UNIT 1: ADVANCE GIS

3DGIS

1.1. INTRODUCTION

Since early '90 GIS has become a sophisticated system for maintaining and analyzing spatial and semantic information on spatial objects. The need for 3D information is rapidly increasing. 2D GIS analysis have shown its limitations in some situations, e.g. noise prediction models (noise spreads out in three dimensions) (Kluijver and Stoter, 2003), water flood models, air pollution models, geological models (Van Wees et al., 2002). Other disciplines that have met the need for 3D geo-information are: 3D urban planning, environmental monitoring, telecommunications, public rescue operations, landscape planning, real-estate market (Stoter and Ploeger, 2003).

The breakthrough of 3D GIS seems not to come off. The developments in the area of 3D GIS are pushed by a growing need for 3D information from one side and new technologies on the other side (Zlatanova et al., 2002).

1.1.1Objective

After going through this unit the learner will able to learn:

- Understand Meaning of 3DGIS
- How to Prepare GIS Modeland How Web GIS work
- Capable To Work on Advance Gis Formats

1.1.3Technology progress

An important development is the improvement of 3D data collection techniques (aerial and close range Photogrammetry, airborne or ground based laser scanning, surveying and GPS). Sensors are faster and more accurate than before. Other new techniques that push 3D GIS developments are hardware developments: processors, memory and disk space devices have become more efficient in processing large data sets. Furthermore elaborated tools to display and interact with 3D data are evolving.GIS software-tools have also made a significant movement towards 3D GIS

.There are few commercial of-the-shelf (COTS) systems that can be categorized as systems that attempt to provide a solution for 3D representation and analysis. Five systems are chosen for detailed consideration, because they constitute a large share of the GIS market and provide some 3D data processing functions. The systems are the 3D Analyst of ArcGIS (see ESRI Inc.), Imagine VirtualGIS (ERDAS Inc., http://www.erdas.com), GeoMedia Terrain (Intergraph Inc., http://www.integraph.com),PAMAP GIS Topographer (PCIGEOMATICS, http:// www.pcigeomatics.com) andAutoCAD Map **3D (**usa.autodesk.com/autocad-map-**3d**/)

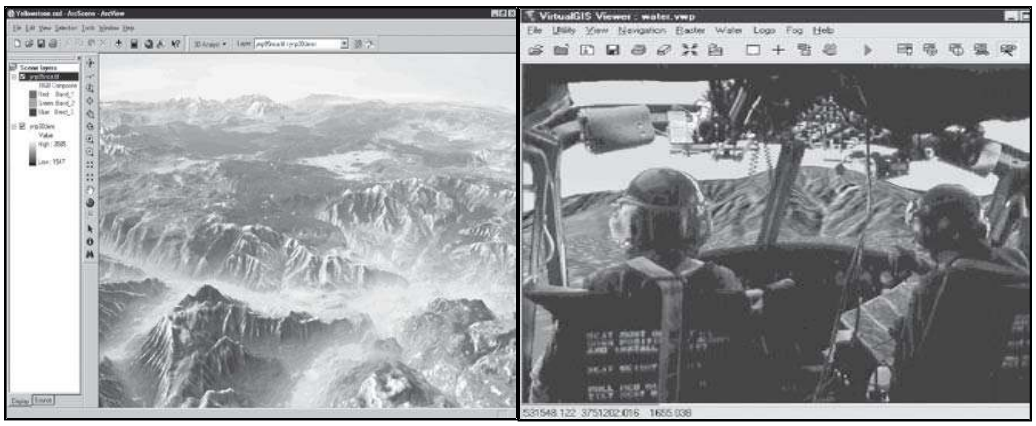


Figure 1.1: Commercial GIS: ArcScene, ESRI (left) and Imagine Virtual GIS, ERDAS (right)

1.1.3.1Working with 3D GIS

Many GIS problems can only be solved using 3D. Seeing your data in 3D can very quickly highlight spatial relationships between GIS features, and analytical tools can quantify these relationships into patternsa 3D GIS operates in a runtime environment just like the computer games and simulators. This environment allows users to travel anywhere in the scene at any time. This is in stark contrast to the animation quality movies that can take hours to render single frames and only follow a specified tract. To create an efficient 3D environment, buildings may be constructed as a wire frame and textured with digital images to dramatically reduce the number of polygons drawn by the computer without losing their character and visual appeal (Figure 1.2). Careful use of shadows can provide the illusion of detail in the building model.

Figure 1.2:Working From 2D Footprints, Building Models Are Constructed As A Wire Frame, Textured From Digital Images, and Completed For Inclusion inthe3D GIS Environments

1.1.3.2 Building Trees

Tree models are usually composed of two or more intersecting polygons with a picture of a tree pasted on all sides. However, for trees that will only be viewed from a distance, a single polygon that uses a lower resolution photo will provide the same visual effect while reducing the graphic impact of the scene.(Figure 1.3) illustrates the construction of a green ash tree for use in a 3DGIS EnvironmentMore 3D visualization environmentsnow support models or symbols thatincorporate levels of detail (LOD), whichcan help improve performance whilemimicking what can or cannot be seenwith the human eye. For example, amodel of a road sign built with LOD mightuse a detailed texture at close range butswitch to simple colors when viewed froma significant distance.Creating a tree model is actuallymuch harder than it looks. The processof extracting a tree from a full digitalpicture to create a texture can be a timeconsuming process. Issues of lighting,feature extraction, size and formattingcan account for hours of work.

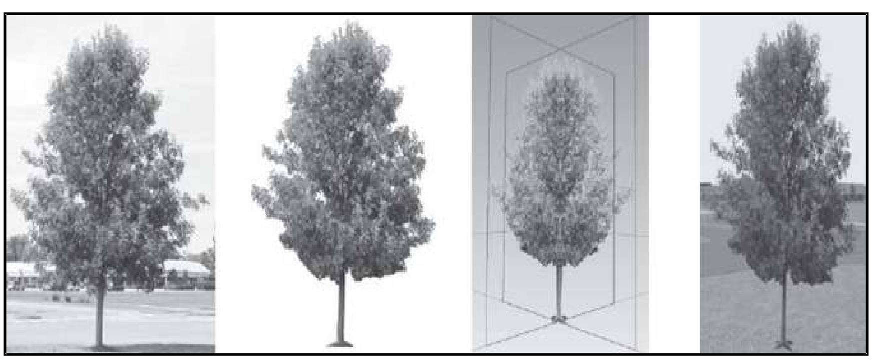
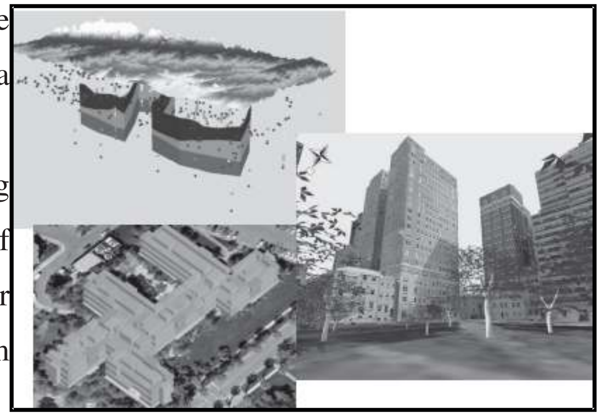


Figure 1.3 : The step involved in the creation of tree symbol: staring with photograph, extracting just the tree, creating the model two polygons and finally positioning the tree on the virtual landscape

1.1.3.2 Visualizing 3D Data

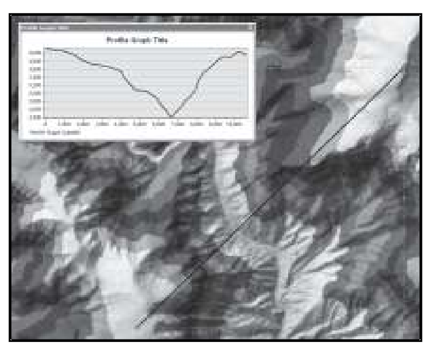
Viewing data in three dimensions gives you new perspectives. Three-dimensional viewing can provide insights that would not be readily apparent from a plan metric map of the same data. For example, instead of inferring the presence of a valley from the configuration of contour lines, you can actually see the valley and perceive the difference in height between the valley floor and a ridge.



ArcGIS 3D Analyst provides two viewing environments for your data. View large volumes of 3D GIS data in a global view usingArcGlobe, or view site-level data in a local coordinate system using ArcScene**Figure** 1.4 Visualizing of 3D data

You can build multilayered 3D environments and control how each layer is symbolized, positioned in 3D space, and rendered. You can also control global properties for the 3D view, such as the illumination or vertical exaggeration. You can select features by using their attributes or their position relative to other features or by clicking individual features in the scene or globe. You can interactively navigate around the 3D view or specify the coordinates of the observer and target for a viewer.

1.1.3.1Analysis in 3D



You can analyze GIS data in three dimensions using geoprocessing tools, and use interactive tools (such as the 3D Measure tool) in a 3D view to solve problems that can't be solved in 2D.Figure 1.5(a): Analysis3D data

You can create and modify functional surfaces with 3D Analyst. 3D surface tools allow you to create surfaces, convert surfaces to 3D features or other surface types, extract surface information, and conduct advanced surface analysis such as slope, aspect, and contouring. Examples of 3D surface analysis are elevation analysis for residential development, groundwater modeling, disaster management, or floodplain mapping.

Figure 1.5(b): Analysis3D data

A suite of 3D volumetric tools can be used to investigate and determine the relationship between 3D features, such as checking if one feature is located inside another or combining two 3D features into one complex shape. For example, you can calculate maximum building heights based on visibility restrictions.

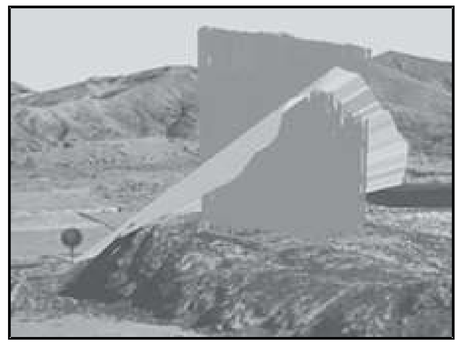


Figure 1.5(c): Analysis 3D data

You can conduct visibility analysis in your 3D GIS environment. A suite of visibility tools exist to conduct visibility analysis. For example, you can use the line-of-sight analysis on a landscape to optimize the location of telecommunication towers, or analyze the effects of a new proposed building on the city skyline.

1.1.4. 3D GIS: Future Vision

Imagine a public meeting where a proposed building is added to a virtual, GIS-enabled landscape. The GIS immediately evaluates the new building for compliance with use constraints as well as setback and height restrictions. The water and waste water systems are connected to the outsidelines (GIS layers) to verify capacity availability. Storm water run-off from the roof and other new impermeable surfaces are evaluated and summarized. Security and emergency vehicle access (including turn around space) are considered from all access routes. Finally, the reviewers can evaluate the appearance and compatibility of the new structure from any vantage point within the existing virtual environmentExpect the opportunities for employing 3D GIS technology to expand at a rapid rate over the next few months and years. Officials are already looking at 3D buildings by floor or even by room in applications related to security and emergency planning.(Figure 1.6)shows thefirst floor of a school as a multi patch feature with the roof and second floor turned off in the display. With detailed terrain and land cover information can we better model both the visual impact and performance of proposed wind turbines on our hillsides? View sheds from the windows of both existing and proposed buildings are now possible in both in a quantified and visual simulation. In reality we have just brushed the surface and exposed only a fraction of other possible technologies that may be applicable to GIS.

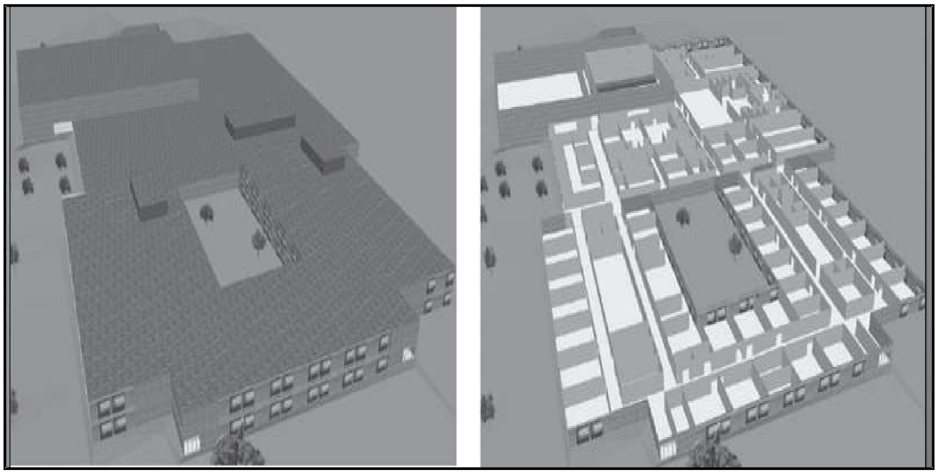


Figure 1.6**:** A building can be modeled in both its exterior presentation and with its interior detail by storing each floor of the building as a multi-patch. This allows the GIS to treat each floor as a layer and store separate attributes related only to that floor.

Check Your Progress

Q.1 Give the Name of 3DGIS software?

Q.2 Fill in the blank.

a)ArcGIS 3D Analyst provides two viewing environments for your data ……..& ArcScence

b)A suite of 3D volumetric tools can be used to investigate and determine the relationship between ……………..

Q. 3 True false against the following:

a)You can build multilayered 3D environments and control how each layer is symbolized, positioned in 3D space

b)Tree models are usually composed of one intersecting polygons with a picture of a tree pasted on all sides.

