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Advanced Microwave Active & Passive Remote Sensing Application and Its Utilization

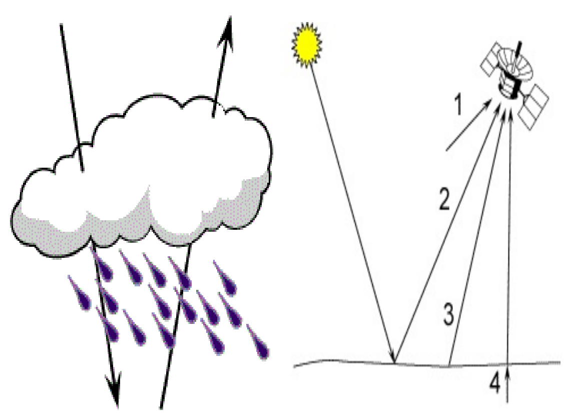
Lokesh R Chawle[1], Ashish Charbe[2], Nilesh Chide[3], Prashant Wanjari[4]
[1,2,3,4]*Electronics Engg. RGCER, Nagpur, Maharashtra*

Abstract—Microwave sensing circumscribes both active and passive forms of remote sensing. Long wavelengths, match up to the visible and infrared. Its radiation can penetrate through haze, cloud cover and dust. Longer wavelengths are not susceptible to atmospheric scattering which affects shorter optical wavelengths all but the heaviest rainfall. Data can be collected at any time because microwave allows detection of microwave energy under almost all environmental conditions. Passive microwave sensing is similar in concept to thermal remote sensing. All objects produce together microwave energy of a small amount. A passive microwave sensor identifies the naturally emitted microwave energy within its ground of view. This secretive energy is related to the temperature and moisture properties of the emitting object or surface. Passive microwave sensors are normally radiometers or scanners and operate systems, I FOCUS ON imaging radars. As with passive microwave sensing, a most significant advantage of radar is the ability of the radiation to penetrate through cloud cover and most weather conditions. It can also be worn to image the surface at every time, day or night. These are the two primary advantages of radar: all-weather and day or night imaging discussed previously except that an antenna is used to detect and record the microwave energy. In this paper different Applications of passive microwave remote sensing consist of oceanography, hydrology and meteorology by come transverse lying through the atmosphere.

Keywords— Active microwave sensor & passive sensor

I. INTRODUCTION

Active microwave sensors provide their own source of microwave radiation to illuminate the target. Active microwave sensors are generally divided into two distinct categories: **imaging and non-imaging**. The most common form of imaging active microwave sensors is RADAR. **RADAR** is an acronym for **Ra**dio **D**etection **A**nd **R**anging, which essentially characterizes the function and operation of a radar sensor. 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. Passive microwave sensors are typically radiometers or scanners and operate in much the same manner as systems discussed previously except that an antenna is used to detect and record the microwave energy.



The microwave energy recorded by a passive sensor can be emitted by the atmosphere (1), reflected from the surface (2), emitted from the surface (3), or transmitted from the subsurface (4). 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.

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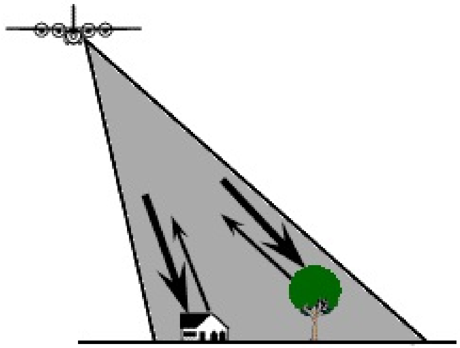
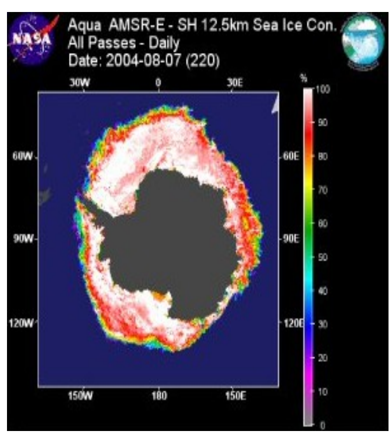


