# DOWNLOAD PDF PHYSICS OF REMOTE SENSING

## Chapter 1 : Remote sensing | Physics Forums

*- Physics of Remote Sensing Topics will include spacecraft orbit considerations, fundamental concepts of radiometry, electromagnetic wave interactions with land and ocean surfaces and Earth's atmosphere, radiative transfer and atmospheric effects, and overviews of some important satellite sensors and observations.*

CH , which is nontoxic and odorless]. This is also reflected by the electronic spectra of the species, but these generally cannot be measured by STM very precisely, because the underlying substrate also has electronic states that obscure them. Being an all-electronic method, STM, however, provides no direct vibrational signature. This approach can reveal vibrational modes of the molecule, but it does not follow established selection rules, it is generally poorly resolved compared to infrared vibrational spectroscopy, and it is applicable only to particular adsorbate-substrate combinations. Alternatively, researchers including Ho [6] , Morgenstern [7] , myself [8] , and others have attempted to combine optical excitation and STM in different ways. We all found that the presence of the tip right above the sample molecules reduces the options in such approaches. Namely, if a pulsed laser is used, the illumination will heat the tip and cause it to expand by many times the tunneling gap. This will smash the tip apex into both the molecule to be investigated and the substrate. Experimental schemes to avoid this either severely limit the utility of the method or allow one only to look for molecular hopping on the surface, which can also be caused by the electronic kick described above [9]. Now, two University of California at Berkeley research groups, one with experience in STM, and the other, specialists in laser design and applications, have teamed up, conceived, and realized an alternative approach [2]. They set up a highly stable, pulsed laser source and pointed it on a spot of a gold surface covered by a particular molecule. Rather than placing their STM tip at the laser spot, they position it on the substrate approximately one millimeter away i. Nevertheless, when tuning the frequency of the laser light to resonate with a molecular vibrational mode, they find a signal in the STM current. This they attribute to the molecule absorbing the light, becoming vibrationally excited, and then dissipating the vibrational energy to the substrate. Remarkably, on the particular molecules they choseâ€”tetramantanesâ€”the resonance turns out to be extremely sharp, allowing for single wave-number resolution in their vibrational spectroscopy, far better than in prior STM-based approaches. The finding of Pechenezhskiy et al. However, it does not yet harness the particular strength of STMâ€”the ability to resolve individual molecules separately. Because of the remote 1 mm away optical excitation, the STM cannot practically image the set of molecules that cause the substrate excitation in the first place. Moreover, the set of molecules excited is very large because it is determined by the submillimeter diameter of the laser spot and not the angstrom sharpness of the tip. It is expected that with better understanding of how the excitation travels through the substrate, e. For now, the ground has been shaken, even if only at the nano level, and it has been recorded at high fidelity. The Nobel Prize in Physics, http: B 82, M. He is currently a professor at the University of California, Riverside.