GIS MODELING

1.2 Introduction

Modeling can be defined in the context of geographic information systems (GIS) as occurring whenever operations of the GIS attempt to emulate processes in the real world, at one point in time or over an extended period. Models are useful and used in a vast array of GIS applications, from simple evaluation to the prediction of future landscapes

What is model? A model is a simplified representation of a phenomenon or a system. A map is model. So are the vector and raster data models for representing spatial features and the relational model for representing a database system A model helps us better understand a phenomenon or a system by retaining the significant feature and relationships of reality

The term modeling is used in several different contexts in the world of GIS, so it would be wise to start with an effort to clarify its meaning, at least in the context of this book. There are two particularly important meanings. First, a data model is defined as a set of expectations about data—a template into which the data needed for a particular application can be fitted. For example, a table is a very simple example of a data model, and in the way in which tables are often used in GIS, the rows of the table correspond to a group or class of real-world features, such as counties, lakes, or trees, and the columns correspond to the various characteristics of the features, in other words, the attributes. This table template turns out to be very useful because it provides a good fit to the nature of data in many GIS applications. In essence, GIS data models allow the user to create a representation of how the world looks. Second, a model (without the data qualification) is a representation of one or more processes that are believed to occur in the real world—in other words, of how the world works. A model is a computer program that takes a digital ++representation of one or more aspects of the real world and transforms them to create a new representation

1. 2.2Classification of GIS models

1. 2.2.1Descriptive or Prescriptive

A descriptive model describes the existing condition of spatial data, and a prescriptive model offers a prediction of what the conditions could be or should be. If we use maps as analogies, a vegetation map would represent a descriptive model and a potential natural vegetation map would represent a prescriptive model. The vegetation map shows existing vegetation, whereas the potential natural vegetation map predicts the vegetation that could occupy a site without disturbance or climate change

1. 2.2.2 Deterministic or Stochastic

Both deterministic and stochastic models are mathematical models represented by equations with parameters and variables. A stochastic model considers the presence of some randomness in one or more of its parameters or variables, but a deterministic model does not. As a result of random processes, the predictions of a stochastic model can have measures of error or uncertainty, typically expressed in probabilistic or statistical model.

1. 2.2.3Static or Dynamic

A dynamic model emphasizes the changes of spatial data and the interactions between variables, whereas a static model deals with the state of spatial data at a given time. Time is important to show the process of change in a dynamic model (peuquet 1994). Many environmental models such as groundwater pollution and soil water distribution are best studied as dynamic models (Rogoeski and Goyne 2002)

1. 2.2.4Deductive or Inductive

A deductive model represents the conclusion derived from a set of premises. These premises are often based on scientific theories or physical laws. An inductive model represents the conclusion derived from empirical data and observations. To assess the potential for a landslide, for example, one can use a deductive model based on laws in physics or use an inductive model based on recorded data from past landslides (Brimicombe 2003)

1.2.3. The Modeling process

In GIS models follows some steps, in which first step define the purpose of model. This analogous to defining a research problem, means what kind of task done by model, Is this compulsory to create model for this work? What kind of data (spatial) and time scales are good for this particular model?

Second step is to divide model into it elements and to define the each elements properties like a flow chart. Third step is use model on real work and run on the software, then you can see how model calibrate the input data and give results. The modeller can split observed data into two subset one subset for developing the model and the other subset for model validation (e.g, chang and Li 2000)

1.2.3.1. Binary models

A binary models based on logical expressions, for select spatial features, from different gis database or raster layer and the result of this models is in binary format . A vector based binary model need overlay process to done the combine geometries and attributes to be used in data query into a composite feature layer (Figure 1.7)

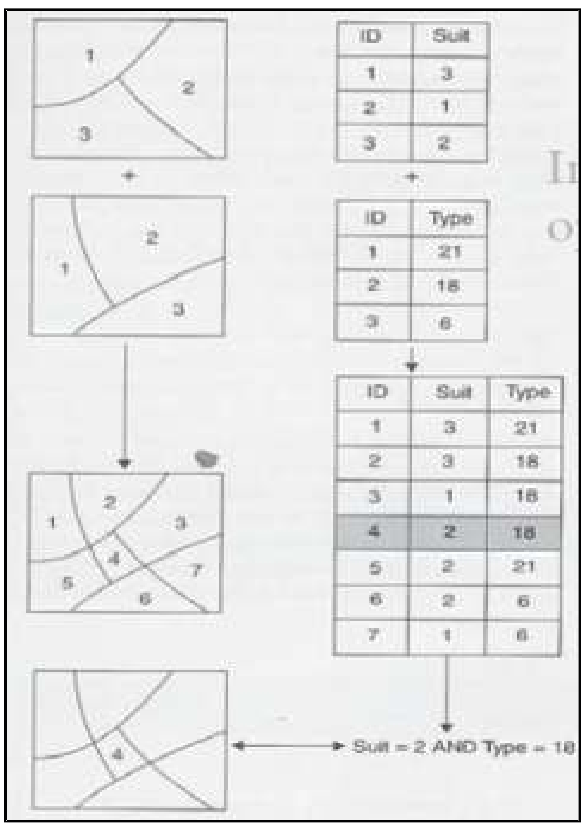


Figure 1.7(a):To build a vector- binary model, first overlay the layer so that their spatial features and attributes (suit and Type) are combined .Then, use the query statement, suit = 2 AND Type = 18, to select polygon 4 and it to the output layer.

But in Raster –based binary model can be derived directly from querying multiple raster's, with each raster representing a criterion (Figure1.8)

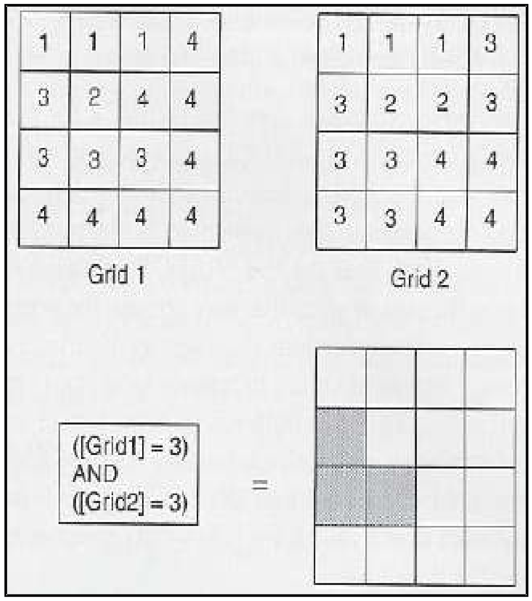


Figure1.8 (b) this diagram illustrate a raster –based binary model use the query statement, [GRID1] =3AND [GRID 2] = 3, to select three cells (shaded) and save them to the output grid

1.2.3.2INDEX MODELS

An index model calculates the index value for each unit area and produces a ranked map based on the index values. An index model is similar to a binary model in that both involve multi criteria evaluation and both depend on overlay operations for data processing. But an index model produces for each unit area an index value rather than a simple yes or no.

1.2.3.2.1The Weighted Linear Combination Method

The primary consideration in developing an index model, either vector –or raster based, is the method for computing the index value. The weighted linear combination method is a common method for computing the index value (Saaty 1980; Banai-kashani 1989; Malczewski 2000).

1.2.3.3 REGRESSION MODELS

A regression model relates a dependent variable to a number of independent (explanatory) variables in an equation, which can then be used for prediction or estimation (Rogerson 2001). Like an index model, a regression model can use overlay operation in a GIS to combine variables needed for the analysis. There are two types of regression model; linear regression and logistic regression

1.2.3.3.1Linear Regression models

Amultiple linear regression model is defined by:

$Y = a + b_1x_1 + b_2\, x_2 + ... \, b_n\, x_n$

Where y is is the dependent variable, x_i is the independent variable i, and $b_{1........}b_n$ are the regression coefficients . All variables in the equation are numeric variables. They can also be the transformation of some variables. Common transformations include square, square root, and logarithmic.

The primary purpose of linear regression is to predict values of y from values of x, but linear regression requires several assumptions about the error, or residual, between the predicated value and the actual value (Miles and shevlin 2001)
The errors have a normal distribution for each set of values of the independent variables
The errors have the expected (mean) value of zero
The variance of the errors is constant for all value of the independent variables
The errors are independent of one variable
Regression models have been used for modelling snow accumulation (chang and Li 2000), wildlife home ranges (Anderson et al.2005), non-point pollution risk (potter et al.2004)

1.2.3.3.2 Logistic Regression model

Logistic regression is used when the dependent variable is categorical (e.g. presence or absence) and the independent variable are categorical, numeric, or both (menard 2002). Although having the same form as linear regression, logistic regression uses the logit of y as the dependent variable:

$$\text{logit}(y) = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots\ldots\ldots\ldots..$$

The logit of y is the natural logarithm of the odds (also called odds ratio):

The main advantage of using logistic regression is that it does not require the assumptions needed for linear regression. Logistic regression models have been developed for predicting grassland bird habitat (Forman et al. 2002), fish habitat (Eikaas et al. 2005) landslide susceptibility (Lee 2005)

1.2.3.4. Process Models

A process model integrates existing knowledge about the environment processes in the real world into a set of relationship and equations for quantifying the processes (Beck et al.1993). Modules or sub-models are often needed to cover different components of a process model .some of these modules may use mathematical equations derived from empirical data, whereas others may use equations derived from laws in physics. A process model offers both a predictive capability and an explanation that is inherent in the proposed processes (Hardisty at al.1993) Therefore; process models are by definition predictive and dynamic models.

Check Your Progress

Q.4 What is Index Model?

Q.5 Fill in the blank.

a)……………. and stochastic models are mathematical models represented by equations

b)Groundwater pollution and soil water distribution are best studied as …………models

Q. 6 True false against the following:

a)A binary models based on logical expressions, for two spatial features

b)The main advantage of using logistic regression is that it does not require the assumptions needed for linear regression.

WEB GIS

1.3.1 Introduction

GIS software has enabled users to view spatial data in its proper format. As a result, the interpretation of spatial data has become easy and increasingly simple to understand. Unfortunately, everyone does not have access to GIS, nor would he be able to spend the time necessary to use it efficiently. Web GIS becomes a cheap and easy way of disseminating geospatial data and processing tools. Many organizations are interested to distribute maps and processing tools without time and location restriction to users. Internet technology has made its way to many government organizations as well as numerous households. The ability to get information through Internet made spatial data providers to explore the Internet resources fordisseminating spatial information.

1.3.2. Web GIS Technology

Development of the Web and expansion of the Internet provide two key capabilities that can greatly help geoscientists.First, the Web allows visual interaction with data. By setting up a Web Server, clients can produce maps. Since the mapsand charts are published on the Internet, other clients can view these updates, helping to speed up the evaluation process.Second, because of the near ubiquitous nature of the Internet, the geospatial data can be widely accessible. Clients can workon it from almost any location. Both of these features altars the way geoscientists do their work in the very near future. Thecombination of easy access to data and visual presentation of it addresses some of the primary difficulties in performinggeosciences evaluations (Gillavry, 2000).

Web GIS is not without its faults. The primary problem is speed; GIS relies on extensive use of graphics. Connectionspeeds over the Internet can make heavy use of graphics intolerably slow for users. It will not match the complexity ofdedicated GIS programs. On the other hand, Web GIS does notrequire the same resources as these programs (GisSoftware). Powerful computers, extensive training, and expensive site licenses are notrequired for a site wide GIS solution (Strand, 1998).

1.3.2.1 Transferred Geo Data

Except attribute data, a decisive question for using GIS in the Internet is the data format (vector or raster), which is used totransfer data to client. For data transmission to the client, map is converted into no space raster or a suitable vector format.When raster data is transferred, a standard Web browser without extension can be used, since Web browser displays GIFand JPEG. That means the data on the server has to be converted to a raster format. The data volume due to the knownimage size and the original data on the server is safe as only an image is sent to the client. The disadvantage of using rasterdata is the lack of comfort of handling and regarding cartographic aspects

Because of low vector data volume, it transmits faster than raster. Vector data handled by a standard Web browser withextended functionality (e.g. using plug-ins). The user gets a more functionality with vector data. For example, single objectscan be selected directly or highlighted. One more advantage of using vector data is the possibility of local processing; it isnot necessary to contact the server per executed browser action. The amount of vector data sent over Web could be three tofour times less than the amount of raster data needed for equivalent resolution resulting in faster response time and greaterproductivity (Nayak, 2000). Disadvantages of vector data are manufacturer dependence, as well as, changing data volume;the amount of data varies with the selected area.

Different consortia are developing future standard formats for transferring data over the Internet. The Open GISconsortium, for example, presents Geography Markup Language (GML). GML shall enable the transport and storage ofgeographical information in extensible Markup Language (XML). Geographic information includes both properties and thegeometry of geographic features (www.opengis.org). The W3C submits Scalable Vector Graphics (SVG), which is alanguage for describing two dimensional vector and mixed vector/raster graphics in XML (www.w3.org).

1.3.2.2 Interactive Web Maps

There are several technology levels to publish map data on the Web, ranging from sites that simply publish static Webmaps to more sophisticated sites which support dynamic maps, interactively customized maps and multiple computerplatforms and operating systems. In terms of Web GIS, the most challenging map is the interactive one. Within the OpenGIS Consortium, a Special Interest Group (SIG) for WWW Mapping is working on issues of Web-based GIS publishing.This group has recently developed an essential model of interactive portrayal (Figure 1.9).