Remote sensing, in simplest terms, means viewing something from a distance rather than by direct contact. A handheld camera is an example of a remote sensing instrument. In terms of earth science, remote sensing refers to the ability of satellites to detect *electromagnetic radiation* from features on the earth's surface or in the atmosphere. Solar energy that reaches the earth is composed of many kinds of radiation, including light that is visible to people, thermal infrared, microwave, radar, and X-rays. Every substance with a temperature greater than *absolute zero* (-273 degrees Celsius, or -459 degrees Fahrenheit) emits some form of electromagnetic radiation. Some satellite sensors detect visible light reflected from the earth's surface or atmosphere, and others detect radiation emitted from the earth.

A. Remote Sensing: Passive Microwave

Remote sensing systems which measure energy that is naturally available are called **passive sensors.** passive sensors can only be used to detect energy when the naturally occurring energy is available. For all reflected energy, this can only take place during the time when the sun is illuminating the Earth. There is no reflected energy available from the sun at night. Energy that is naturally emitted (such as thermal infrared) can be detected day or night, as long as the amount of energy is large enough to be recorded. Clouds do not emit much microwave radiation, compared to sea ice. Thus, microwaves can penetrate clouds and be used to detect sea ice during the day and night, regardless of cloud cover.

Microwave emission is not as strongly tied to the temperature of an object, compared to infrared. Instead, the object's ***physical properties***, such as atomic composition and crystalline structure, determine the amount of microwave radiation it emits. The crystalline structure of ice typically emits more microwave energy than the liquid water in the ocean. Thus, sensors that detect passive microwave radiation can easily distinguish sea ice from ocean.



B. Remote Sensing: Active Microwave

on the other hand, provide their own energy source for illumination. The sensor emits radiation which is directed toward the target to be investigated. The radiation reflected from that target is detected and measured by the sensor. Advantages for active sensors include the ability to obtain measurements anytime, regardless of the time of day or season. Active sensors can be used for examining wavelengths that are not sufficiently provided by the sun, such as microwaves, or to better control the way a target is illuminated. However, active systems require the generation of a fairly large amount of energy to adequately illuminate targets. Some examples of active sensors are a laser fluorosensor and synthetic aperture radar

II. APPLICATIONS OF REMOTE SENSING

There are probably hundreds of applications - these are typical:

Meteorology - Study of atmospheric temperature, pressure, water vapor, and wind velocity.

Oceanography: Measuring sea surface temperature, mapping ocean currents, and wave energy spectra and depth sounding of coastal and ocean depths

Glaciology- Measuring ice cap volumes, ice stream velocity, and sea ice distribution. (Glacial)

Geology- Identification of rock type, mapping faults and structure.

Topography and cartography - Improving digital elevation models.

Agriculture Monitoring the biomass of land vegetation

Forest- monitoring the health of crops, mapping soil moisture Botany- forecasting crop yields.

Hydrology- Assessing water resources from snow, rainfall and underground aquifers.

Disaster warning and assessment - Monitoring of floods and landslides, monitoring volcanic activity, assessing damage zones from natural disasters.

Planning applications - Mapping ecological zones, monitoring deforestation, monitoring urban land use.

Oil and mineral exploration- Locating natural oil seeps and slicks, mapping geological structures, monitoring oil field subsidence.

Military- developing precise maps for planning, monitoring military infrastructure, monitoring ship and troop movements

Urban- determining the status of a growing crop

Climate- the effects of climate change on glaciers and Arctic and Antarctic regions

Sea- Monitoring the extent of flooding

Rock- Recognizing rock types

Space program- is the backbone of the space program

Seismology: as a premonition.

