielectric constant* of objects and surroundings.

Variable Frequencies:

Higher frequency = better spatial resolution, decreased depth penetration
Lower frequency = better depth penetration, reduced spatial resolution

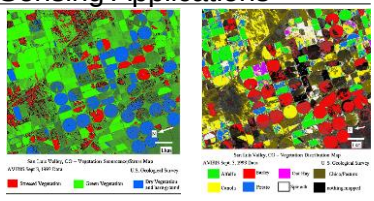
Ice = several hundred meters; dry soil = up to 15 m; wet soil = few cms.

Ground Penetrating Radar

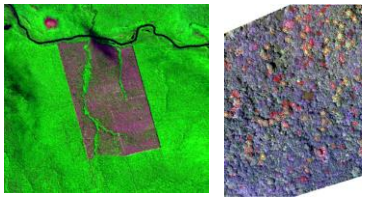


Remote Sensing Applications

Agriculture:
→ Crop mapping, stress assessment…

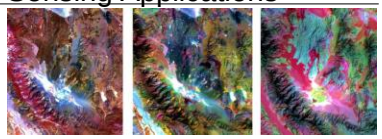


Forestry:
→ Mapping harvested areas, deforestation, species identification, forest fires…

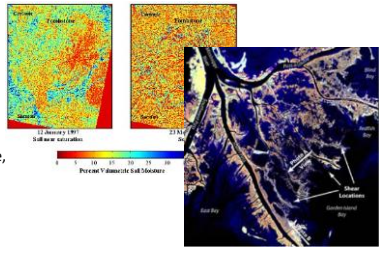


Remote Sensing Applications

Geology:
→ Terrain analysis, structure mapping, geologic unit mapping

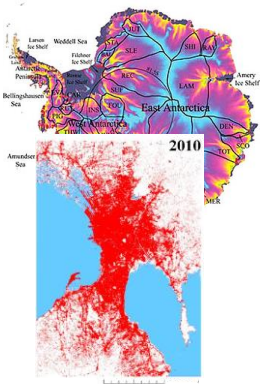


Hydrology:
→ Flood delineation, water level mapping, soil moisture, water quality



Remote Sensing Applications

Ice, snow, glaciers:
→ Ice type, concentration, ice motion, ice melt



Land cover:
→ Land use change (urban/rural), biomass mapping, land cover type.

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NSERC CREATE AMETHYST

AMETHYST

Advanced Methods, Education and Training in Hyperspectral Science and Technology

AMETHYST web site: http://www.uleth.ca/artsci/amethyst/

NSERC CREATE Program :
Collaborative Research and Training Experience

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AMETHYST

Advanced Methods, Education and Training in Hyperspectral Science and Technology

Key AMETHYST Program Features

- $1,650,000 over 6 years (80 % to go to trainee stipends) (2010-2016)
- Targeting awards to 50 research trainees over six years
- 32 external collaborators for internship placements

Main AMETHYST Program Objectives

- Provide enhanced learning experiences in cross-disciplinary settings
- Establish a program of workshops and workplace internships
- Ensure professional skills development for workforce preparation
- Create a structured and interdisciplinary approach to imaging science education

University of Lethbridge | Education and Research

AMETHYST

Advanced Methods, Education and Training in Hyperspectral Science and Technology

Primary AMETHYST Research Areas

- Imaging spectroscopy and remote sensing technologies for resource and environmental monitoring and studies of terrestrial vegetation dynamics
- Scene physics and analysis research on satellite image understanding
- Spectroscopic laboratory studies and field instruments for monitoring atmospheric greenhouse gases
- Advanced research on magnetic resonance contrast mechanisms of neural tissue and magnetic resonance imaging contrast agents

Related University of Lethbridge Research and Pedagogical Building Blocks in Place

- Multi-Disciplinary Major BSc in Remote Sensing
- Terrestrial and Atmospheric Remote Sensing Laboratory Facilities
- Earth Sensing Laboratory Calibration and Image Correction Services
- Alberta Water and Environmental Science Building

University of Lethbridge

Education and Research

Remote Sensing Faculty - University of Lethbridge

Professors:

- **Dr. Laura Chasmer – Geography**
- **Dr. Craig Coburn - Geography**
- **Dr. Albert Cross – Neuroscience**
- **Dr. Chris Hopkinson - Geography**
- **Dr. Derek Peddle - Geography**
- **Dr. Adriana Predoi-Cross - Physics**
- **Dr. Karl Staenz – Geography**

Adjunct Faculty:

- **Dr. Ron Hall - Cdn Forestry Service (Geography)**
- **Dr. Nadia Rochdi - ATIC (Physics)**
- **Dr. Anne Smith - Agriculture Canada (Geography)**
- **Dr. Phil Teillet – (Physics)**
- **Dr. Jinkai Zhang – ATIC (Geography)**

If interested in Remote Sensing….

CANADIAN REMOTE SENSING SOCIETY
SOCIÉTÉ CANADIENNE DE TÉLÉDÉTECTION

www.CRSS-SCT.ca

Contact: derek.peddle@uleth.ca