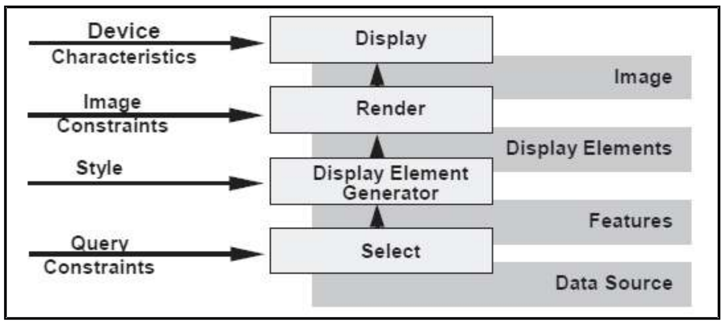


Figure1.9:Open GIS model of portrayal workflow (Doyle 1999)

This model is a very useful tool to analyze and compare different architectures for Internet Map Servers and other Internetbased GIS applications. Moreover, it is more precise than the common expression, which often leads to misunderstandings.The interactive portrayal model has four tiers:

- The Selection process retrieves data from a geospatial data source according to query constraints such as a searcharea or thematic selections
- The Display Element Generator process turns the selected geospatial data into a sequence of display elements. It attaches styles such as symbols, line styles, fill styles to spatial features, generates annotation from alphanumeric attributes, sorts the display elements in a certain order and does other graphical processing
- The Render takes the display elements and generates a rendered map. Examples of rendered maps are In-memory display lists, GIF-files or postscript files
- The Display process makes the rendered map visible to the user on a suitable display device Between these four tiers, there are three different types of data

1.3.2.3. Internet Map Servers

Internet Map Server (IMS) applications allow GIS database custodians to easily make their spatial data accessible through a web browser interface to end-users. High-speed corporate intranets make an ideal network for distributing data in this manner, given the fact that bandwidth requirements can be high. Making data available to the entire world is certainly feasible and any organization that has a public website can certainly add an IMS without opening up too many additionalsecurity holes. For a working IMS, software requires two components to function. A geospatial data processing engine that runs on theserver side as a service, Servlet or Common Gateway Interface (CGI) application, and processes the raw spatial data into a map and a standard web server that manages the incoming requests and replies with the proper map data back to the client side browser or application window. The end product is either a JPEG or GIF image or vector, which is transmitted back tothe client browser or a stream of data that is interpreted by a plug-in to the client browser. IMS that transmit back an image have a limited capability that does not extend much beyond pan, zoom, and basic vector attribute query. The featurestreaming IMS requires a downloadable plug-in, but allows for advanced buffer, query, labeling and sub setting operations to be performed. Some IMS sites offer both a plug-in and a simple HTML version, which is nice for plug-in weary surfers.

1.3.3. Web GIS Architectures

In performing the GIS analysis tasks, Web GIS is similar to the client/server typical three-tier architecture. The geo-processing is breaking down into server-side and client-side tasks. A client typically is a Web browser. The server-sideconsists of a Web Server, Web GIS software and Database (Figure 1.10) (Helali, 2001).

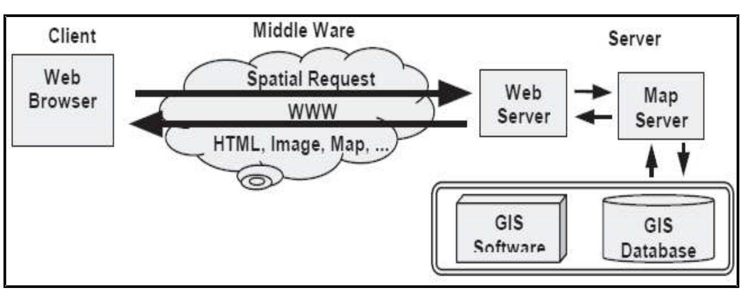


Figure 1.10: How a typical web gis model works

This model of network widely exists within enterprises, in which some computers act as servers and others act as clients.Sever simply have the proprietary GIS running, and add a client interface at the client side and a middleware at the serverside to communicate between the client and the proprietary GIS software.

Recent development in object oriented programming make it possible to produce software components, and send them tothe client before running it in the client machine, such as Java classes, ActiveX components and plug-ins. This comes out tothe thick client GIS. The thick-client architecture let the client machine do the most processing works locally. Both thin andthick-client systems have some advantages and drawbacks, but they are not the best solution in terms of taking advantage ofnetwork resources.

1.3.3.1 Thin Client Architecture (Server Side Applications)

The thin client architecture is used in typical architecture. In a thin-client system, the clients only have user interfaces tocommunicate with the server and display the results. All the processing is done on the server actually as shown in Figure 2.The server computers usually have more power than the client, and manage the centralized resources. Besides, the mainfunctionality is on the Server side in thin architecture there is also the possibility for utility programs at the server side to belinked to the server software. (Figure 1.11) shows schematic communication between Web browser, Web Server and GISserver. On the Web Server side, there are some possibilities to realize the GIS connection to the World Wide Web; CGI,Web Server Application Programming Interface (API), Active Server Pages (ASP), Java Server Pages (JSP) and Java-Servlet. The descriptions of the five possibilities mentioned above are in Helali, (2001)

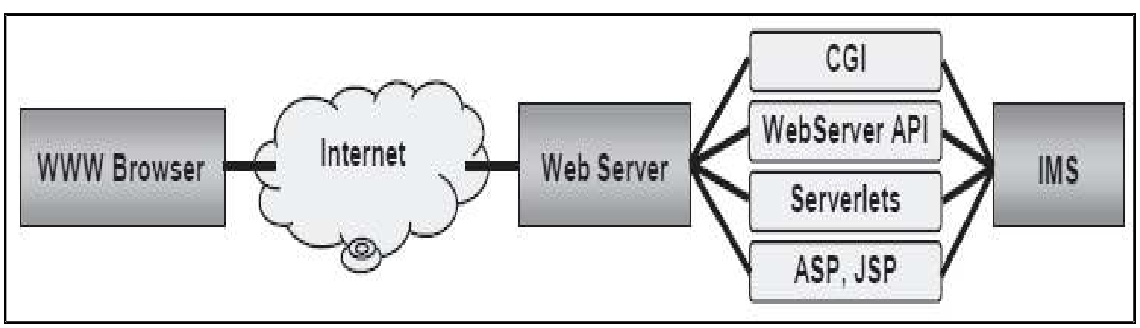


Figure 1.11: server side Application

The user on the client side does not need any knowledge about the linkage of the IMS at the server side, but the systemadministrator or application developers should be familiar with these techniques. This Architecture used in ESRI ArcViewIMS, MapObjects IMS and MapInfo MapXtreme systems.

1.3.3.2 Thick Client Architecture (Client Side Applications)

In general, a Web browser can handle HTML documents, and embedded raster images in the standard formats. To deal withother data formats like vector data, video clips or music files, the browser's functionality has to be extended. Using exactlythe same client sever communication in Thin Client architecture, vector files format could not be used. To overcome thisproblem most browser applications offer a mechanism that allows third tier programs to work together with the browser asa Plug-in. The user interface functionality has progressed from simple document fetching to more interactive applications. Thisprogress is as follows: HTML, CGI, using HTML forms and CGI, Java script to increase user interface capabilities, Javaapplets to provide client-side functionality. Currently user interface capabilities combined with remote invocations (Figure 1.12) (Byong-Lyol, 1998).

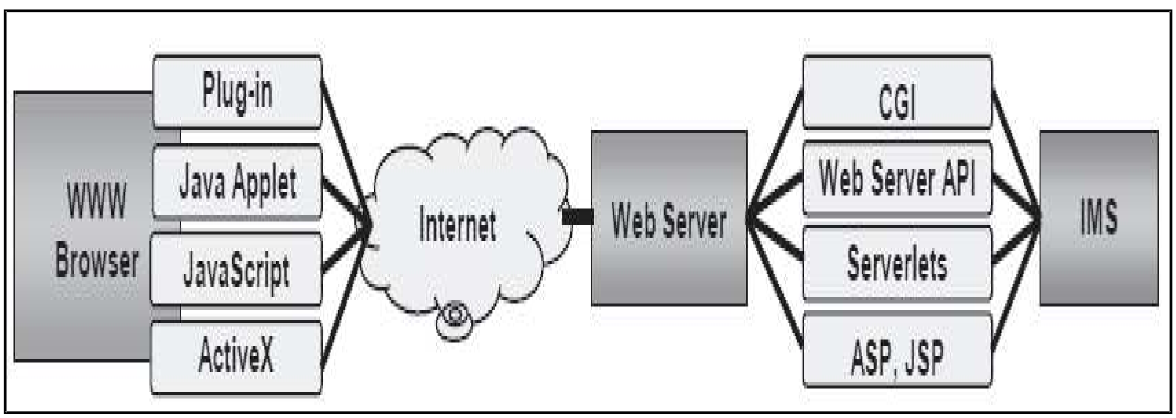


Figure 1.12: client side Application

1.3.3.3 Medium Client Architecture

For avoiding vector data in client side and reducing problems of previous architectures, Medium Client is suggested. Withusing extensions in both client and server side, clients may have more functionally than Thin client architecture. In Figure 1.13these four components in interactive map are pictured as services, each with interfaces, which can be invoked by clients ofthat service

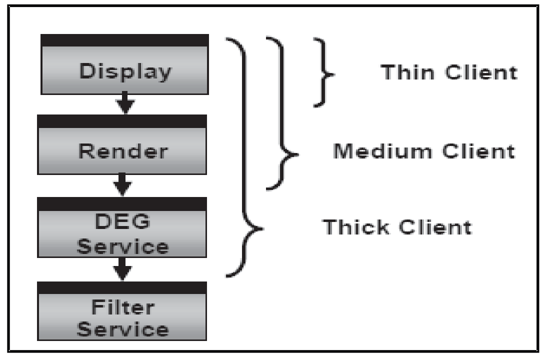


Figure1.13: Medium Client position in open GIS point of view

In other words, if a user's computer contains just the display service, then that user would be said to be using a thin client.If the user’s computer additionally contained a render service, then that user would be said to be using a medium client.And finally, if the user’s computer also contained the display element generator service that would indicate the user is usinga thick client.

1.3.4. Web GIS Development

Developing a Web GIS is more than simply buying the appropriate hardware and software. Several strategies have beenproposed to provide successful implementation (Alesheikh & Helali 2001). The implementation strategies have beenscientifically assessed and modified so that the requirement of any project can be met with minimum cost and time. Figure 1.14 shows the Web GIS development cycle, which is described in terms of 8 major activities starting with therequirement analysis and ending with on-going use and maintenance of the Web GIS system

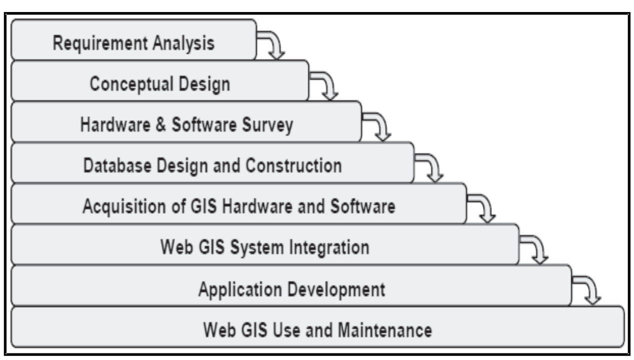


Figure 1.14: Web GIS Development cycle

1.3.4.1 Requirement Analysis

The object of the project is to disseminate road information through the Internet, so that constituents can easilyaccess the data. The requirement analysis step has been performed through interviewing potential users. This step producedtwo critical pieces of information:

- A list of functions that is needed. The required functions are the basic visualization functions such as Pan, Zoom, and more advanced functions such as object identification, spatial query, and shortest path. Clients can use these functions to view road information, and peripheral constructs such as gas stations and rest areas.
- A master list of available/needed geographic data. During theproject several roadlayershas captured for information using GPS.In this project, only 25 layers of information have been used that includes; police station, restaurants, gas station

The information gained in the requirement analysis activity went directly into the Conceptual GIS Design activity.

1.3.4.2 Conceptual Design

Once the required data has been identified, the data model that identifies the entities and their relationships were designed.Since, the data will be delivered through a central server, and clients will have access to raster formats, Medium Clientarchitecture was chosen providing the users with access to interactive maps.

1.3.4.3 Survey of Available Software and Hardware

Selecting suitable software is an important step in a successful implementation. Software was evaluated on functionalityand performance and independent of the hardware and operating system and also respect to the required functionsand cost. Web GIS requires specific hardware configuration. Since the volume of transferred data is huge, the speed of Internetconnection is vitally important. Most of the data are sent from map server to clients; as such the Send speed should be more than 128kbs and for computerProcessors should Dual or core 2 Duo with 2GB Ram.

1.3.4.4 Database Design and Construction

The primary purpose of this phase of the Web GIS development process was to specify "how" the Web GIS performs therequired applications. Database design involved defining how graphics will be symbolized (i.e., color, weight, size,symbols, etc.), how graphics files will be structured, how non graphic attribute files will be structured, what is the activelayer, in what scale shall the layers expose, how GIS products will be presented (e.g., map sheet layouts, report formats,etc.), and what management and security restrictions will be imposed on file access. Completing the following activitiesdoes this:

- Selecting a source (document, map, digital file, etc) for each entity and attribute included in the Entity-Relationship diagram
- Setting-up the actual database design (logical/physical design)
- Defining the procedures for converting data from source media to the database. Since the formats of the data were selected to be ESRI compatible, the needed data were converted to such format
- Define procedures for managing and maintaining the database.
-

1.3.4.5 Acquisition of GIS Hardware and Software

The database design activity was conducted concurrently with the pilot study and benchmark activities. Actual proceduresand the physical database design cannot be completed before specific GIS hardware and software has been selected while atthe same time GIS hardware and software selection cannot be finalized until the selected GIS can be shown to adequatelyperform the required functions on the data. Thus, these three activities (design, testing, and Hardware/Software acquisition)have been conducted concurrently and iteratively.

1.3.4.6 Web GIS System Integration

At this point in the Web GIS development process the Web GIS hardware and software have been acquired and dataconversion is complete. The object of this phase was then to integrate different components of the hardware and software,to test them to make sure they work as expected, and to initiate all procedures necessary to use the GIS.

1.3.4.7 Application Development

The initial Requirement Analysis contained some applications of a complex nature. However, the majority of initialapplications was straightforward, and can be implemented using the basic functionality that is part of the Web GIS software(e.g., display). The more complex applications were not supported by the basic functions of Web GIS but have beenprogrammed. Ease of use, user-friendliness, and reducing the volume of data transfer were the critical issues considered inthe development.

1.3.4.8 Web GIS Use and Maintenance

The final step in web GIS implementation was to put the system to use. With system integration and testing completed and all applications available for use, the system was released to users. Two activities were in place:

- User support and service, in which new applications will be determined, and
- System maintenance (database, hardware, software), in which the Web GIS must run smoothly

Check Your Progress

Q.7 What is Internet Map Server?

Q.8 Fill in the blank.

a)For avoiding vector data in client side use………………. architectures

b)Web browser can handle……….. documents and embedded raster images in the standard formats.

