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A Review on Methodologies of Remote sensing, GPS And GIS

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ABSTRACT : *Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation emitted from aircraft or satellites).*

Remote sensing makes it possible to collect data on 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. This paper takes review of methods used in remote sensing, GPS and GIS technology and inters relationship among them for different applications

Keywords *- Remote sensing, GPS, GIS*

*I.*INTRODUCTION TO REMOTE SENSING:

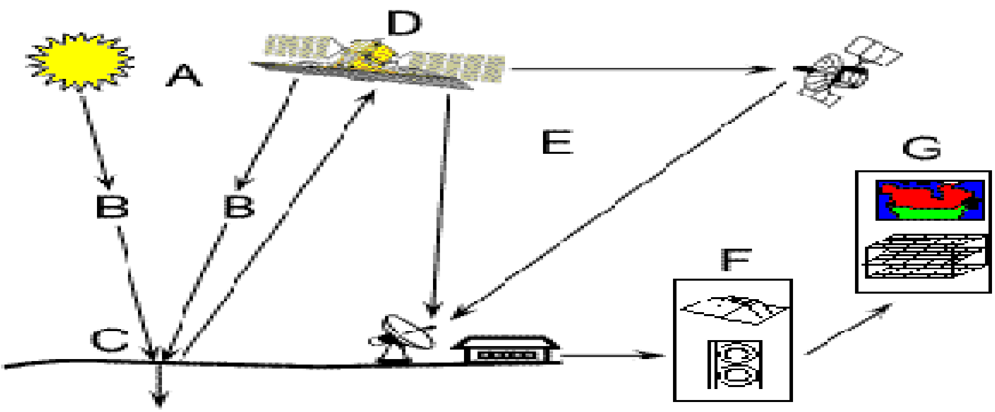
Remote sensing is the measurement and analysis of electromagnetic radiation reflected from, transmitted through, or absorbed and scattered by the atmosphere, the hydrosphere and by material at or near the land surface, for the purpose of understanding and managing the Earth's resources and environment.

The technical term "remote sensing" was first used in the United States in the 1960's, and encompassed photogrammetry, photo-interpretation, photo-geology etc. Since Landsat-1, the first earth observation satellite was launched in 1972; remote sensing has become widely used.

The characteristics of an object can be determined; using reflected or emitted electro-magnetic radiation, from the object. That is, "each object has a unique and different characteristic of reflection or emission if the type of the environmental condition is different." Remote sensing is a technology to identify and understand the object or the environmental condition through the uniqueness of the reflection or emission.

1.1 Remote Sensing Phenomenon

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. However remote sensing also involves the sensing of emitted energy and the use of non-imaging sensors.



1. Energy Source or Illumination (A) - the first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.

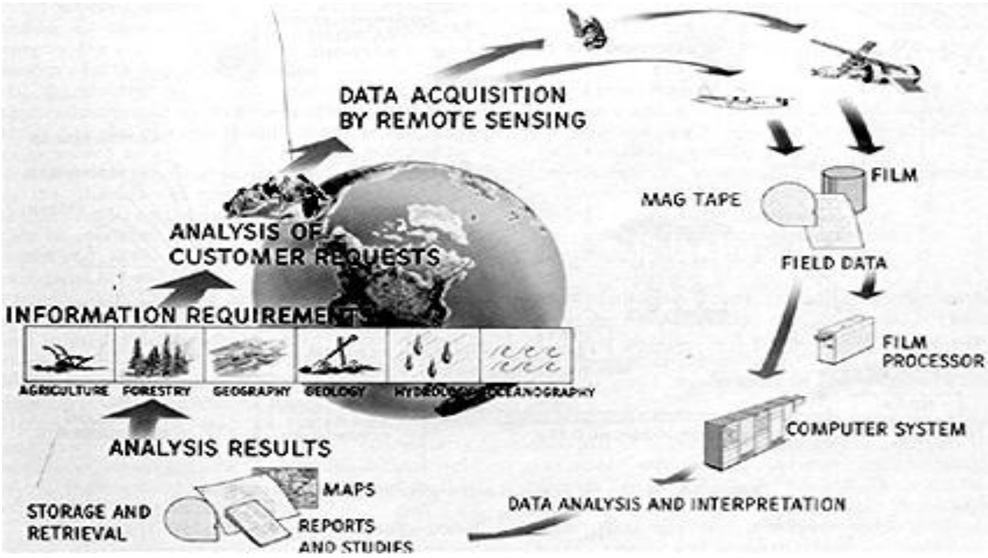
2. Radiation and the Atmosphere (B) - as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.