## Chapter 2 : Remote Sensing â€” Department of Physics

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Play media This video is about how Landsat was used to identify areas of conservation in the Democratic Republic of the Congo , and how it was used to help map an area called MLW in the north. Passive sensors gather radiation that is emitted or reflected by the object or surrounding areas. Reflected sunlight is the most common source of radiation measured by passive sensors. Examples of passive remote sensors include film photography , infrared , charge-coupled devices , and radiometers. Active collection, on the other hand, emits energy in order to scan objects and areas whereupon a sensor then detects and measures the radiation that is reflected or backscattered from the target. RADAR and LiDAR are examples of active remote sensing where the time delay between emission and return is measured, establishing the location, speed and direction of an object. Illustration of remote sensing Remote sensing makes it possible to collect data of dangerous or inaccessible areas. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin , glacial features in Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Military collection during the Cold War made use of stand-off collection of data about dangerous border areas. Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed. Other uses include different areas of the earth sciences such as natural resource management , agricultural fields such as land usage and conservation, [6] [7] and national security and overhead, ground-based and stand-off collection on border areas. For a summary of major remote sensing satellite systems see the overview table. Applications of remote sensing[ edit ] Further information: Remote sensing geology and Remote sensing archaeology Conventional radar is mostly associated with aerial traffic control, early warning, and certain large scale meteorological data. Other types of active collection includes plasmas in the ionosphere. Laser and radar altimeters on satellites have provided a wide range of data. By measuring the bulges of water caused by gravity, they map features on the seafloor to a resolution of a mile or so. By measuring the height and wavelength of ocean waves, the altimeters measure wind speeds and direction, and surface ocean currents and directions. Ultrasound acoustic and radar tide gauges measure sea level, tides and wave direction in coastal and offshore tide gauges. Light detection and ranging LIDAR is well known in examples of weapon ranging, laser illuminated homing of projectiles. LIDAR is used to detect and measure the concentration of various chemicals in the atmosphere, while airborne LIDAR can be used to measure heights of objects and features on the ground more accurately than with radar technology. Radiometers and photometers are the most common instrument in use, collecting reflected and emitted radiation in a wide range of frequencies. The most common are visible and infrared sensors, followed by microwave, gamma ray and rarely, ultraviolet. They may also be used to detect the emission spectra of various chemicals, providing data on chemical concentrations in the atmosphere. Spectropolarimetric Imaging has been reported to be useful for target tracking purposes by researchers at the U. They determined that manmade items possess polarimetric signatures that are not found in natural objects. These conclusions were drawn from the imaging of military trucks, like the Humvee , and trailers with their acousto-optic tunable filter dual hyperspectral and spectropolarimetric VNIR Spectropolarimetric Imager. These thematic mappers take images in multiple wavelengths of electro-magnetic radiation multi-spectral and are usually found on Earth observation satellites , including for example the Landsat program or the IKONOS satellite. Maps of land cover and land use from thematic mapping can be used to prospect for minerals, detect or monitor land usage, detect invasive vegetation, deforestation, and examine the health of indigenous plants and crops, including entire farming regions or forests. Weather satellites are used in meteorology and climatology. Hyperspectral imaging produces an image where each pixel has full spectral information with imaging narrow spectral bands over a contiguous spectral range. Hyperspectral imagers are used in various applications including mineralogy, biology, defence, and environmental measurements. Within the scope of the combat against desertification , remote sensing allows researchers to follow up and monitor risk areas in the long term, to determine desertification factors, to support decision-makers in defining relevant measures of environmental management, and to assess their impacts. Overhead gravity data collection was first used in aerial submarine detection. Seismograms taken at different locations can locate and measure earthquakes after they occur by comparing the relative intensity and precise timings. Ultrasound sensors, that emit high frequency pulses and listening for echoes, used for detecting water waves and water level, as in tide gauges or for towing tanks. To coordinate a series of large-scale observations, most sensing systems depend on the following: High-end instruments now often use positional information from satellite navigation systems. The rotation and orientation is often provided within a degree or two with electronic compasses. Compasses can measure not just azimuth i. More exact orientations require gyroscopic-aided orientation , periodically realigned by different methods including navigation from stars or known benchmarks. Inverse problem Generally speaking, remote sensing works on the principle of the inverse problem. While the object or phenomenon of interest the state may not be directly measured, there exists some other variable that can be detected and measured the observation which may be related to the object of interest through a calculation. The common analogy given to describe this is trying to determine the type of animal from its footprints. For example, while it is impossible to directly measure temperatures in the upper atmosphere, it is possible to measure the spectral emissions from a known chemical species such as carbon dioxide in that region. The frequency of the emissions may then be related via