1.4. Summary

This unit elaborate Advance Gis types and explain how advance Gis provides users with freedom to analyze spatial problems within their specific industry. And discuss on three different advanceGis format, like what is 3DGIS, how we visualizing &analysis 3Ddata, basic components of models and its applications of models and introduction of webGis and it structure

1.5. Glossary

- **Model: -** simplified representation of a phenomenon or system.
- **Binary model: -** A Gis model that uses logical expressions to select feature from a composite feature layer or multiple rasters.
- **KML:-K**eyhole **M**arkup **L**anguage is an XML-based language to express geo-graphic annotation and visualization on existing or future Web-based, two-dimensional maps and three-dimensional Earth browsers. KML was developed to use it with Google Earth, and was originally named Keyhole Earth Viewer.
- **Java Script: -**Java script is a scripting language most often used for client-side web developments. It was the originating dialect of the ecmascript standard. It is a dynamic, weakly typed, prototype-based language with first-class functions. JavaScriptwas influenced by many languages and was designed to be easier for non-programmers to work with.
- **3D graphics: -**3D graphiccreate the illusion of depth in 2D-images. 3D computer graphics rely on many of the same algorithms as 2D computer vector graphics do in awire frame model. 2D applications use 3D techniques to achieve certain effects, and 3D may still use 2D techniques for rendering.
- **Cache: Cache: - is** a temporary storage area, where frequently accessed data can be stored for rapid access. Once the data is stored in a cache, future use can be made by accessing the cached copy rather than re-computing the original data, reducing the average access time considerably. If a user revisits a Web page after only a short interval, the page data may not need to be re-obtained from the Web server.

1.6. Answer to check your progress/Possible Answers to SAQ

Ans.1 ArcGIS, Imagine VirtualGIS (ERDAS), GeoMedia Terrain, PAMAP GIS Topographer (PCIGEOMATICS), AutoCAD Map **3D**

Ans.2 Fill in the blank.

(**a**)ArcGlobe (**b**) 3D features

Ans. 3 True false against the following:

(**a**) True (**b**) False

Ans.4 An index model calculates the index value for each unit area and produces a ranked map based on the index values. An index model is similar to a binary model in that both involve multi criteria evaluation and both depend on overlay operations for data processing. But an index model produces for each unit area an index value rather than a simple yes or no.

Ans.5 Fill in the blank.

(**a**) Deterministic (**b**) Dynamic

Ans. 6 True false against the following:

(**a**) False (**b**) True

Ans.7 Internet Map Server (IMS) applications allow GIS database custodians to easily make their spatial data accessible through a web browser interface to end-users. High-speed corporate intranets make an ideal network for distributing data in this manner, given the fact that bandwidth requirements can be high. Making data available to the entire world is certainly feasible and any organization that has a public website can certainly add an IMS without opening up too many additional security holes

Ans.8 Fill in the blank.

(**a**)Medium Client (**b**) HTML

1.7. Reference

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2. Www.cabnr.unr.edu/saito/intmod/docs/merwade_gismodeling.ppt

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4. Introduction to geographic information systems – kang-tsung chang

5-http://maps.unomaha.edu/peterson/gis/final_projects/1996/swanson/gis_paper.html

6-http://resources.arcgis.com/content/3dgis/10.0/manage

7-spatial data modelling for 3d Gis --by alias abdul-rahman, morakot pilouk,

8-http://www.isprs.org/proceedings/xxxiv/part4/pdfpapers/422.pdf

9-web Gis: principles and applications [paperback] Pinde fu (author), jiulin sun (author)

10-fundamentals-of-remote-sensing.-by Noam Levin ,November 1999

1.8. Suggested Readings

1.Advanced Spatial Analysis: The CASA Book of GIS
Paul A Longley (Author), Michael Batty (Editor), Mac Rubel (Editor), Paul A. Longley (Author)

2.GIS Tutorial 3: Advanced Workbook [David W. Allen (Author), Jeffery M. Coffey (Author)

1.9. Terminal Questions

Q1.Write the names of different 3D GIS Software

Q2.What is Web GIS Architectures?

Q3.Different between Thick and Thin client architecture

Q4.Describe the difference between a descriptive model and a prescriptive model

Q5.How does an index model differ from a binary model?

Q6. What kinds of variables can be used in a logistic regression model?

Q7. Explain the weighted linear combination Method

Q8. How does a static model differ from a dynamic model

UNIT 2: ADVANCE REMOTE SENSING

THERMAL REMOTE SENSING

2.1. INTRODUCTION

The basis of passive imaging systems is that sensor detects and measure the E.M. radiation reflected or emitted from different surface features. Two surfaces may have very similar reflected characteristics within in visible and infrared part of E.M. spectrum and may not be distinguishable, but because they may have dissimilar thermal properties. They may be distinguished in thermal infrared spectrum. Objects radiate energy as a function of their temperature in thermal infrared wavelength. This emitted energy may be remote sensed using thermal sensor in the wavelength range from 3 to 14 µm. its generally record broad spectral bands typically 8.0 to 14 µm for image from aircraft and 10.5to 12.0 µm for image from satellites.

2.2 Objective

After going through this unit the learner will able to learn:

- Types of Advance Remote sensing
- Thermal Hyperspectral , Microwave , Lidar
- Applications of Advance Remote Sensing.

2.3. Thermal Properties of Objects

All object having temperature above 0°k emit thermal radiation whose intensity and spectral composition are a function of material type and temperature of the object, According Stefan Boltzmann law, the energy radiate by an object at a particulartemperature is given by-

$M = \sigma T^4$Where, "σ" is the Stefan Boltzmann constant $5.67*10^{-11}$ $w/m^2/k^4$

"T"- absolute temperature "M"- (radiant existence) W/M^2

AS “M” various with forth power of “T”. The object even with close difference in temperature can be distinguished from remote sensing measurement.

A black body obeys this law, whereas natural bodies do not obey this law and a constant emissivity (έ) has to be introduced in the above equation.

$M = έ \sigma T4$ Where έ is the emissivity

The emissivity is a measure of the ability of a material both to radiate and to absorb energy and is define as-

- Energy actually emitted by unit area of surface in unit time at a given temperature
- Energy emitted by unit area of a black body in unit time at the same temperature.
- The emissivity of a black body is equal to 1 and all other materials have a value less than one.

2.4. Technical Termsin Thermalremote sensing

- **Kinetic Heat**– kinetic heat is the kinetic energy of particles of matter in random motion, which causes the particles to collide resulting in change of energy state and emission of E.M. radiation. The kinetic heat energy of the object thus converted in to radiant energy.
- **Radiant Flux**- the E.M. energy radiated from a source is called radiant flux and is measured in watts per square centimeter.
- **Kinetic Temperature**- the concentration of kinetic heat of a material is called kinetic and is measured by thermometer placed in direct contact with the material.
- The concentration of radiant flux of a body is called radiant temperature. This may be measured remotely by devices that detect E.M. radiation in thermal infrared region
- **Thermal Capacity-(C)**It is the ability of material to store heat and is define as the number of calories required to raise 1 gm of a material to 1°c and is expressed in calories/g/°c. Most metals have low value of c (approx 0.09), while many natural surface like vegetation, rock and soil have thermal capacity value of 0.2, and water has value of 1

2.5. EnergyExchange Theory

Heat energy istransferred from one place to another by three mechanisms;

- **Conduction** →Heat may be conducted directly from one object to another as when a pan is direct physical contact with a hot burner
- **Convection**→ Heat transfer through the physical movement of heated matter .the circulation of heated water and air example of convection.
- **Radiation** → Heat transfer in form of E.M. waves. Heat from the sun reaches the earth by radiation. It is primary interest to uses remote sensing science because it is only form energy transfer that can take place in vacuum such as the regionbetween the sun and the earth.

2.6. IR Region and ElectroMagnetic Spectrum

The IR region is that portion of the EM spectrum ranging in wave length from 0.7 to 1000 µm. The reflected IR region range from 0.7 to 3.0 µm and is dominated by reflected solar energy, Band 4, 5 & 7 of the LAND SAT TM recorded this region. The reflected IR region also includes the photographic IR band (0.7 to 0.9 µm)which may be detected by direct IR sensitive film.

IR radiation at wavelength of 3 to 14 µm is called the thermal IR regions

Thermal IR imagery is usually obtained in the wave length region.

(i) 3 to 5.5 µm range and

(ii) 8 to 14 µm range because of atmospheric absorption at other wave length.

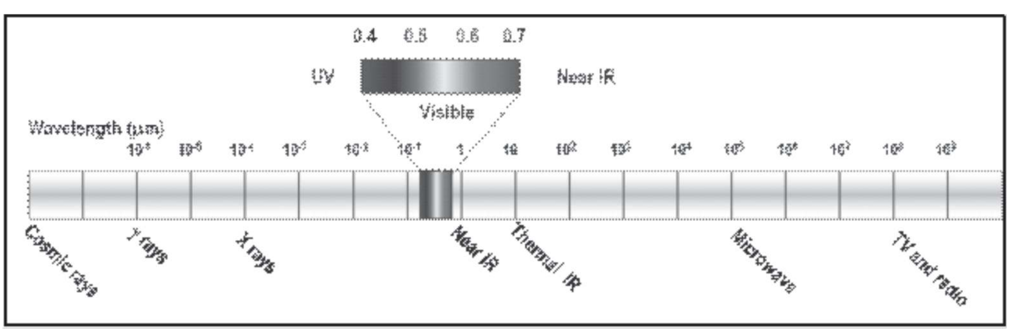


Figure 2.2 Electromagnetic Spectrum

1. Energy in g-ray, X-ray & UV region is absorbed by the earth's atmosphere, hence not used for remote sensing.
2. Spectral sensitivity of human eye extends from 0.4 to 0.7 µm
3. Remote sensing deals with energy in visible, infrared, thermal and microwave regions.
4. These regions are further subdivided into bands

2.7. Interaction of Thermal Radiation with Terrain Elements

In thermal remote sensing we are interested in the radiation emitted from terrain features.In the process the energy incident on the surface of a terrain element. Elements can be absorbed, reflected or transmitted. According with the principle of conservation of energy,we can state the relationship between incident energy and its disposition upon interaction with a terrain element as

$E_I=E_A+E_R+E_T$
Where:-
E_I=Incident Energy
E_A=Absorb Energy
E_R=Reflected Energy
E_T=Transmitted Energy

Energy Interactions with the Earth's Surface
Energy Balance Equation:

$E_I = E_R + E_A + E_T$

Incident = Reflected + Absorbed + Transmitted

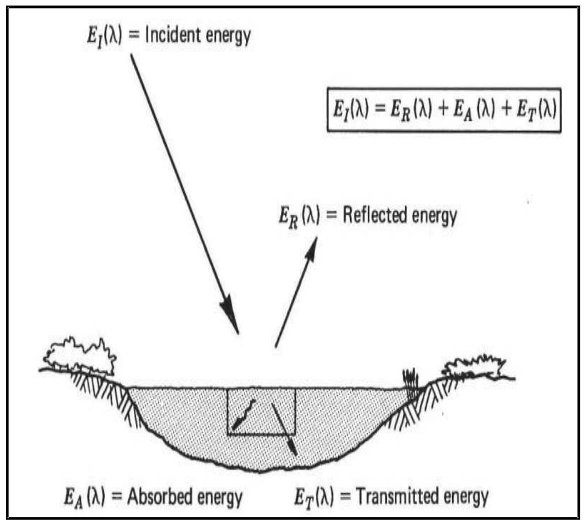


Figure 2.3 Showing Interactions mechanism

Interaction with matter can change the following properties of incident radiation.

Intensity, Direction, Wavelength, Polarization, Phase

This equation is divided by the quantity E_I

$$E_I / E_I = E_A / E_I + E_R / E_I + E_T / E_I$$

The terms on the right side of this equation comprise ratio that are convenient in further describing .We define this as

$\alpha(\lambda) = E_A / E_I$, $\rho(\lambda) = E_R / E_I$, $\tau(\lambda) = E_T / E_I$

We can now restate this equation in this form:-

$\alpha(\lambda)+\rho(\lambda)+\tau(\lambda) = 1$

This equation defines the inter-relation among a terrain elements absorbing reflecting and transmitting properties.

According the Kirchhoff radiation law the spectral emissivity of an object equals its Spectralabsorbance

$$\acute{\varepsilon}(\lambda)= \alpha(\lambda)$$

if $\tau(\lambda)=0$

Thus According this

$$\alpha(\lambda)+\rho(\lambda)=1$$

This equation has direct relationship between an object emissivity and its reflectance in the thermal region of the spectrum. The lower an objects reflectance, the higher its emissivity

2.8. Factors Affecting Thermal Image Quality

Image quality depends upon three main group of factor

2.8.1 Ground Properties

Lateral variation in the relevant ground properties (namely, thermal properties such as thermal inertia, emissive etc. as may be) across the scene influences the radiometric image quality.

2.8.2 Environment Factors

a. **Solar Illumination and Time ofSurvey:-**Remote sensing data should be acquired at a time when energy condition is stable and optimum for detecting differences in ground properties. In the solar reflection region energy condition depend on the Azimuth and angle of sun elevation and the time go survey. Thermal-IR survey is usually carried out in the predawn hours when ground temperatures arequite stable.

b. **Path Radiance:-**Path radiance works as a background single and tends to reduce image contrast ratio. In the thermal-IR region, the major cause of path radiance is atmospheric emission; its effect can be minimized by confining sensing to atmospheric windows.

Digital techniques are also available for reducing the effects of path radiance and improvingthe image quality.

c. **Meteorological Factors:-**Meteorological factors such as rain, wind, cloud cover etc. may significantly alter the ground properties and influence response in the optical region.