3. Interaction with the Target (C) - 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.
4. Recording of Energy by the Sensor (D) - 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.
5. Transmission, Reception, and Processing (E) - 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 into an image (hardcopy and/or digital).
6. Interpretation and Analysis (F) - the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.
7. Application (G) - 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.

Remote sensing is classified into three types with respect to the wavelength regions:

- **Visible and Reflective Infrared Remote Sensing,**
- **Thermal Infrared Remote Sensing and**
- **Microwave Remote Sensing.**

II. TYPICAL REMOTE SENSING SYSTEM:



This chart shows a simple closed-loop cyclic process, unencumbered by the various feedback loops that no doubt exist. The starting point and end point as well, is the set of panels labeled Information Requirements. This focuses on the ultimate driver of any information management system: the user and his/her recurring needs. Various disciplines concerned with Earth observations and resources are represented.

The terrestrial globe in the background reminds us that the system should be worldwide in scope. Information requirements logically lead to user/customer demands. The best remote sensing system approach is the one most responsive to these demands.

Before radiation used for remote sensing reaches the Earth's surface it has to travel through some distance of the Earth's atmosphere. Particles and gases in the atmosphere can affect the incoming light and radiation. These effects are caused by the mechanisms of **scattering** and **absorption**.

III. SENSOR TECHNOLOGY:

Most remote sensing instruments (sensors) are designed to measure photons. The fundamental principle underlying sensor operation centers on what happens in a critical component - the detector. This is the concept of the photoelectric effect that there will be an emission of negative particles (electrons) when a negatively charged plate of some appropriate light-sensitive material is subjected to a beam of photons. The electrons can then be made to flow from the plate, collected, and counted as a signal. A key point: The magnitude of the electric current produced (number of photoelectrons per unit time) is directly proportional to the light intensity. Thus, changes in the electric current can be used to measure changes in the photons (numbers; intensity) that strike the plate (detector) during a given time interval. The kinetic energy of the released photoelectrons varies with frequency (or wavelength) of the impinging radiation.

Microwave remote sensing, using microwave radiation using wavelengths from about one centimeter to a few tens of centimeters enables observation in all weather conditions without any restriction by cloud or rain. This is an advantage that is not possible with the visible and/or infrared remote sensing. In addition, microwave remote sensing provides unique information on for example, sea wind and wave direction, which are derived from frequency characteristics, Doppler effect, polarization, back scattering etc. that cannot be observed by visible and infrared sensors. However, the need for sophisticated data analysis is the disadvantage in using microwave remote sensing.

3.1 Active & Passive Remote Sensing

Active sensors 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. Whereas passive remote sensing uses natural energy source such as Sun light. Passive sensors can be utilized in day time.

IV. IMAGE ANALYSIS:

In order to take advantage of and make good use of remote sensing data, we must be able to extract meaningful information from the imagery. Interpretation and analysis of remote sensing imagery involves the identification and/or measurement of various targets in an image in order to extract useful information about them. Targets in remote sensing images may be any feature or object which can be observed in an image. Most

of the common image processing functions available in image analysis systems can be categorized into the following four categories:

- Preprocessing – For reducing noise & distortions
- Image Enhancement – To improve appearance.
- Image Transformation – For continuous acquisition of data.
- Image Classification and Analysis **-** to digitally identify and classify pixels in the data.

