Active and Passive Microwave Sensors

M.Sc. Remote Sensing and GIS
IInd Semester

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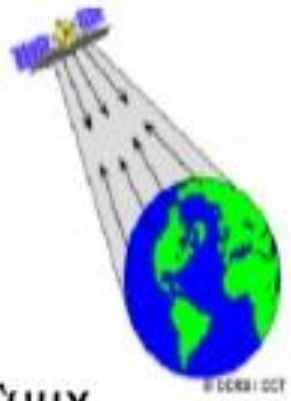
Active & Passive sensors

Active Sensors: Active Remote sensors create their own electromagnetic energy that is transmitted from the sensor towards the terrain, interacts with the terrain producing a backscatter of energy and is recorded by the remote sensor's receiver.



Passive Sensors: Passive sensor detects the naturally emitted microwave energy within its field of view.

Passive microwave sensing

- Passive microwave sensing is similar in concept to thermal remote sensing.
- All objects emit microwave energy of some magnitude, but the amounts are generally very small.
- A passive microwave sensor detects the naturally emitted microwave energy within its field of view. This emitted energy is related to the temperature and moisture properties of the emitting object or surface.
- Because the wavelengths are so long, the energy available is quite small compared to optical wavelengths. Thus, the fields of view must be large to detect enough energy to record a signal.
- Most passive microwave sensors are therefore characterized by low spatial resolution.
- Applications of passive microwave remote sensing include meteorology, hydrology, and oceanography

Passive sensors

- Remote sensing systems which measures natural energy
- Sun provides source of energy for remote sensing
- Energy from sun is either reflected as is the case for visible wavelengths or absorbed and re-emitted as it is for infrared wavelength

- Remote sensing systems which measures naturally available energy are called passive remote sensing

- Passive remote sensing can only take place when sun is illuminating the earth

- Or no reflected energy available from the sun at night

- Energy which is naturally emitted (infrared) can be detected day or night provided energy should be emitted large enough to be recorded

- Passive remote sensing is also possible in microwave region

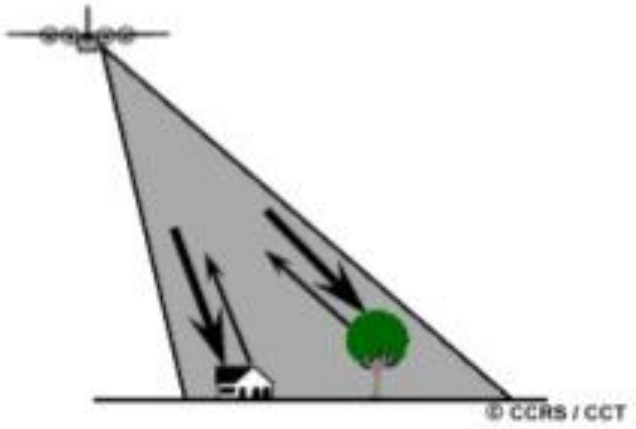
Disadvantage

- Passive sensors will work only during the day time as sun's reflected energy is not available for illumination at night

- Seasonal dependency

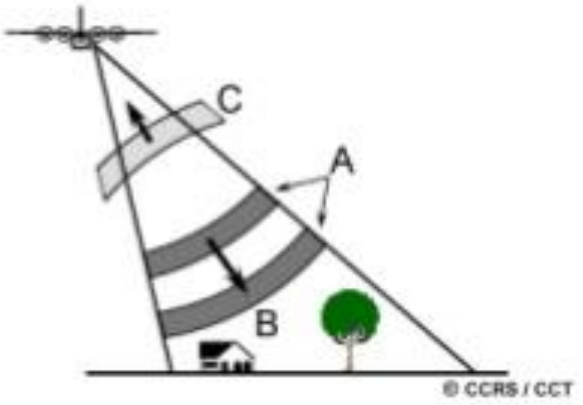
Active microwave sensing

- Active microwave sensors provide their own source of microwave radiation to illuminate the target
- The most common form of imaging active microwave sensors is RADAR.
- **RADAR is** an acronym for **RAdio Detection And Ranging**
- RADAR transmits a microwave (radio) signal towards the target and detects the backscattered portion of the signal.
- The strength of the backscattered signal is measured to discriminate between different targets and the time delay between the transmitted and reflected signals determines the distance (or range) to the target



How Radar Works

- A **radar** is essentially a ranging or distance measuring device.
- It consists fundamentally of a transmitter, a receiver, an antenna, and an electronics system to process and record the data.
- The transmitter generates successive short bursts (or pulses of microwave (A) at regular intervals which are focused by the antenna into a beam (B). The radar beam illuminates the surface obliquely at a right angle to the motion of the platform.
- The antenna receives a portion of the transmitted energy reflected (or backscattered) from various objects within the illuminated beam (C).