For example- rain increases soil moisture, which alters ground Albino and thermal inertia.

d. **Atmospheric Factors:-**

A) AbsorptionandTransmission:-Energy is absorbed by various molecules in the AtmosphereOzone, water vapour and carbon dioxide are most efficient absorbersHalf of the spectrum between 0 – 22 □m is not useful for RS.Optical RS: 0.4 – 2 □m, Thermal: 3 – 5 □m and 8 – 14 □m

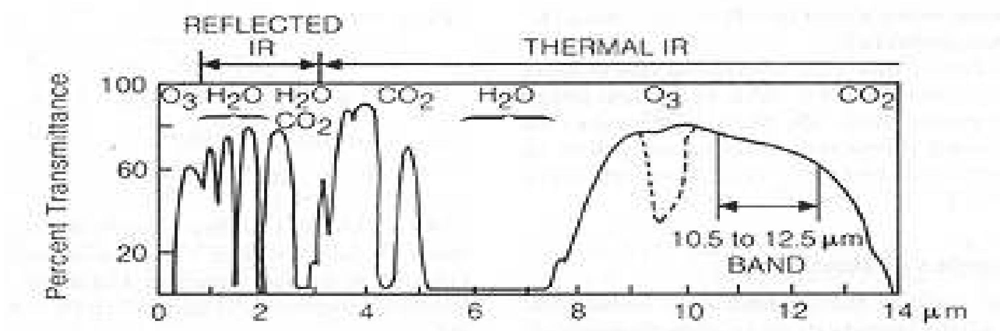


Figure2.4 Atmospheric windows

b) Atmosphericfactors:-The atmospheric has a significant effect on the on the intensity and spectral composition of the energy recorded by a thermal system. The effect that the atmosphere has on a ground signal will depend on the degree of atmospheric absorption, scatter and emission at the time and place of sensing. Gases and suspended particles in the atmosphere may absorb radiation emitted from ground object, resulting in a decrease in the energy reaching a thermal sensor.Dust, carbon particles, smoke and water droplets are also effect to thermal radiation.

2.8.3Sensor System Factors

a. **Effect of Optical Imaging System:-**The optical imaging component namely lenses, mirrors, prisms etc. are not absolutely perfect but real and therefore minor diffraction, aberrations etc. are present However, their effects are quite negligible.

b. **Image Motion:-**The relative moment of the sensor platform with respect to the ground being imaged during the period streaks on the image. Forward motion compensation (FMC) device have to be used for better result. FMC device may still be necessary in order to achieve high spatial resolution

c. **Stripping:-**When a series of detector elements is used for imaging a scene (e.g. in the case of Land sat MSS and TM or in CCD linear or area arrays), the radiometric response of all the detector elements may not be identical. This non identical response of all the causes striping and could lead to a serious duration in image quality

d.

2.9. Thermal IR image Sources

Several instruments are available for the remote acquisition of surface information in TIR region

The majority of them are Either Airborne or Space borne with a few field instruments.

- **Heat Capacity mapping Mission (HCMM)**= 10.5- 12.5 µm; Resolution 600m
- **Thermal Infrared Multispectral Scanner (TIMS)**= 6bands between 8-12 µm
- **NOAA AVHRR =** 5 bands; Resolution 1.1km
- **Landsat Thematic Mapper TM Band 6 =** 10.4 -12.5 µm; 60 m resolution
- **Advanced Space Borne Thermal Emission Reflectance Radiometer (ASTER) (Terra)**

  High Resolution Multispectral imager

  3 bands in VNIR (0.5- 1.0 µm); 15 meter

  6 bands in SWIR (1.0 -2.5 µm); 30 m resolution

  5 bands in TIR (8- 12 µm); 90 m resolution
- **ATLAS (Airborne Terrestrial Applications Sensor)**

  6 visible, 2 TM mid IR, and 6

  Thermal bands ranging from 8.2-12.5µm

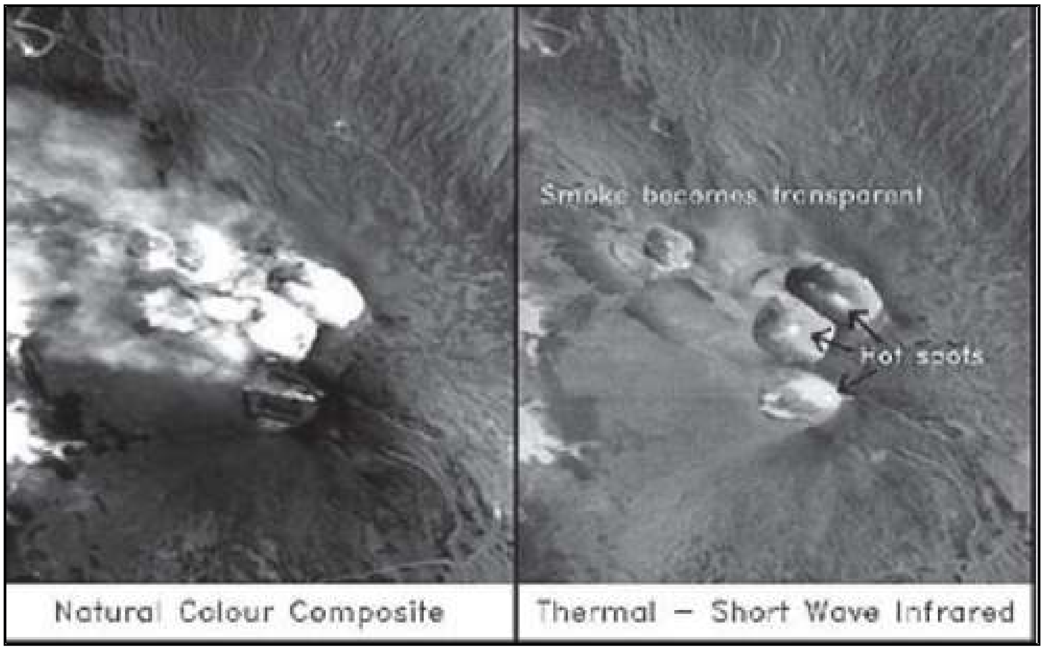


Figure2.5 Difference between NCC image and Thermal SWIR image

Check Your Progress

Q.1 What is Thermal Remote Sensing?

Q.2 What is Kinetic Heat?

Q.3 Fill in the blank.

a)The IR region is that portion of the EM spectrum ranging in wave length from ………….

b)………………..works as a background single and tends to reduce image contrast ratio

c) Thermal Infrared Multispectral Scanner (TIMS) …………...bands between 8-12 µm

Q. 4 True false against the following:

a)Heat transfer through the physical movement of heated matter .the circulation of heated water and air example of convection.

b)E.M. energy radiated from a source is called radiant flux and is measured in watts per square inch

Microwave RemoteSensing

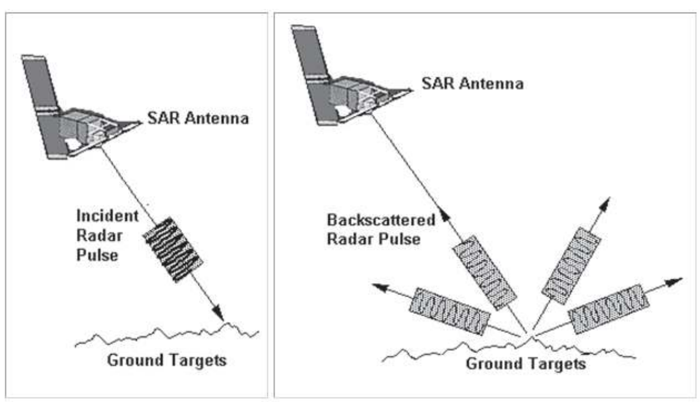
2.10.1 INTRODUCTION

Microwave remote sensinguse microwave radiation wavelength 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

Synthetic aperture radar (SAR), microwave scatter meters, radar altimeters etc are active microwave sensors.

2.10.2. Synthetic Aperture Radar (SAR)

In synthetic aperture radar (SAR) imaging, microwave pulses are transmitted by an antenna towards the earth surface. The microwave energy scattered back to the spacecraft is measured. The SAR makes use of the radar principle to form an image by utilizing the time delay of the backscattered signals



A radar pulse is transmitted from the antenna to the ground	The radar pulse is scattered by the ground targets back to the antenna.

Figure 2.6Interaction s of radar pulse with earth surface

In real aperture radar imaging, the ground **resolution** is limited by the size of the microwave beam sent out from the antenna. Finer details on the ground can be resolved by using a narrower beam. The beam width is inversely proportional to the size of the antenna, i.e. the longer the antenna, the narrower the beam.

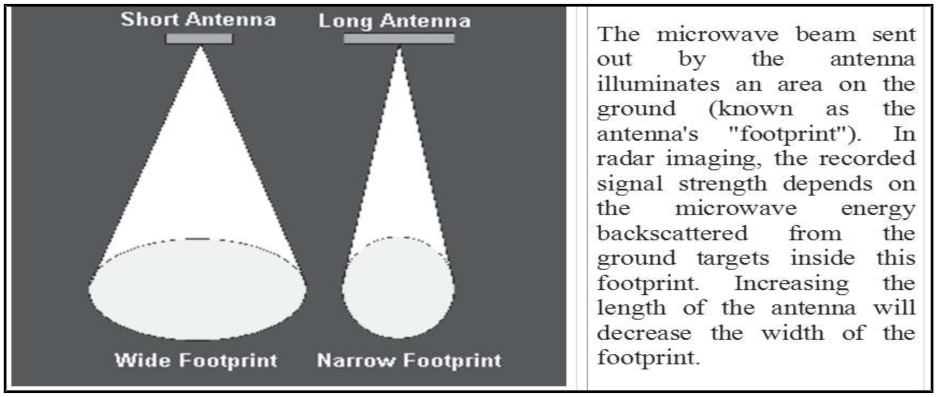
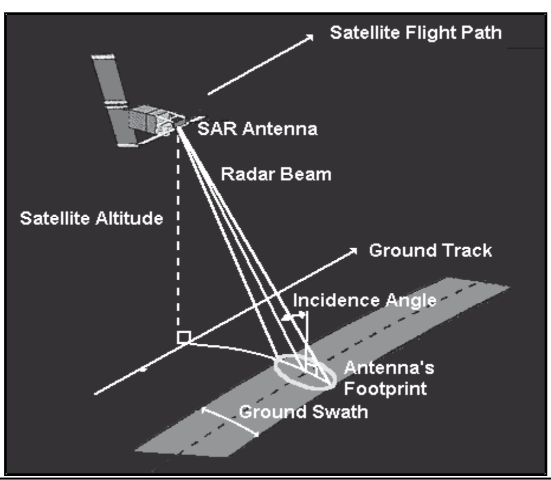


Figure 2.7

It is not feasible for a spacecraft to carry a very long antenna which is required for high resolution imaging of the earth surface. To overcome this limitation, SAR capitalizes on the motion of the space craft to emulate a large antenna (about 4 km for the ERS SAR) from the small antenna (10 m on the ERS satellite) it actually carries on board imaging geometry for a typical strip-mapping synthetic aperture radar imaging system. The antenna's footprint sweeps out a strip parallel to the direction of the satellite's ground track.



2.10.3. Interaction between Microwaves and Earth's Surface

When microwaves strike a surface, the proportion of energy scattered back to the sensor depends on many factors:

- Physical factors such as the dielectric constant of the surface materials which also depends strongly on the moisture content;
- Geometric factors such as surface roughness, slopes, orientation of the objects relative to the radar beam direction;
- The types of land cover (soil, vegetation or man-made objects).
- Microwave frequency, polarization and incident angle.

2.10.4. SAR Images

Synthetic Aperture Radar (SAR) images can be obtained from satellites such as ERS, JERS and RADARSAT. Since radar interacts with the ground features in ways different from the optical radiation, special care has to be taken when interpreting radar images.

An example of a ERSSAR image is shown below together with a SPOTmultispectralnatural colour composite image of the same area for comparison.

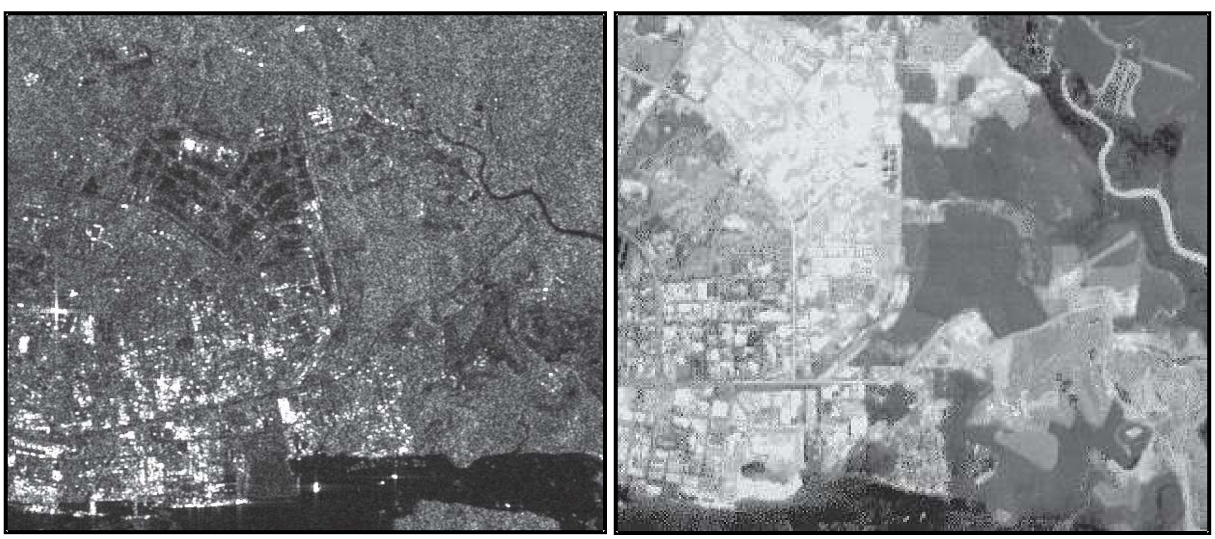


Figure 2.9 ERS SAR image (pixel size=12.5 m) SPOT multispectral image in natural color (Pixel size = 20m)

The urban area on the left appears bright in the SAR image while the vegetated areas on the right have intermediate tone. The clearings and water (sea and river) appear dark in the image. These features will be explained in the following sections. The SAR image was acquired in September 1995 while the SPOT image was acquired in February 1994. Additional clearings can be seen in the SAR image

2.10.5. Speckle Noise

Unlike optical images, radar images are formed by coherent interaction of the transmitted microwave with the targets. Hence, it suffers from the effects of **speckle noise** which arises from coherent summation of the signals scattered from ground scatterers distributed randomly within each pixel. A radar image appears noisier than an optical image. The speckle noise is sometimes suppressed by applying a **speckle removal filter** on the digital image before display and further analysis.