4.1 Benefits of remotely sensed data:

a) Remotely sensed data acquired by the Earth observation satellites provides a number of benefits for studying the Earth's surface, including:

- Continuous acquisition of GIS data & Regular revisit capabilities
- Broad regional coverage, Good spectral & spatial resolution
- Ability to manipulate/enhance & combine satellite digital data with other digital data
- Cost effective data , Map-accurate data,
- Possibility of stereo viewing & Large archive of historical data

4.2 Some Applications:

- Assessment and monitoring of vegetation types and their status
- Soil surveys, Crop yield assessment & Coastal surveys
- Mineral & natural resource exploration, Natural disaster assessment
- Map making and revision, Urban planning, Pollution monitoring
- Water resources planning and monitoring, Storm forecasting

V. WHAT IS GPS?

The Global Positioning System (GPS) is a location system based on a constellation of about 24 satellites orbiting the earth at altitudes of approximately 11,000 miles. GPS was developed by the United States Department of Defense (DOD), for its tremendous application as a military locating utility. The DOD's investment in GPS is immense. Billions and billions of dollars have been invested in creating this technology for military uses. However, over the past several years, GPS has proven to be a useful tool in non-military mapping applications as well.

GPS satellites are orbited high enough to avoid the problems associated with land based systems, yet can provide accurate positioning 24 hours a day, anywhere in the world. Uncorrected positions determined from GPS satellite signals produce accuracies in the range of 50 to 100 meters. When using a technique called differential correction, users can get positions accurate to within 5 meters or less.

Today, many industries are leveraging off the DOD's massive undertaking. As GPS units are becoming smaller and less expensive, there are an expanding number of applications for GPS. In transportation applications, GPS assists pilots and drivers in pinpointing their locations and avoiding collisions. Farmers can use GPS to guide equipment and control accurate distribution of fertilizers and other chemicals. Recreationally, GPS is used for providing accurate locations and as a navigation tool for hikers, hunters and boaters. Many would argue that GPS has found its greatest utility in the field of Geographic Information Systems (GIS). With some consideration for error, GPS can provide any point on earth with a unique address (its precise location).

A GIS is basically a descriptive database of the earth (or a specific part of the earth). GPS tells you that you are at point X,Y,Z while GIS tells you that X,Y,Z is an oak tree, or a spot in a stream with a pH level of 5.4. GPS tells us the "where". GIS tells us the "what". GPS/GIS is reshaping the way we locate, organize, analyze and map our resources.

5.1 Concept of GPS:

Global Positioning System (GPS) technology is a fast and accurate method of determining the location of any point of interest anywhere on the face of the earth at any time during the day or night, 365 days per year. The technology collects and processes signals from Satellites in orbit around the earth to determine the location of points of interest on the ground.

Different technologies with different accuracy are available for different applications. Hand held units costing from a few hundred to a few thousand dollars are available to the public, and with accuracies ranging from +/- 100 meters to +/- 5 meters, are suitable only for navigation and orienteering. The position of the unit is displayed "on-the-fly". Training and expertise required is minimal. More expensive mapping grade systems can produce sub-meter level horizontal accuracies, with generally variable and unreliable vertical (elevation or altitude) accuracies. The user must occupy each point for a brief time to collect data before a location is obtained. These systems are suitable for mapping natural resources such as timber, farmland, and wetlands/marsh and are less affected by "canopy" than survey grade technologies. Decimeter level horizontal accuracies can be obtained with "post processing".