III. PRINCIPLES AND PROCESS OF REMOTE SENSING

Remote sensing actually done from satellites as Land sat or airplane or on the ground. To repeat the essence of the definition above, remote sensing uses instruments that house sensors to view the spectral, spatial and radiometric relations of observable objects and materials at a dist ance. Most sensing modes are based on sampling of photons corresponding frequency in telectromagnetic (EM) spectrum. In much of remote sensing, the process involves an interaction between incident radiation and the targets of interest. This is exemplified by the use of imaging systems where the following seven elements are involved. Note, however that remote sensing also involves the sensing of emitted energy and the use of non-emitted sensors.

A. Energy Source Or Illumination

The first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.

B. Radiation And The Atmosphere

As the energy travels from its source the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.

C. Interaction With The Target

Once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.

D. Recording Of Energy By The Sensor

After the energy has been scattered by, or emitted from the target, we require a sensor (remote - not in contact with the target) to collect and record the electromagnetic radiation.

E. Transmission, Reception, And Processing

The energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed

F. Interpretation And Analysis

The processed image is interpreted, visually and/or digitally or electronically, to extract information about the target, which was illuminated.

G. Application

The final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem.

IV. ATMOSPHERE EFFECTS

Our eyes inform us that the atmosphere is essentially transparent to light, and we tend to assume that this condition exists for all Electromagnetic radiation. In fact, however, the gases of the atmosphere selectively scatter light of different wavelengths. The gases also absorb Electromagnetic energy at specific wavelength intervals called absorption bands. The intervening regions of high energy transmittance are called atmospheric transmission bands, or windows. The transmission and absorption bands are shown in the following figure, together with the gases responsible for the absorption bands. Particles and gases in the atmosphere can affect the incoming light and radiation. These effects are

caused by the mechanisms of, **Transmittance, Scattering and Absorption.**

A. Transmittance

Some radiation penetrates through atmosphere, water, or other materials. Atmospheric Transmission Windows Each type of molecule has its own set of absorption bands in various parts of the electromagnetic spectrum. As a result, only the wavelength regions outside the main absorption bands of the atmospheric gases can be used for remote sensing. These regions are known as the Atmospheric Transmission Windows. The wavelength bands used in remote sensing systems are usually designed to fall within these windows to minimize the atmospheric absorption effects. These windows are found in the visible, near-infrared, certain bands in thermal infrared and the microwave regions.

B. Scattering

Scattering occurs when particles or large gas molecules present in the atmosphere interact with and cause the electromagnetic radiation to be redirected from its original path. How much scattering takes place depends on

several factors including the wavelength of the radiation, the abundance of particles or gases, and the distance the radiation travels through the atmosphere. There are three types of scattering which take place Rayleigh, Mie, and nonselective scattering, which absorbance and re-remittance of EM energy by particles without changing wavelength.

C. Absorption

Absorption is the other main mechanism at work when electromagnetic radiation interacts with the atmosphere. Some radiation is absorbed through electron or molecular reactions within the medium encountered; a portion of the energy incorporated can then be re-emitted (as emittance), largely at longer wavelengths, so that some of the sun's radiant energy engages in heating the target giving rise then to a thermal response. In contrast to scattering, this phenomenon causes molecules in the atmosphere to absorb energy at various wavelengths. Ozone, carbon dioxide, and water vapour are the three main atmospheric constituents which absorb radiation. Any effort to measure the planetary atmosphere, must consider where the atmosphere absorbs.