thermodynamics to the temperature in that region. The quality of remote sensing data consists of its spatial, spectral, radiometric and temporal resolutions. Spatial resolution The size of a pixel that is recorded in a raster image â€" typically pixels may correspond to square areas ranging in side length from 1 to 1, metres 3. Spectral resolution The wavelength of the different frequency bands recorded â€" usually, this is related to the number of frequency bands recorded by the platform. Current Landsat collection is that of seven bands, including several in the infrared spectrum, ranging from a spectral resolution of 0. The Hyperion sensor on Earth Observing-1 resolves bands from 0. Radiometric resolution The number of different intensities of radiation the sensor is able to distinguish. Typically, this ranges from 8 to 14 bits, corresponding to levels of the gray scale and up to 16, intensities or "shades" of colour, in each band. It also depends on the instrument noise. Temporal resolution The frequency of flyovers by the satellite or plane, and is only relevant in time-series studies or those requiring an averaged or mosaic image as in deforesting monitoring. Cloud cover over a given area or object makes it necessary to repeat the collection of said location. In order to create sensor-based maps, most remote sensing systems expect to extrapolate sensor data in relation to a reference point including distances between known points on the ground. This depends on the type of sensor used. For example, in conventional photographs, distances are accurate in the center of the image, with the distortion of measurements increasing the farther you get from the center. Another factor is that of the platen against which the film is pressed can cause severe errors when photographs are used to measure ground distances. The step in which this problem is resolved is called georeferencing , and involves computer-aided matching of points in the image typically 30 or more points per image which is extrapolated with the use of an established benchmark, "warping" the image to produce accurate spatial data. As of the early s, most satellite images are sold fully georeferenced. In addition, images may need to be radiometrically and atmospherically corrected. Radiometric correction Allows avoidance of radiometric errors and distortions. The illumination of objects on the Earth surface is uneven because of different properties of the relief. This factor is taken into account in the method of radiometric distortion correction. Topographic correction also called terrain correction In rugged mountains, as a result of terrain, the effective illumination of pixels varies considerably. In a remote sensing image, the pixel on the shady slope receives weak illumination and has a low radiance value, in contrast, the pixel on the sunny slope receives strong illumination and has a high radiance value. For the same object, the pixel radiance value on the shady slope will be different from that on the sunny slope. Additionally, different objects may have similar radiance values. These ambiguities seriously affected remote sensing image information extraction accuracy in mountainous areas. It became the main obstacle to further application of remote sensing images. The purpose of topographic correction is to eliminate this effect, recovering the true reflectivity or radiance of objects in horizontal conditions. It is the premise of quantitative remote sensing application. Atmospheric correction Elimination of atmospheric haze by rescaling each frequency band so that its minimum value usually realised in water bodies corresponds to a pixel value of 0. The digitizing of data also makes it possible to manipulate the data by changing gray-scale values. Interpretation is the critical process of making sense of the data. Image Analysis is the recently developed automated computer-aided application which is in increasing use. Object-Based Image Analysis OBIA is a sub-discipline of GIScience devoted to partitioning remote sensing RS imagery into meaningful image-objects, and assessing their characteristics through spatial, spectral and temporal scale. Old data from remote sensing is often valuable because it may provide the only long-term data for a large extent of geography. At the same time, the data is often complex to interpret, and bulky to store. Modern systems tend to store the data digitally, often with lossless compression. The difficulty with this approach is that the data is fragile, the format may be archaic, and the data may be easy to falsify. One of the best systems for archiving data series is as computer-generated machine-readable ultrafiche , usually in typefonts such as OCR-B , or as digitized half-tone images. Ultrafiches survive well in standard libraries, with lifetimes of several centuries. They can be created, copied, filed and retrieved by automated systems. They are about as compact as archival magnetic media, and yet can be read by human beings with minimal, standardized equipment. Data processing levels[ edit ] To facilitate the discussion of data processing in practice, several processing "levels" were first defined in by NASA as part of its Earth Observing System [17] and steadily adopted since then, both internally at NASA e. Level Description 0 Reconstructed, unprocessed instrument and payload data at full resolution, with any and all communications artifacts e. A Level 1 data record is the most fundamental i. Level 2 is the first level that is directly usable for most scientific applications; its value is much greater than the lower levels. Level 2 data sets tend to be less voluminous than Level 1 data because they have been reduced temporally, spatially, or spectrally. Level 3 data sets are generally smaller than lower level data sets and thus can be dealt with without incurring a great deal of data handling overhead. These data tend to be generally more useful for many applications. The regular spatial and temporal organization of Level 3 datasets makes it feasible to readily combine data from different sources. While these processing levels are particularly suitable for typical satellite data processing pipelines, other data level vocabularies have been defined and may be appropriate for more heterogeneous workflows. This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed.