By measuring the time delay between the transmission of a pulse and the reception of the backscattered "echo" from different targets, their distance from the radar and thus their location can be determined

Active sensors

- Active sensors provides their own energy source for illumination
- Sensors emits radiations which is directed towards the target to be investigated
- The radiation reflected from that target is then detected and measured by the sensors

- Its advantage is that we can obtain measurements anytime regardless of the time of the day or season

- Another advantage is that active sensors can be used for examining wavelengths that are not sufficiently provided by the sun such as microwaves

- Active systems require the generation of a fairly large amount of energy to adequately illuminate the targets. Example is radar

Applications

- Flood mapping, Snow mapping, Oil Slicks
- Sea ice type, Crop classification,
- Forest biomass / timber estimation, tree height
- Soil moisture mapping, soil roughness mapping / monitoring
- Wave height monitoring
- Crop yield, crop stress
- Flood prediction
- Landslide prediction

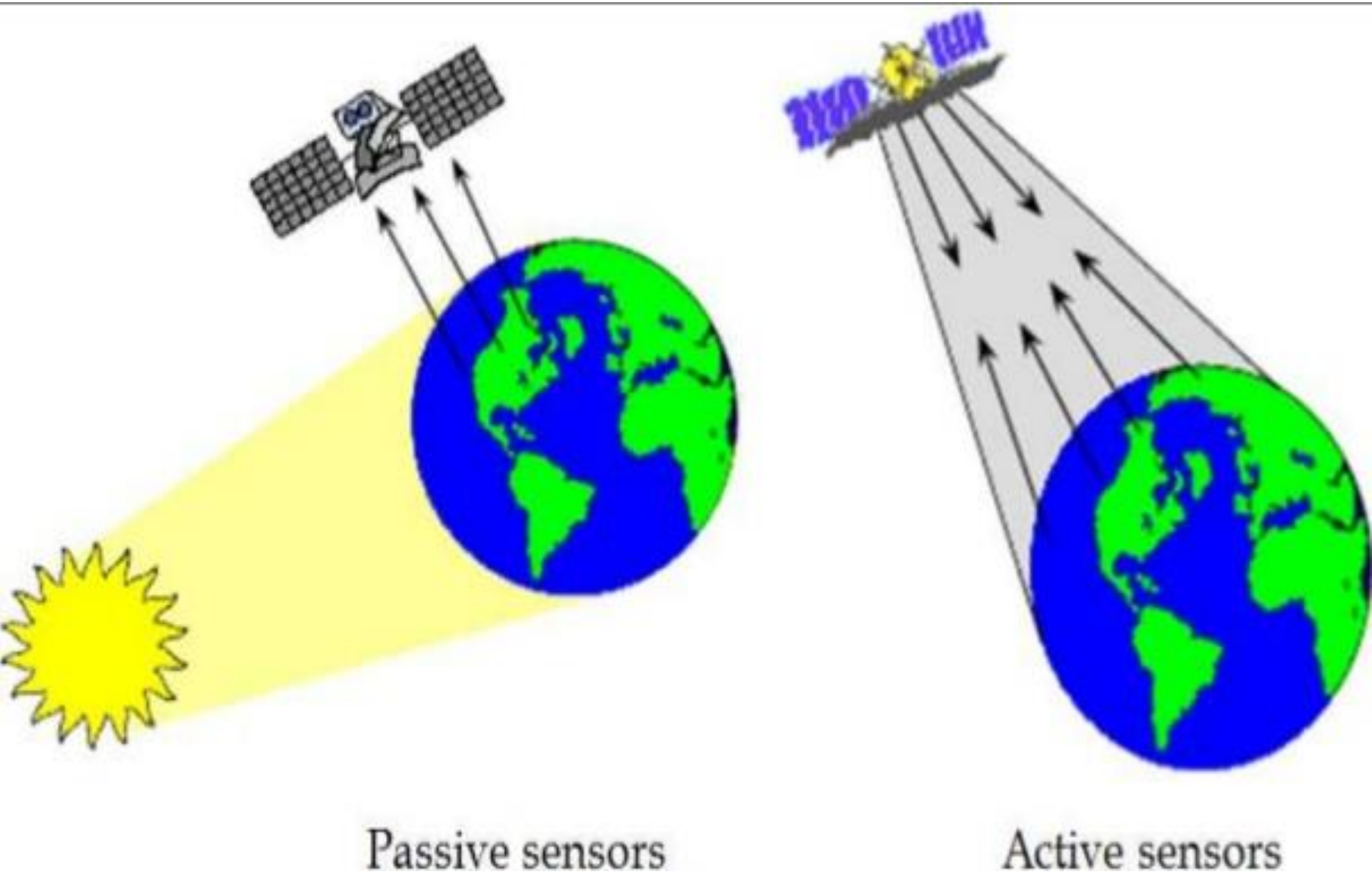
Difference between Active & Passive Sensors

Active Sensors

- Active transducers generate electric current or voltage directly in response to environmental stimulation.
- Active sensors provides their own energy source for illumination.
- Active sensors are able to obtain measurements anytime (Day & Night).

Passive Sensors

- Passive transducers produce a change in some passive electrical quantity, such as capacitance, resistance, or inductance, as a result of stimulation. These usually require additional electrical energy for excitation.
- Passive sensors can only be used to detect energy when the naturally occurring energy is available.
- Passive Sensors can obtain measurements only in the Day time.


Passive sensors
Active sensors

Applications of Active & Passive Sensors

- ***Radarsat*:** Imaging characteristics, mapping of vegetation, vegetated terrain and sand terrain
- ***LISS:*** Land use, land cover and geological aspects
- ***SPOT:*** Resources of earth and environmental aspects
- ***Landsat:*** Seasonal features like weather, atmosphere, rainfall on images