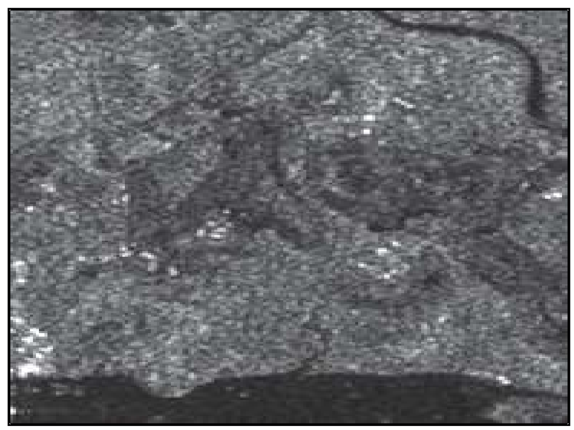


Figure 2.10 this image is extracted from the above SAR image showing the clearing areas between the rivers and the coastline. The image appears “grainy “due to the presence of speckles

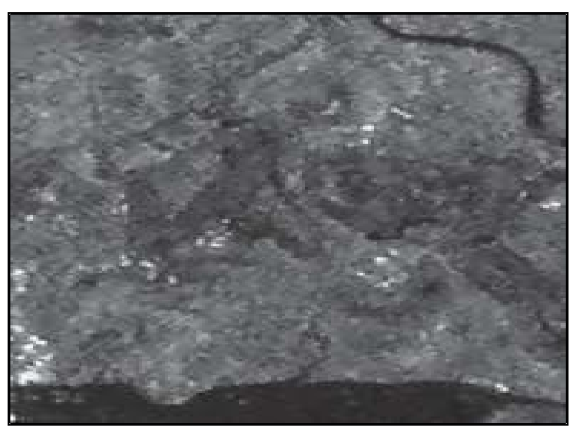


Figure 2.11 this image shows the effects of applying a speckle removal filter to the SAR image. The vegetated areas and the clearing now appear more homogeneous

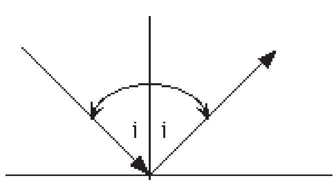
2.10.6. Backscattered Radar Intensity

A single radar image is usually displayed as a grey scale image, such as the one shown above. The intensity of each pixel represents the proportion of microwave backscattered from that area on the ground which depends on a variety of factors: types, sizes, shapes and orientations of the scatterers in the target area; moisture content of the target area; frequency and polarization of the radar pulses; as well as the incident angles of the radar beam. The pixel intensity values are often converted to a physical quantity called the backscattering coefficient or normalized radar cross-section measured in decibel (dB) units with values ranging from +5 dB for very bright objects to -40 dB for very dark surfaces.

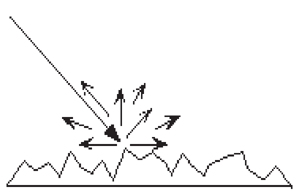
2.10.7. Interpreting SAR Images

Interpreting a radar image is not a straightforward task. It very often requires some familiarity with the ground conditions of the areas imaged. As a useful rule of thumb, the higher the backscattered intensity, the rougher is the surface being imaged

Flat surfaces such as paved roads, runways or calm water normally appear as dark areas in a radar image since most of the incident radar pulses are specularly reflected away.



Specular Reflection: A smooth surface acts like a mirror for the incident radar pulse. Most of the incident radar energy is reflected away according to the law of Specular reflection, i.e. the angle of reflection is equal to the angle of incidence. Very little energy is scattered back to the radar sensor.



Diffused Reflection: A rough surface reflects the incident radar pulse in all directions. Part of the radar energy is scattered back to the radar sensor. The amount of energy backscattered depends on the properties of the target on the ground.

Calm sea surfaces appear dark in SAR images. However, rough sea surfaces may appear bright especially when the incidence angle is small. The presence of oil films smoothen out the sea surface. Under certain conditions when the sea surface is sufficiently rough, oil films can be detected as dark patches against a bright background.

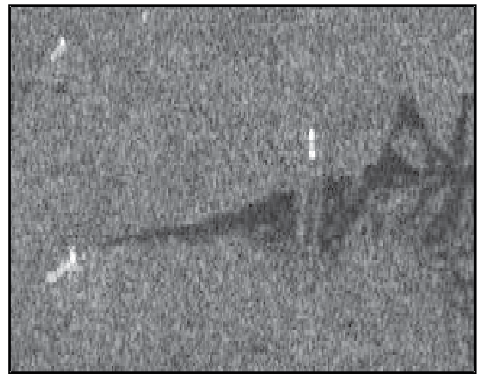
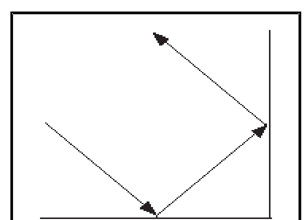


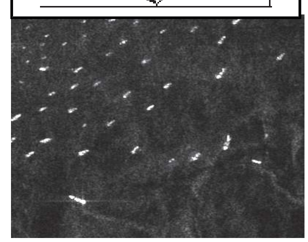
Figure 2.12a ship (bright target near the bottom left corner) is seen discharging oil into the sea in this ERS SAR image

Trees and other vegetations are usually moderately rough on the wavelength scale. Hence, they appear as moderately bright features in the image. The tropical rain forests have a characteristic backscatter coefficient of between -6 and -7 dB, which is spatially homogeneous and remains stable in time. For this reason, the tropical rainforests have been used as calibrating targets in performing radiometric calibration of SAR images.

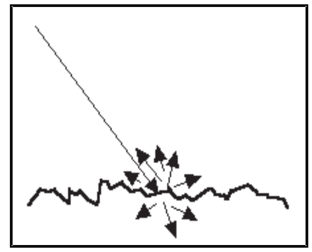
Very bright targets may appear in the image due to the **corner-reflector** or **double-bounce** effect where the radar pulse bounces off the horizontal ground (or the sea) towards the target, and then reflected from one vertical surface of the target back to the sensor. Examples of such targets are ships on the sea, high-rise buildings and regular metallic objects such as cargo containers. Built-up areas and many man-made features usually appear as bright patches in a radar image due to the corner reflector effect.



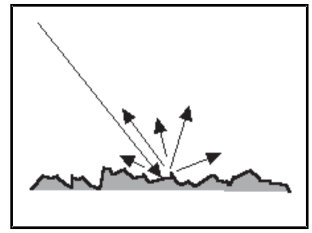
Corner Reflection: When two smooth surfaces form a right angle facing the radar beam, the beam bounces twice off the surfaces and most of the radar energy is reflected back to the radar sensor.



This SAR image shows an area of the sea near a busy port. Many ships can be seen as bright spots in this image due to corner reflection. The sea is calm, and hence the ships can be easily detected against the dark background. (Figure 2.13)

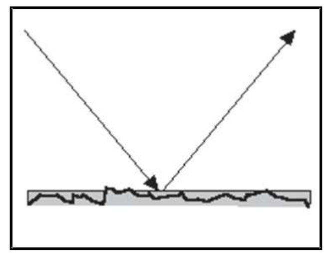


The brightness of areas covered by bare soil may vary from very dark to very bright depending on its roughness and moisture content. Typically, rough soil appears bright in the image. For similar soil roughness, the surface with higher moisture content will appear brighter.



Dry Soil: Some of the incident radar energy is able to penetrate into the soil surface, resulting in less backscattered intensity(Figure 2.14)

Wet soil: The large difference in electrical properties between water and air results in higher backscattered radar intensity(Figure 2.15)



Flooded soil: Radar is specularly reflected off the water surface, resulting in low backscattered intensity. The flooded area appears dark in the SAR image(Figure 2.16)

2.10.8Multi-Temporal SAR Images

If more than one radar images of the same area acquired at different time are available, they can be combined to give a multi-temporal colour composite image of the area. For example, if three images are available, then one image can be assigned to the Red, the second to the Green and the third to the Blue colour channels for display. This technique is especially useful in detecting landcover changes over the period of image acquisition. The areas where no change in landcover occurs will appear in grey while areas with landcover changes will appear as colourful patches in the image.

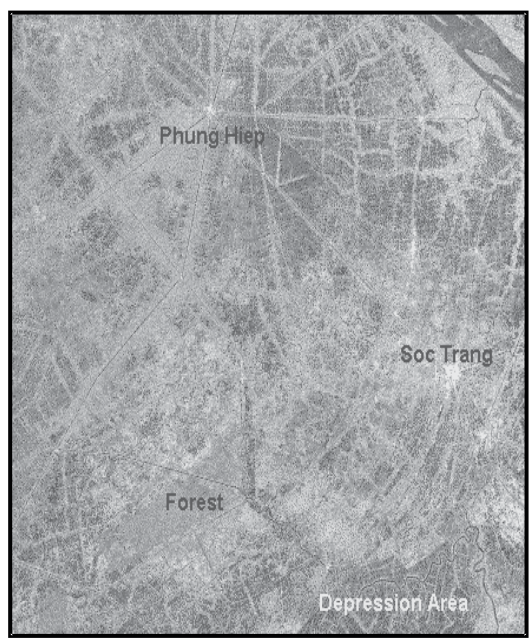


Figure 2.17Multi-Temporal Colour Composite SAR Image

This image is an example of a multi-temporal colour composite SAR image. The area shown is part of the rice growing areas in the Mekong River delta, Vietnam, near the towns of Soc Trang and Phung Hiep. Three SAR images acquired by the ERS satellite during 5 May, 9 June and 14 July in 1996 are assigned to the red, green and blue channels respectively for display. The colourful areas are the rice growing areas, where the landcovers change rapidly during the rice season. The greyish linear features are the more permanent trees lining the canals. The grey patch near the bottom of the image is wetland forest. The two towns appear as bright white spots in this image. An area of depression flooded with water during this season is visible as a dark region.

Check Your Progress

Q. 5 Fill in the blanks

a) Calm sea surfaces appear …………………in SAR images

b)Very bright targets may appear in the image due to the …………..

Q. 6 True false against the following.

a) SAR, microwave scatter meters, radar altimeters are active microwave sensors.

b) A single radar image is usually displayed as a grey scale image

Hyperspectral

2.11.1 INTRODUCTION

Recent advances in remote sensing and geographic information has led the way for the development of Hyperspectral sensors. Hyperspectral remote sensing, also known as imaging spectroscopy, is a relatively new technology that is currently being investigated by researchers and scientists with regard to the detection and identification of minerals, terrestrial vegetation, and man-made materials and backgrounds.

The concept of Hyperspectral remote sensing began in the mid-80 and to this point has been used most widely by geologists for the mapping of minerals. Actual detection of materials is dependent on the spectral coverage, spectral resolution, and signal-to-noise of the spectrometer, the abundance of the material and the strength of absorption features for that material in the wavelength region measured.

Hyperspectral remote sensing combines imaging and spectroscopy in single systems which often includes large data sets and require new processing methods. Hyperspectral data sets are generally composed of about 100 to 200 spectral bands of relatively narrow bandwidths (5-10 nm), Hyperspectral imagery is typically collected (and represented) as a data cube with spatial information collected in the X-Y plane, and spectral information represented in the Z-direction

2.11.2 Differences between Hyperspectral and Multispectral Imaging

The distinction between hyper- and multi-spectral is sometimes based on an arbitrary "number of bands" or on the type of measurement, depending on what is appropriate to the purpose.Multispectral imaging deals with several images at discrete and somewhat narrow bands. Being "discrete and somewhat narrow" is what distinguishes multispectral in the visible from color photography. A multispectral sensor may have many

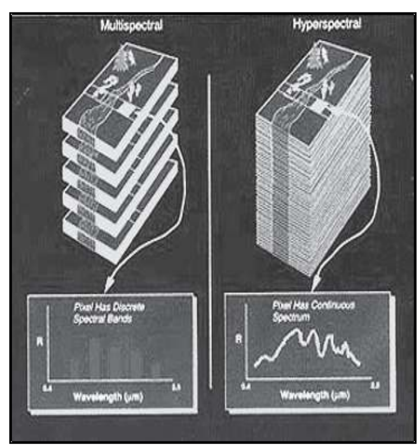


Fig: 2.18 Multispectral/ Hyperspectral comparison

Bands covering the spectrum from the visible to the longwave infrared Multispectral images do not produce the "spectrum" of an object. Landsat is an excellent example.

Hyperspectral deals with imaging narrow spectral bands over a continuous spectral range, and produce the spectra of all pixels in the scene. So a sensor with only 20 bands can also be Hyperspectral when it covers the range from 500 to 700 nm with 20 bands each 10 nm wide. (While a sensor with 20 discrete bands covering the VIS, NIR, SWIR, MWIR, and LWIR would be considered multispectral.)

2.11.3 Processing of Hyperspectral Imagery

Recent advances in sensor technology have led to the development of Hyperspectral sensors capable of collecting imagery containing several hundred bands over the spectrum. However, the increase in the number of bands is both a blessing and a curse. The large number of bands provides the opportunity for more materials to be discriminated by their respective spectral response. However, this large number of bands is the characteristic which leads to complexity in analysis techniques. The techniques described in the following sections are those which are widely used by the USGS, NASA's Jet Propulsion Laboratory, ENVI, and others. There are, however, other methods and algorithms to extract information from Hyperspectral sensors.

2.11.3.1. Radiometric Correction

Hyperspectral imaging sensors collect radiance data from either airborne or space borne platforms which must be converted to apparent surface reflectance before analysis techniques can take place. Atmospheric correction techniques have been developed that use the data themselves to remove spectral atmospheric transmission and scattered path radiance.