# DOWNLOAD PDF PHYSICS OF REMOTE SENSING

## Chapter 3 : Atmospheric physics - Wikipedia

*The science and engineering of remote sensing--theory and applications The Second Edition of this authoritative book offers readers the essential science and engineering foundation needed to understand remote sensing and apply it in real-world situations.*

Remote sensing Remote sensing is the small or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device s that is not in physical or intimate contact with the object such as by way of aircraft , spacecraft , satellite , buoy , or ship. In practice, remote sensing is the stand-off collection through the use of a variety of devices for gathering information on a given object or area which gives more information than sensors at individual sites might convey. In modern usage, the term generally refers to the use of imaging sensor technologies including but not limited to the use of instruments aboard aircraft and spacecraft, and is distinct from other imaging-related fields such as medical imaging. There are two kinds of remote sensing. Passive sensors detect natural radiation that is emitted or reflected by the object or surrounding area being observed. Reflected sunlight is the most common source of radiation measured by passive sensors. Examples of passive remote sensors include film photography , infra-red, charge-coupled devices , and radiometers. Active collection, on the other hand, emits energy in order to scan objects and areas whereupon a sensor then detects and measures the radiation that is reflected or backscattered from the target. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin , the effects of climate change on glaciers and Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Military collection during the cold war made use of stand-off collection of data about dangerous border areas. Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed. Other uses include different areas of the earth sciences such as natural resource management , agricultural fields such as land usage and conservation, and national security and overhead, ground-based and stand-off collection on border areas. In addition to the density of incident light, the dissipation of light in the atmosphere is greater when it falls at a shallow angle. Solar radiation contains variety of wavelengths. Visible light has wavelengths between 0. This increases the temperature of the nearby stratosphere. This is because Earth is much colder than the sun. The wavelength of maximum energy is around 10 micrometers. Cloud physics Cloud physics is the study of the physical processes that lead to the formation, growth and precipitation of clouds. Clouds are composed of microscopic droplets of water warm clouds , tiny crystals of ice, or both mixed phase clouds. Under suitable conditions, the droplets combine to form precipitation , where they may fall to the earth. Advances in radar and satellite technology have also allowed the precise study of clouds on a large scale.

## Chapter 4 : Physics of Remote Sensing - Earth Science Simplified

*EE/Ae Introduction to the Physics of Remote Sensing. Course Description. This course provides an overview of the physics behind space remote sensing instruments.*

Remote Sensing What is Remote Sensing? Remote Sensing is a technology to gather information and analysing about an object or phenomenon without making any physical contact. This technology is used in numerous fields like geography, hydrology, ecology, oceanography, glaciology, geology. A geographic information system is a tool that is used for mapping and analyzing feature events on Earth. The remote sensing and gis technology combine major database operations like statistical analysis and query, with maps. The GIS manages information on locations and provides tools for analysis and display of different statistics that include population, economic development, characteristics and vegetation. It also allows linking databases to make dynamic displays. These abilities make GIS different from other systems and make it a wide range private and public remote sensing applications for planning and predicting outcomes from remote sensing satellites. There are three essential elements for Remote Sensing â€" A platform to hold the instrument A target or object An instrument or sensor to observe the target Brief History of Remote sensing: The technology of modern remote sensing began with the invention of the camera. Cameras were fixed in balloons for the sake of taking images. During WWI, cameras were mounted on aeroplanes to get an aerial view of lands which proved to bring revolution in the military. It was only during the space age, Satellite remote sensing evolved. They were used for the purpose of imaging Earth surfaces as well as to sensor other spacecraft. Evelyn Pruitt of the U. Office of Naval Research. Satellites equipped with sensors observing earth are known as the remote sensing satellites. Optical sensors detect solar radiation reflected or scattered from the earth and thus develops images of Earth. This is known as the Optical and Infrared Remote Sensing. The images formed by these sensors resembles that of photographs taken by a camera. Practise This Question Find the reading of the spring balance shown in figure.