V. APPLICATIONS OF REMOTE SENSING TO HYDROLOGY AND HYDROGEOLOGY

The Hydrological Cycle A brief overview of hydrological processes will help to set a framework for describing those areas where remote sensing can assist in observing and in managing water resource system. Generally speaking, the hydrological cycle traces water through different physical processes, from liquid water through evaporation into the atmosphere, back into the liquid (or sometimes the frozen) state as precipitation falling on land areas

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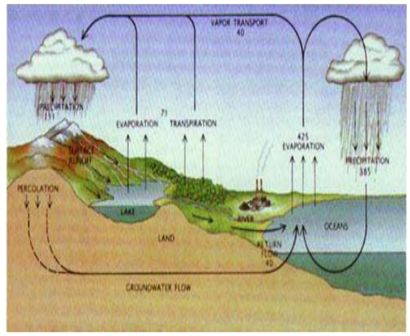
either run off into rivers and streams or percolate into the soil, or evaporate. Moisture reaching the water table becomes ground water. As a general rule, both surface and ground water flow under the force of gravity toward streams and lakes, and ultimately oceans. The return of water to the oceans can thought of as completing the cycle



A. Precipitation

Accurate measurement of precipitation is a continuing goal in meteorological research and a continuing need in hydrology which depends greatly on these data for modeling. Ground-based radar is probably the most accurate method of determining a real precipitation in use today. Satellite images from GOES, NOAA, TIROS-N, TRMM and NIMBUS opened a whole new world of data on clouds and frontal systems. Work carried out by several researchers has led to the following conclusions: A. In thick clouds (more than one kilometer) rain is possible when the upper

B. Applications In Hydrology

Hydrology is the study of water on the Earth's surface, whether flowing above ground, frozen in ice or snow, or retained by soil. Hydrology is inherently related to many other applications of remote sensing, particularly forestry, agriculture and land cover, since water is a vital component in each of these disciplines. Most hydrological processes are dynamic, not only between years, but also within and between seasons, and therefore require frequent observations. Remote sensing offers a synoptic view of the spatial distribution and dynamics of hydrological phenomena, often unattainable by traditional ground surveys. Radar has brought a new dimension to hydrological studies with its active sensing capabilities, allowing the time window of image acquisition to include inclement weather conditions or seasonal or diurnal darkness.

C. Examples Of Hydrological Applications Include

wetlands mapping and monitoring, soil moisture estimation snow pack monitoring / delineation of extent, measuring snow thickness, determining snow-water equivalent, river and lake ice monitoring, flood mapping and monitoring drainage basin mapping and watershed modeling irrigation canal leakage detection irrigation scheduling surface of the cloud is at less that –15 C.

The probability of rain is inversely proportional to the temperature of the upper surface of the cloud.

Precipitation intensity is directly proportional to the area of the upper surface of the cloud at temperature of less than –15 C.

D. Remote Sensing Application In Geomorphology

Geomorphology is the science of study of the landforms of the earth Geomorphologic analysis of surface forms of the earth is a direct form of interpretation from space images. Aerial photos with required forward overlap usually provide the third dimension of height, which adds to the precision of interpretation including morphometry. Geomorphology as a science developed much later than geology although several aspects of geomorphology areembedded in geological processes.

E. Advantages Of Active Remote Sensing

Sending and receiving EMR that can pass through cloud, precipitation

Images can be obtained at user-specified times, even at night.

Sending and receiving EMR that can penetrate tree canopy, dry surface, deposits, snow …

Permits imaging at shallow look angles, resulting in different **perspectives that cannot always be obtained using aerial photography.**

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Providing information on surface roughness, dielectric properties, and moisture content.

All weather, day-and-night imaging capac

VI. CONCLUSION

Remote sensing creates demand for better environmental law. Remote sensing is an unparalleled source of information that convey environmental changes in a visually compelling way. As a result, it is extremely useful for raising awareness and developing the political support necessary to strengthen MEAs and environmental laws at the national level. Remote sensing data provide a synoptic view of many environmental trends. Remotely sensed imagery can provide both snapshots and data over time that address environmental issues at global, regional and national scales. It can provide these in consistent formats and in ways that complement national-level data collection efforts, which are often under-resourced and inconsistent from country to country.