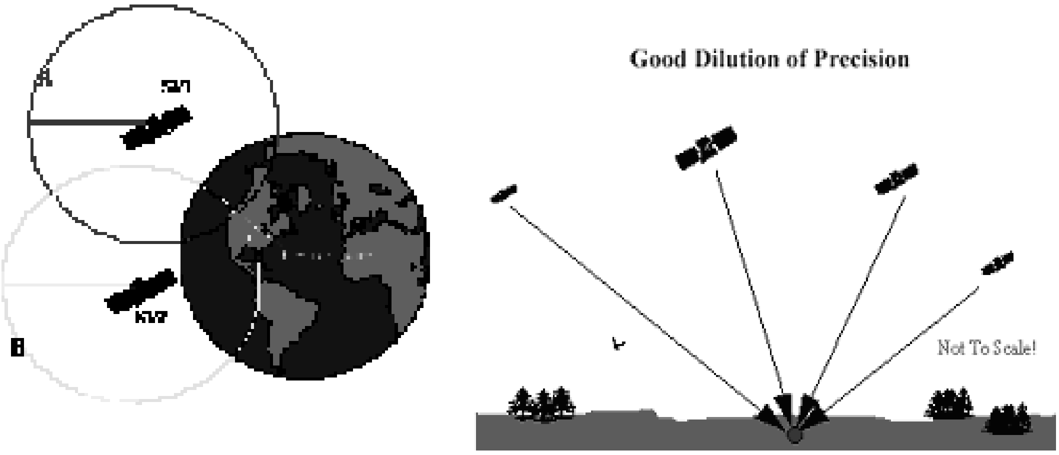


Figure: Determination of location of an Object

5.2 Trilateration - How GPS Determines a Location

In a nutshell, GPS is based on satellite ranging - calculating the distances between the receiver and the position of 3 or more satellites (4 or more if elevation is desired) and then applying some good old mathematics. Assuming the positions of the satellites are known, the location of the receiver can be calculated by determining the distance from each of the satellites to the receiver. GPS takes these 3 or more known references and measured distances and "triangulates" an additional position. GPS determines distance between a GPS satellite and a GPS receiver by measuring the amount of time it takes a radio signal (the GPS signal) to travel from the satellite to the receiver. Radio waves travel at the speed of light, which is about 186,000 miles per second. So, if the amount of time it takes for the signal to travel from the satellite to the receiver is known, the distance from the satellite to the receiver (distance = speed x time) can be determined. If the exact time when the signal was transmitted and the exact time when it was received are known, the signal's travel time can be determined.

5.3 Using Differential GPS to Increase Accuracy

As powerful as GPS is, +/-50 - 100 meters of uncertainty is not acceptable in many applications. How can we obtain higher accuracies?

A technique called **differential correction** is necessary to get accuracies within 1 -5 meters, or even better, with advanced equipment. Differential correction requires a second GPS receiver, a ***base station***, collecting data at a stationary position on a precisely known point (typically it is a surveyed benchmark). Because the physical location of the base station is known, a correction factor can be computed by comparing the known location with the GPS location determined by using the satellites.

The differential correction process takes this correction factor and applies it to the GPS data collected by a GPS receiver in the field.

5.4 GPS for GIS:

GIS is a computerized mapping system that enables the user to visualize statistical information. GPS determines a location of object on the surface of the Earth. These objects are referred to as "Features", and are used to build a GIS. It is the power of GPS to precisely locate these Features which adds so much to the utility of the GIS system. On the other hand, without Feature data, a coordinate location is of little value.

1. Feature Types:

There are three types of Feature which can be mapped: Points, Lines and Areas. A Point Feature is a single GPS coordinate position which is identified with a specific Object. A Line Feature is a collection of GPS positions which are identified with the same Object and linked together to form a line. An Area Feature is very similar to a Line Feature, except that the ends of the line are tied to each other to form a closed area.

2. Describing Features:

As stated above, a Feature is the object which will be mapped by the GPS system. The ability to describe a Feature in terms of a multi-layered database is essential for successful integration with any GIS system.

For example, it is possible to map the location of each house on a city block and simply label each coordinate position as a house. However, the addition of information such as color, size, cost, occupants, etc. will provide the ability to sort and classify the houses by these categories. These categories of descriptions for a Feature are known as Attributes. Tying this database to position information is the core philosophy underlying any GIS system.

3. Feature Lists:

The field data entry process can be streamlined by the use of a Feature List. The Feature List is a database which contains a listing of the Features which will be mapped, as well as the associated Attributes for each Feature. In addition, the Feature List contains a selection of appropriate Values for each Attribute.

The Feature List can be created on a hand-held GPS data collector, or on a PC. When a Feature List is used in the field, the first step is to select the Feature to be mapped. Once a Feature is selected, the Attributes for that Feature are automatically listed. A Value for each Attribute can then be selected from the displayed list of predetermined Values. The use of a Feature List streamlines the data entry process and also ensures consistent data entry among different users in the same organization.