## Chapter 5 : Remote Sensing & Aerial Vehicles | Department of Physics â€“ The University of Texas at Dall

*Remote Sensing is the science of acquiring, processing and interpreting images that record the interaction between the electromagnetic energy and matter (Sabins, ). Remote sensing offers extensive applications in almost every area of science from monitoring forest fires to geologic mapping.*

Microwave 1mm-1m Longest wavelengths using in Remote Sensing. The gases absorb the Electromagnetic radiation at specific wavelengths called absorption bands. However the high interviewing transmittance regions are often known as Atmospheric Windows. Scattering When the incoming radiation and light passes through the atmosphere it will affected by the atmospheric particles and this will result the redirection of the light from its original path is known as scattering. The amount of particles present in the atmosphere, wavelength of radiation and the distance of radiation travels through the atmosphere are the major elements which influences the amount of scattering. Following are the major types of scattering. Rayleigh scattering Rayleigh scattering occurs when particles are very small when compared to incoming solar radiation. The small particles of dust, nitrogen and oxygen molecules are causing such type of scattering. The effect of Rayleigh scattering is much more in shorter wavelengths than longer wavelengths. The phenomena of sky appears blue during the day time is because of the Rayleigh scattering the shorter wavelengths of visible spectrum Blue scattered more than that of longer wavelength. Mie scattering Unlike Rayleigh scattering, Mie scattering occurs when the incoming solar radiation and the atmospheric particles have the same size. Dust, pollen, smoke and water vapour are causes Mie scattering which tend to affect longer wavelengths than those affected by Rayleigh scattering. Non selective scattering This occurs when than particles size is much larger than the radiation. Water droplets and dust particles can cause this type of scattering. Non selective scattering gets its name from the fact is that it scattering all the wavelengths equally. Absorption Absorption is another main mechanism that happens when the EMR interacts with atmospheric particles and gases. When the EMR passes through the atmosphere the molecules in the atmosphere absorbs energy at various wavelengths. Ozone absorbs the harmful ultraviolet rays of incoming solar radiation. This also causes to avoid the ultraviolet rays from Remote Sensing sensors. Carbon dioxide is referred as the green house gas. The presence of water vapour in the atmosphere varies place to place. On the other hand Active sensor gives own energy for illumination so it enables to detect and record the images at any time. They are weather independent also; artificial microwaves can penetrate clouds, light and shadow. But Passive sensors are not weather independent. Radar signals can penetrate into vegetation and soil and even can give you the surface information at mm to m depth level at the same time major disadvantage is that radar signals do not contain any spectral characters while Passive Remote Sensing signals have spectral characters. Unlike active sensors passive sensor have the ability to produce fine resolution image. Active Remote sensors are cost intensive also when compared to passive sensor. Sensors and Satellites In the previous section we made discussions about Remote Sensing energy components and its physics. In here we are going to discuss about the collection of reflected energy. It is the responsibility of the sensor to detect and capture the emitted or reflected energy from the target. In order to capture the energy, the sensor must reside on a stable surface called Platforms. Different types of sensors are there on the basis of Platforms. Ground based sensors are using to record to collect the detailed information about the Earth surface. The data collected by ground based sensor is used to compare the data collected by other sensors like satellite based or to understand the surface features more detailed. One advantage is that the atmospheric disturbances are absent in this type of sensing. The sensor may place on a ladder, scaffolding or crane etc. Aircrafts are the major platforms in Aircraft based sensors. Helicopters are also occasionally using. Aircrafts are using to collect the detailed information about the Earth surface at any time. Major disadvantage is that it is not possible to fly aircrafts at bad weather. In the space remote sensing are conducted from either using Space shuttle or Satellites. These kinds of Satellites are often known as Remote Sensing satellites. Satellite based sensors are the most efficient and wide spread in the world. These can give a global level coverage but it is costly. Cost is often an important factor while choosing the sensor. These satellites have some characteristics that makes this is a unique platform in Remote Sensing sensors.