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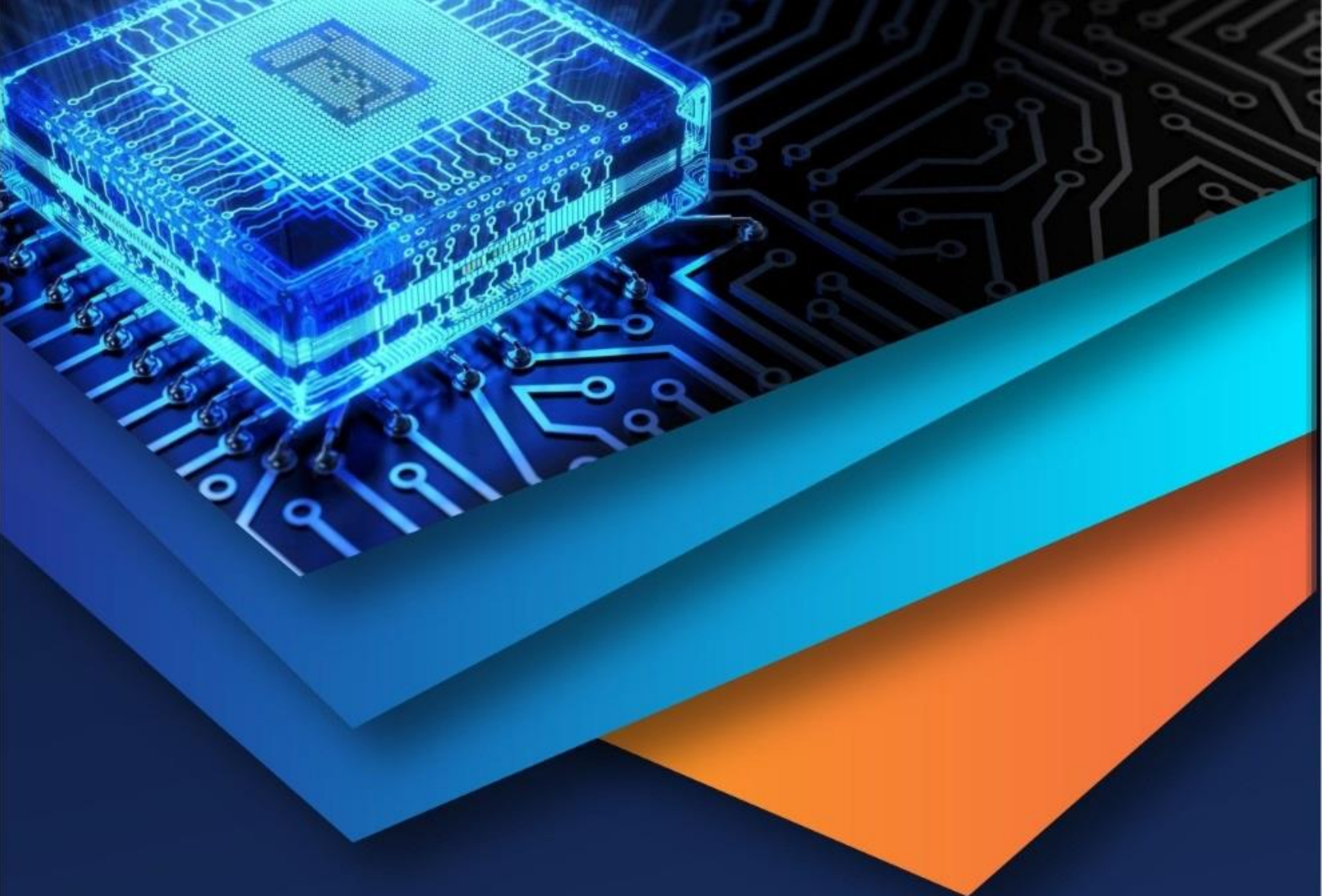

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