4. Exporting to a GIS System:

The final step in incorporating GPS data with a GIS system is to export the GPS and Feature data into the GIS system. During this process, a GIS "layer" is created for each Feature in the GPS job. For example, the process of exporting a GPS job which contains data for House, Road and Lot Features would create a House layer, a Road layer and a Lot layer in the GIS system.

These layers can then be incorporated with existing GIS data. Once the GPS job has been exported, the full power of the GIS system can be used to classify and evaluate the data.

Combining data of different types and from different sources, such as we have described above, is the pinnacle of data integration and analysis. In a digital environment where all the data sources are geometrically registered to a common geographic base, the potential for information extraction is extremely wide. This is the concept for analysis within a digital **Geographical Information System (GIS)** database. Any data source which can be referenced spatially can be used in this type of environment.

The examples include digital maps of soil type, land cover classes, forest species, road networks, and many others, depending on the application. The results from a classification of a remote sensing data set in map format, could also be used in a GIS as another data source to update existing map data. In essence, by analyzing diverse data sets together, it is possible to extract better and more accurate information in a synergistic manner than by using a single data source alone. There are a myriad of potential applications and analyses possible for many applications.

VI. CONCLUSION:

Thus as per our discussion so far we could see how this new technology has proved so much beneficial for all the sections of human life. Remote Sensing can play a significant role in keeping the disasters caused due to natural calamities at bay.

India presently is utilizing this technology in getting the weather forecasts. Being an agricultural country, India is looking forward to apply Remote Sensing to estimate crop yields, lands suitable for cultivation.

GPS & GIS are evolving technologies that are providing new means to search & locate any object on the earth's surface. They will provide new trends to facilitate & ease the human life. Our country's Defense is looking forward to utilize this technology for Nation's Security.

Technologies and inventions are boon so long they are for the welfare of mankind and progress of civilization. All the developed and under-developed countries should come forward and join hands to channelize this invention for an all round betterment of this lovely mother earth.

REFERENCES:

[1] APPLICATION OF REAL TIME GIS USING REMOTE SENSING AND RTK-GPS FOR LOCAL GOVERNMENT:GEOSCIENCE AND REMOTE SENSING SYMPOSIUM, 2004. IGARSS '04. PROCEEDINGS. 2004 IEEE INTERNATIONAL: 20-24 SEPT. 2004 **BY** OKUNO, A. KANAZAWA INST. OF TECHNOL., ISHIKAWA; SHIKADA, M. 4790 - 4792 VOL.7

[2] M.Shikada, A.Okuno et al. Coordinate Transformation of Large-scale Map Data for Real-time Update of Maps using RTK-GPS, The Journal of Survey,Vol.54,No.8,pp. 10-13.2004

[3] M.Shikada, A.Okuno et al. Coordinate Transformation of Large-scale Map Data for Real-time Update of Maps using RTK-GPS, The Journal of Applied Survey Technology, Vol.15, pp.51-56, 2004

[4] S. Murai, 2002. Geoinfoematics, Revised Edition, pp.10-41, pp.62-63, pp. 70-164

[5] M. Tobita, 2002. Japanese Geodetic Datum 2000 and coordinates transformation, pp.42-64, pp.136-156

[6] A. Okuno and M. Shikada, "Application of REAL TIME GIS using RTK-GPS for Local Government, XX International Society of Photogrammetry and Remote Sensing Symposium,pp.1-6,2004.

[7] A., Chieko, M., Naoko, S., Masaaki, H. Tomita, K. Iwamura, "Management of Mapping in Local Government using Remote Sensing and the REAL TIME GIS", IEEE 2002, International Geoscience and Remote Sensing Symposium, 0-7803-7537-8/02, 2002

ooks:

- Satellite Remote Sensing and Its Role in Global Change Research
  - By John Wagers.
- GPS Principles and Interpretation
  - By W.H. Freeman and Company, New York.
- GIS Concepts & Implementation
  - By D.W. Dewman.

Websites:

http://www.nrcan.gc.ca (Definitions & Concept of GIS & GPS)
http://www.webserve.gsfc.nasa.gov (Satellite Remote Sensing)