Orbits The path which is followed by satellites is referred as Orbit. Orbits vary along with their altitude and their orientation and rotation related to the Earth. To monitor a particular place regularly in the earth surface we are using geostationary orbits. The satellites following the same orbit are called geostationary satellites. This orbit has a very high altitude of KM approximately. The satellites revolving through the orbit have a speed match with the rotation of Earth. This allows monitoring a particular place continuously. These satellites cover the local time regularly , referred as Sun synchronous satellites. This enables the consistent illumination conditions when acquiring images of specific season over successive years. Resolution Properties Some instruments taking images from very high altitude and it may give a global coverage or country level coverage. It is not possible to extract information about your home from the global level coverage. In order to extract information we have to design a new sensor to provide Centimeter level information. While designing the sensor or using the output image we have to look up about resolution. There are four distinct types of resolutions are there they are Spatial Resolution The ability of the sensor to detect the smallest single object in the Earth surface is referred as Spatial Resolution. Extraction of details from the image is highly depends upon the spatial resolution. IFOV is the angular cone of visibility of the sensor. The size of the area viewed is determined by multiplying IFOV by the distance from the ground to the sensor. Spectral Resolution Simply we can define as the ability of the sensor to record the information on a particular spectral range is called Spectral Resolution or the ability of the sensor to define fine wavelengths. Spectral resolution is highly important while designing the sensor. It defines the nature of the study. Different objects have different spectral signature. Temporal Resolution Like other resolution properties temporal resolution is also important in Remote Sensing studies. Temporal resolution means the revisit of the satellite over the particular area at same interval of time. The temporal resolutions of the satellites are usually several days which enable to capture the images of an area regularly and can monitor well. The images collected over a given interval are called multi-temporal data, which is the main advantage. Different types of scanning systems are using in Remote Sensing for acquiring the data. Multi spectral Scanning A scanning system collecting data over a various wavelengths but not continuous is referred as Multi spectral scanning system. It is the most commonly using scanning system in the world. There are two methods are deployed in the multi spectral scanning system for acquiring information about the Earth surface. Across Track scanning Across Track scanning scans the surface in a series of lines. These lines are perpendicular to the direction of the motion of the sensor. Each line is scanned from one side of the sensor to another side. This is done by using rotating mirror. This type scanning is also known as whisk broom scanning Along Track Scanning This type scanning uses a forward motion of the sensor to detect the successive scan lines and these lines are perpendicular to the flight direction. These systems are also referred as push broom scanning system. Instead of rotating mirror here using a linear array of detectors located I the focal plane of the sensor. Unlike multi spectral system Thermal sensors using photo deters sensitive to direct contact of photons on their surface, to detect emitted thermal radiation. These sensors are measuring the surface temperature of the target. Thermal Imaging is typically using the across track scanning system. Thermal sensors normally have large IFOV to ensure enough energy reaching to the sensor to make reliable measurements. Major Earth observational satellites and their sensors.

## Chapter 6 : Remote sensing - Wikipedia

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## Chapter 7 : EE/GE Introduction of the Physics of Remote Sensing

*Remote Sensing is a technology to gather information and analysing about an object or phenomenon without making any physical contact. This technology is used in numerous fields like geography, hydrology, ecology, oceanography, glaciology, geology.*

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## Chapter 8 : Applied Remote Sensing â€“ Masters of Professional Science

*Remote Sensing is not a scientific discipline in the classical sense; it is rather a collection of a large variety of diagnostic methods, mainly using electromagnetic waves covering the spectrum from radio waves (wavelength > 1 m) to gamma rays (< 10 m).*

## Chapter 9 : Topic: Remote Sensing | CosmoLearning Physics

*Part III. Physics of Remote Sensing: An swer each question on the physics of remote sensing. Each question is worth 5 points. Partial credit is available.*