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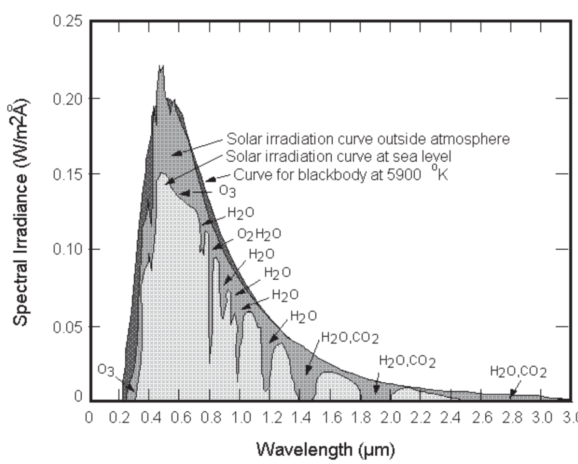


Figure 2.19 Solar spectrums with Atmospheric absorptions

The ATREM software was developed to determine the scaled surface reflectance from Hyperspectral imagery from both AVIRIS and HYDICE sensors. The atmospheric scattering used by ATREM is modeled after the MODTRAN 5S code. The ATREM software assumes that the surface is horizontal and has a Lambertian reflectance. If topography is known, then the scaled surface reflectance can be converted into real surface reflectance.

The ATREM model is a good approximation to radiometric correction of the imagery. However, calibration of the ATREM surface reflectance to *in situ* measurements should improve the final results. A by-product from the ATREM software is an image of the columnar water vapor which was removed from the input Hyperspectral data. The two figures below represent an AVIRIS frame prior to the ATREM correction and a water vapor scene removed from an AVIRIS scene which was acquired over the Kennedy Space Center on March 23, 1996. The images show a significant amount of water vapor removed from the imagery which causes attenuation of the upwelling radiance.

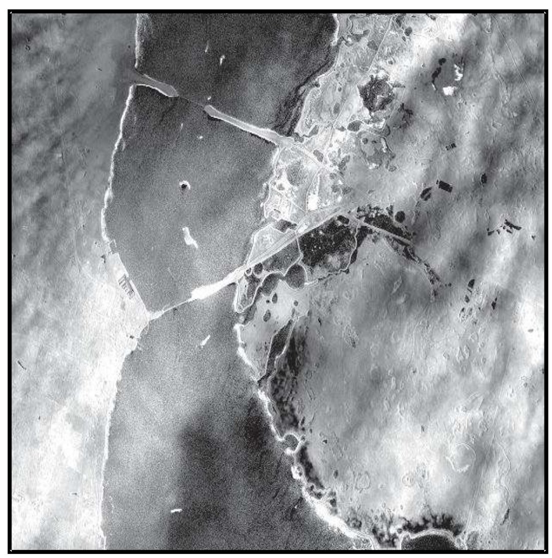


Figure2.20 OriginalAVIRIS Data Over KSC (Bands 20, 29 AVIRISData 40) Columnar Water Vapor Image Removed From Using ATREMProgram

2.11.3.2. Minimum Noise Fraction (MNF) Transformation

While Hyperspectral imagery is capable of providing a continuous spectrum ranging from 0.4 to 2.5 microns (in the case of AVIRIS) for a given pixel, it also generates a vast amount of data required for processing and analysis. Due to the nature of Hyperspectral imagery (i.e. narrow wavebands), much of the data in the 0.4-2.5 micron spectrum is redundant.

A minimum noise fraction (MNF) transformation is used to reduce the dimensionality of the hyperspectral data by segregating the noise in the data. The MNF transform is a linear transformation which is essentially two cascaded Principal Components Analysis (PCA) transformations. The first transformation decorrelates and rescales the noise in the data. This results in transformed data in which the noise has unit variance and no band to band correlations. [ENVI] The second transformation is a standard PCA of the noise-whitened data.

For this particular example, an AVIRIS frame over the Kennedy Space Center was radio-metrically corrected using ATREM and a MNF transformation was performed on the ATREM-corrected imagery. In this particular frame, the first 14 eigenvectors of the MNF transformation contain coherent information which can be used for further processing

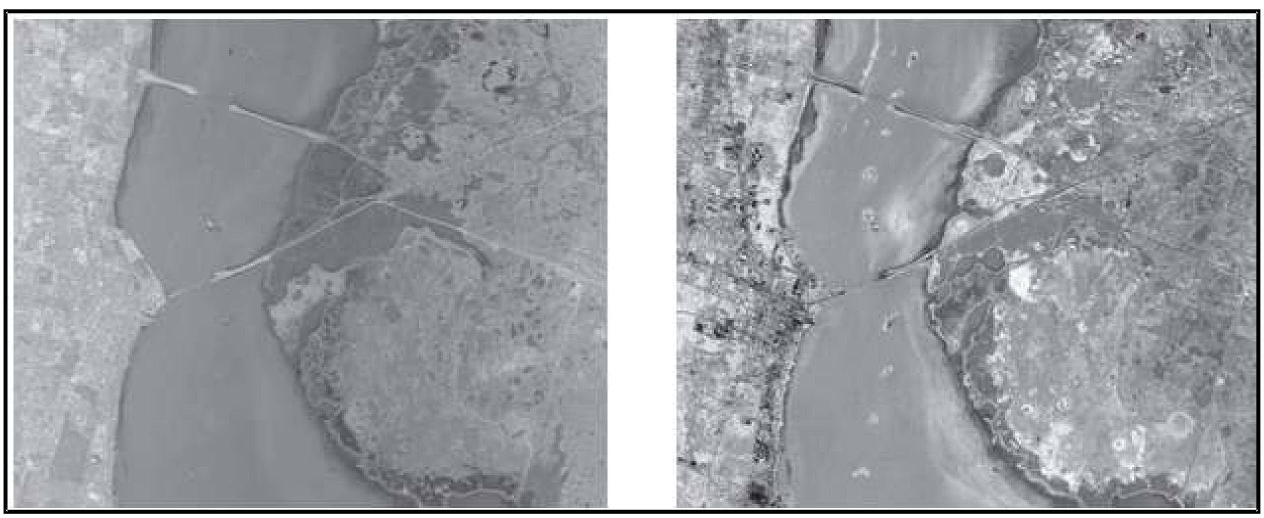


Figure 2.21Eigenvectors 1, 2, &Of MNF Transform Data Eigenvectors 6, 9, &12of MNF Transform Data

2.11.3.3. Pixel Purity Index

The Pixel Purity Index (PPI) is a prsocessing technique designed to determine which pixels are the most spectrally **unique** or **pure**. Due to the large amount of data, PPI is usually performed on MNF data which has been reduced to coherent images. The most spectrally pure pixels occur when there is mixing of end members. The PPI is computed by continually projecting n-dimensional scatter plots onto a random vector. The extreme pixels for each projection are recorded and the total number of **hits** is stored into an image. These pixels are excellent candidates for selecting end members which can be used in subsequent processing

2.11.4. Analysis of Hyperspectral Imagery

2.11.4.1. Spectral Angle Mapper Classification

The Spectral Angle Mapper Classification (SAM) is an automated method for directly comparing image spectra to known spectra (usually determined in a lab or in the field with a spectrometer) or an end member. This method treats both (the questioned and known) spectra as vectors and calculates the spectral angle between them. This method is insensitive to illumination since the SAM algorithm uses only the vector **direction** and not the vector **length**. The result of the SAM classification is an image showing the best match at each pixel. This method is typically used as a first cut for determining the mineralogy and works well in areas of homogeneous regions. The USGS maintains a large spectral library, mostly composed of mineral and soil types, which image spectra, can be directly compared.

2.11.4.2. Spectral Unmixing/Matched Filtering

Most surfaces on the earth, geologic or vegetated, are not homogeneous which results in a mixture of signatures characterized by a single pixel. Depending on how the materials are mixing on the surface results in the type of mathematical models capable of determining their abundances. If the mixing is rather large than the mixing of the signatures can be represented as a linear model. However, if the mixing is microscopic, then the mixing models become more complex andnon-linear

Matched filtering is based on a well known signal processing method and creates a quick means of detecting specific minerals based on matches to specific library or endmember spectra. The matched filtering algorithm maximizes the response of a known end member while suppressing the response of the background. The result of the matched filtering resembles the results from the linear unmixing methods and is usually represented as a grayscale image with values ranging from 0 to 1 which correspond the relative degree of the match.

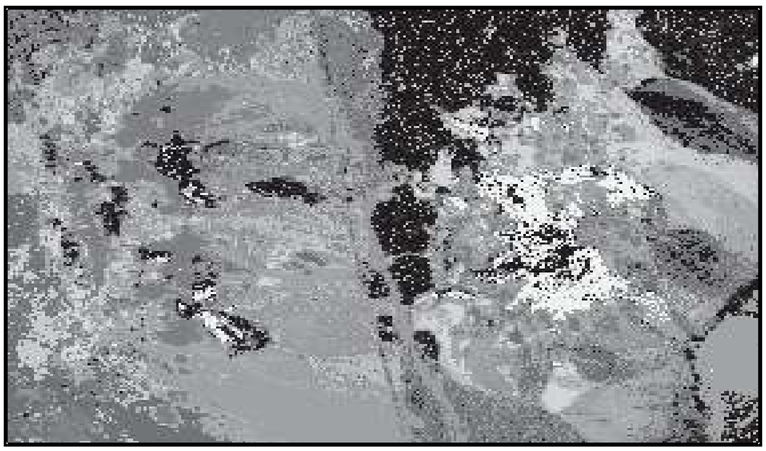


Figure 2.23 Classified Image of 1995 AVIRIS Frame Over Cuprite, Nevada Using Spectral Unmixing Techniques

Check Your Progress

Q.7. what is the Difference between Hyperspectral and Multispectral Image?

Q.8 Fill in the blank.

a)Hyperspectral data sets are generally composed of about …………….spectral bands of relatively narrow bandwidths (5-10 nm),

b)The ………………software was developed to determine the scaled surface reflectance from Hyperspectral imagery from both AVIRIS and HYDICE sensors

c) ………………..transformation is used to reduce the dimensionality of the Hyperspectral data by segregating the noise in the data.

LIDAR

2.12.1 INTRODUCTION

Lidar (light detection and ranging) has become an established method for collecting very dense and accurate elevation values. This active remote sensing technique is similar to radar but uses light pulses instead of radio waves. Lidar is typically "flown" or collected from planes (Figure 2.24) and produces a rapid collection of points (more than 70,000 per second) over a large collection area. Collection of elevation data using lidar has several advantages over most other techniques. Chief among them are higher resolutions, centimeter accuracies, and penetration in forested terrain.

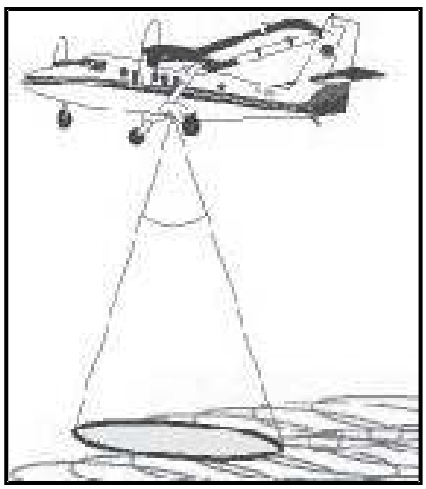


Figure 2.24 Airborne Lidar Schematic

2.12.1What Is Airborne Lidar?

Lidar, which is commonly spelled LiDAR and also known as LADAR or Laser Altimetry, is an acronym for light detection and ranging. It is analogous to radar (radio detection and ranging), except that it is based on discrete light pulses and measured travel times. The location and elevation of the reflecting surface are derived from 1) the time difference between the laser pulse being emitted and returned, 2) the angle that the pulse was 'fired' at, and 3) the location and height of the aircraft (i.e. the sensor location).Because the energy for measurement is generated by the sensor (i.e., the laser), lidar is defined as an active sensor. This allows lidar to becollected at night when the air is clearer and contains less air traffic than the daytime. In fact, most lidar data are collected at night, but unlike radar, lidar cannot penetrate clouds, rain, or dense haze and must be flown during fair weather. Lidar instruments can rapidly measure the Earth's surface, at sampling rates greater than 150 kilohertz (i.e., 150,000 pulses per second). The resulting product is a densely spaced network of highly accurate Georeferanced elevation points (Figure 2.25) often called a point cloud—that can be used to generate three-dimensional representations of the Earth's surface and its features. Bathymetric lidar, which uses a different laser (green vs. infrared wavelength), can be used in areas with relatively clear water to measure the seafloor elevation. Typically, lidar elevations are accurate to about 6 to 12 inches (15 to 30 centimeters) but have relative accuracies (e.g., heights of hills, banks, and dunes) that can be better than that.

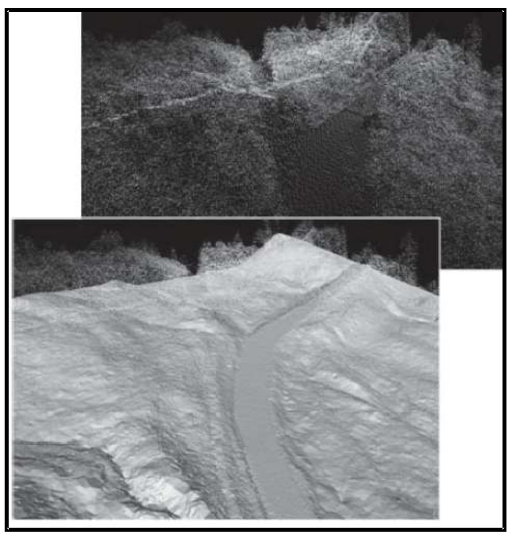


Figure2.25 Lidar point and surface products

The ability to "see under trees" is a reoccurring issue when acquiring elevation data using remote sensing data collected from above the Earth's surface (e.g., airplanes or satellites). Lidar is able to see through holes in the canopy or vegetation. Dense forests or areas with complete coverage (as in a rain forest), however, often have few "openings" and so have poor ground representation (i.e., all the points fall on trees). A rule of thumb is that if you can look up and see the sky through the trees, then that location can be measured with Lidar. For this reason,
Collecting lidar in "leaf off" conditions is advantageous for measuring ground features in heavily forested areas.

2.12.3 Basic Principles and Techniques

The basic idea (Figure 2.26) is fairly straightforward: measure the time that it takes a laser pulse to strike an object and return to the aircraft, which has a known location, determine the distance using the travel time, record the laser angle, and then, from this information, compute where the reflecting object (e.g., ground, tree, car, etc.) is located in three dimensions

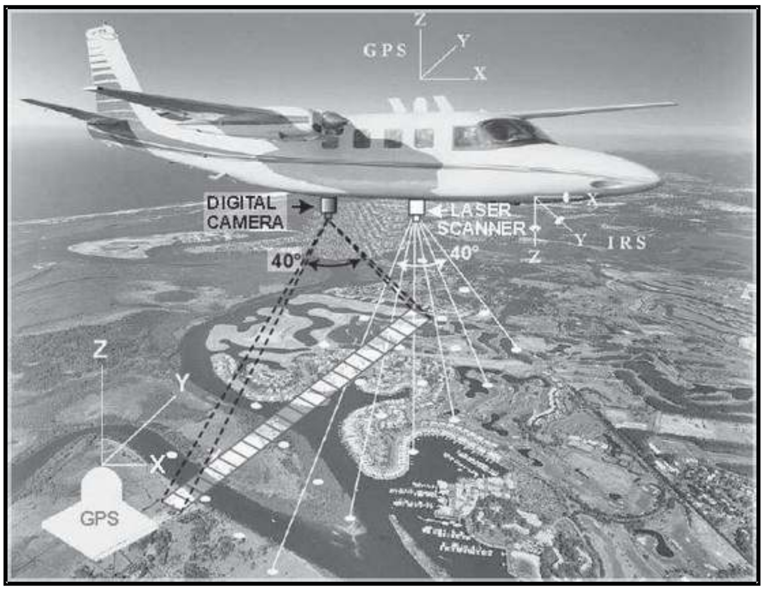


Figure 2.26 Basic Lidar Data Collection Schematic (Jie Shan, Purdue University)

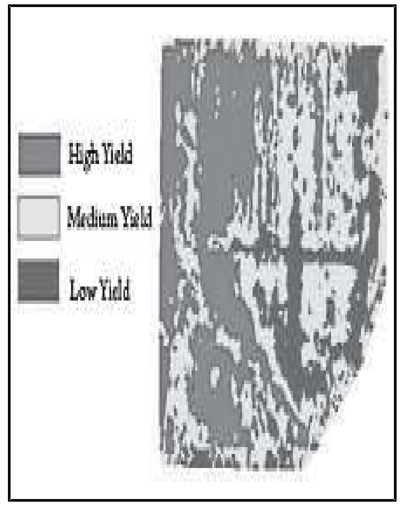
In reality, to achieve a high level of accuracy, this process is a bit more complicated since it is important to know, within a centimeter or so, where the plane is as it flies at 150 to 200 miles perhour, bumping up and down, while keeping track of 150,000 Lidar pulses per second. Fortunately several technologies-especially the Global Positioning System (GPS) and precision gyroscopes-came together to make it possible

Major advancements in Inertial Measuring Units (IMU) or Inertial Navigation Systems (INS) have been instrumental in making the exact positioning of the plane possible. These systems are Capable of measuring movement in all directions and parlaying these measurements into aposition. They are, however, not perfect and lose precision after a short time (e.g., 1 second). Avery high level GPS, which records several types of signals from the GPS satellites, is used to“update or reset” the INS or IMU every half of a second or so. The GPS positions are recordedby the plane and also at a ground station with a known position. The ground station provides a“correction” factor to the GPS position recorded by the plane.

2.12.4 Application

2.12.4.1Agriculture

LIDAR can be used to help farmers determine which areas of their fields to apply costly fertilizer. LIDAR can create a topographical map of the fields and reveals the slopes and sun exposure of the farm land. Researchers at the Agricultural Research Service blended this topographical information with the farm land’s yield results from previous years. From this information, researchers categorized the farm land into high-, medium-, or low-yield zones. This technology is valuable to farmers because it indicates which areas to apply the expensive fertilizers to achieve the highest crop yield.



2.12.4.2 Archaeology

LIDAR can also provide archaeologists with the ability to create high-resolution digital elevation models (DEMs) of archaeological sites that can reveal micro-topography that are otherwise hidden by vegetation. LiDAR-derived products can be easily integrated into a Geographic Information System (GIS) for analysis and interpretation.

2.12.4.3Geology and soil science

High-resolution digital elevation maps generated by airborne and stationary LIDAR have led to significant advances in geomorphology, the branch of geosciences concerned with the origin and evolution of Earth's surface topography. LIDAR's abilities to detect subtle topographic features such as river terraces and river channel banks, measure the land surface elevation beneath the vegetation canopy, better resolve spatial derivatives of elevation, and detect elevation changes between repeat surveys have enabled many novel studies of the physical and chemical processes that shape landscapes.

2.12.4.4 Forest and Tree Studies

A very costly and time-consuming aspect of timber management is the effort spent in the field measuring trees (Figure 1-6). Typically a sample of trees is measured for a number of parameters and the results are statistically extrapolated throughout the harvest area. Trees must be measured to determine how much wood is present, when it is most appropriate to harvest, and how much to harvest.

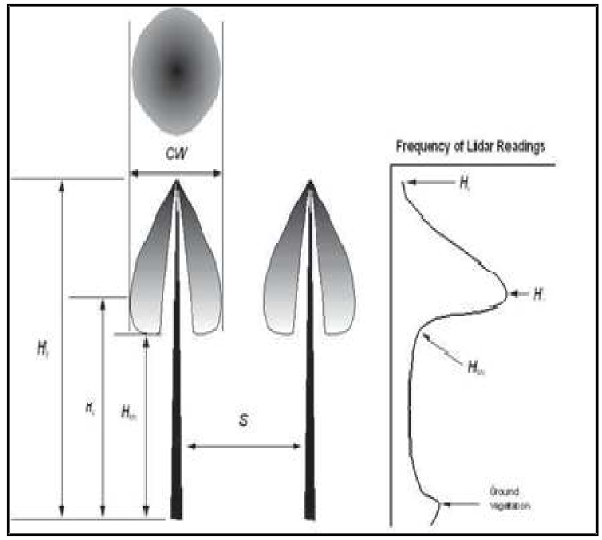


Figure 2.28 Tree Canopy Information (H = Height, CW = Crown Width, S = Spacing)
Gathered from Lidar (from Mississippi State University)

Check your Progress

Q.9. what is Lidar?

Q.8 Fill in the blank.

a) Lidar instruments can rapidly measure the Earth's surface, at sampling rates greater than …………… kilohertz

b)…………… have been instrumental in making the exact positioning of the plane possible

c)LIDAR can create a …………….map of the fields and reveals the slopes and sun exposure of the farm land

5. Summary

This unit covered different techniques of Advance remote sensing, in which explain all basic concept ofthermal, microwave, Hyperspectral and lider remote sensing's techniques and their applications

6. Glossary

- **Across Track**-An across-track sensor is one that uses a mirror system that moves from side to side in the range to obtain remote sensing data.
- **Along-Track: -**An along-track sensor is made up of a linear detector array of CCDs (Charge Coupled Device) that obtains data in the platform's direction of motion
- **Beam: -**A focused pulse of energy. The antenna beam of a side-looking radar (SLAR) is directed perpendicular to the flight path and illuminates a swath parallel to the platform ground track
- **Circularly Polarized Antenna:-**An antenna that is designed to radiate a left-hand or right-hand circularly polarized electromagnetic wave in its far field.
- **Co-Polarization Maxima** The antenna polarization state for which maximum backscattered power is received from a particular target. For co-polarization, transmit and receive antennas are the same.
- **Radar Angles: -** A radar echo from a region where there are no visible targets; may be caused by insects, birds, or refractive index variations in the atmosphere.

Answer to check your progress/Possible Answers to SAQ

Ans 1. Two surfaces may have very similar reflected characteristics within in visible and infrared part of E.M. spectrum and may not be distinguishable, but they may be distinguished in thermal infrared spectrum. Objects radiate energy as a function of their temperature in thermal infrared wavelength. This emitted energy may be remote sensed using thermal sensor in the wavelength range from 3 to 14 µm. its generally record broad spectral bands typically 8.0 to 14 µm for image from aircraft and 10.5to 12.0 µm for image from satellites.

Ans .2kinetic heat is the kinetic energy of particles of matter in random motion, which causes the particles to collide resulting in change of energy state and emission of E.M. radiation. The kinetic heat energy of the object thus converted in to radiant energy

Ans 3.(a). 0.7 to 1000 μm , **(b)** Path radiance , **(c)** 6

Ans4. **(a)** True **(b)** False

Ans5. **(a).** Dark, **(b)** . Corner-reflector

Ans 6. **(a). True** **(b)** True

Ans.7.A multispectral sensor may have manyBands covering the spectrum from the visible to the long wave infrared Multispectral images do not produce the "spectrum" of an object. Landsat is an excellent example.

Hyperspectral deals with imaging narrow spectral bands over a continuous spectral range, and produce the spectra of all pixels in the scene. So a sensor with only 20 bands can also be Hyperspectral when it covers the range from 500 to 700 nm with 20 bands each 10 nm wide. (While a sensor with 20 discrete bands covering the VIS, NIR, SWIR, MWIR, and LWIR would be considered multispectral.)

Ans.8.(a).100 to 200 **(b)** ATRM **(c)**Minimum Noise Fraction

Ans9. Lidar (light detection and ranging) has become an established method for collecting very dense and accurate elevation values. This active remote sensing technique is similar to radar but uses light pulses instead of radio waves. Lidar is typically "flown" or collected from planes and produces a rapid collection of points (more than 70,000 per second) over a large collection area.

Ans10. **(a)** 150**(b)**Inertial Navigation Systems **(c)**Topographical

7. Suggested Readings

1. Thermal Remote Sensing in Land Surface Processes (Dale A. Quattrochi, Jeffrey C. Luvall)

2. Hyperspectral Remote Sensing: Principles and Applications (Marcus Borengasser , William S. Hungate , Russell L. Watkins

3. Microwave Remote Sensing: From theory to applications (Fawwaz Tayssir Ulaby, Richard K. Moore, and Adrian K. Fung)

8. References

1. Remote sensing of the environment [John R. Jensen]

2. Remote sensing Geology [Ravi P. Gupta]

3. Remote sensing and image interpretation [Lillsand and Kiefer]

4. Remote sensing principles and interpretation [Floyd F. Sabins]

5.http://www.csr.utexas.edu/projects/rs/hrs/hyper.html#background

6. http://www.csc.noaa.gov/digitalcoast/data/coastallidar/_pdf/What_is_Lidar.pdf

7. http://www.ferris.edu/faculty/burtchr/papers/lidar_principles.pdf

8.http://www.nps.edu/academics/centers/remotesensing/Presentations/Lidar%20Presentations/IntroductiontoLIDAR.pdf

9. http://www.sarusersmanual.com/ManualPDF/NOAASARManual_CH01_pg001-024.pdf

10.http://www.jars1974.net/pdf/04_Chapter03.pdf

8. TerminalQuestions

Q1. Explain energy exchange theory

Q2.How Stefan boltzman n law work?

Q3. What happen when thermal radiation interacts with earth surface?

Q4.Write down the SAR satellites name

Q5 what is speckle noise

Q6.Differences between Hyperspectral and multispectral imaging

UNIT 3: DIGITAL IMAGE PROCESSING-II

Digital Image Processing

3.1. INTRODUCTION

In today's world of advanced technology where most remote sensing data are recorded indigital format, virtually all image interpretation and analysis involves some element of digitalprocessing. Digital image processing may involve numerous procedures including formattingand correcting of the data, digital enhancement to facilitate better visual interpretation, or evenautomated classification of targets and features entirely by computer. In order to processremote sensing imagery digitally, the data must be recorded and available in a digital formsuitable for storage on a computer tape or disk. Obviously, the other requirement for digitalimage processing is a computer system, sometimes referred to as an **image analysissystem**, with the appropriate hardware and software to process the data. Severalcommercially available software systems have been developed specifically for remote sensingimage processing and analysis.

For discussion purposes, most of the common image processing functions available in imageAnalysis systems can be categorized into the following four categories:

- Preprocessing
- Image Enhancement
- Image Transformation
- Image Classification and Analysis

In first Semester (unit-1) already discuss on Image Transformation and Image classification, so in this Unit-2 we will cover Image Enhancement Techniques

3.2Objective

After going through this unit the learner will able to learn:

- Understand Image Enhancement Techniques
- Radiometric correction , Atmospheric correction

- Advance Technique of spectral Ratioing

3.3. Image Enhancement

Enhancements are used to make it easier for visual interpretation and understanding ofimagery. The advantage of digital imagery is that it allows us to manipulate the digital pixelvalues in an image. The contraststretch, density slicing, edge enhancement, and spatial filtering are the more commonly usedtechniques. Image enhancement is attempted after the image is corrected for geometricand radiometric distortions. Image enhancement methods are applied separately to eachband of a multispectral image. Digital techniques have been found to be most satisfactorythan the photographic technique for image enhancement, because of the precision and wideVariety of digital processes

3.3.1Contrast Enhancement

Contrast generally refers to the difference in luminance or grey level values in animage and is an important characteristic. It can be defined as the ratio of the maximumintensity to the minimum intensity over an image.

$$C = \frac{I_{max}}{I_{mix}}$$

Contrast ratio has strong bearing on the resolving power and delectability of an image .Larger this ratio, more easily it is to interpret the image

Contrast enhancement techniques expand the range of brightness values in an imageso that the image can be efficiently displayed in a manner desired by the analyst. Thedensity values in a scene are literally pulled farther apart, that is, expanded over a greaterrange. The effect is to increase the visual contrast between two areas of differentuniform densities. This enables the analyst to discriminate easily between areas initiallyhaving a small difference in density

Contrast enhancement can be effected by a linear or non linear transformation.

3.3.1.1. Linear Contrast Stretch

This is the simplest contrast stretch algorithm. The grey values in the originalimage and the modified image follow a linear relation in this algorithm. A density number inthe low range of the original histogram is assigned to extremely black, and a value at thehigh end is assigned to extremely white. The remaining pixel values are distributed linearlybetween these extremes. The features or details that were obscure on the original imagewill be clear in the contrast stretched image.In exchange for the greatly enhanced contrast of most original brightness values,there is a trade off in the loss of contrast at the extreme high and low density numbervalues. However, when compared to the overall contrast improvement, the contrast lossesat the brightness extremes are acceptable trade off, unless one was specificallyinterested in these elements of the scene.

The equation Y = ax+b performs the linear transformation in a linear contraststretch method. The values of 'a' and 'b' are computed from the equations

a = (Ymax - Ymin)/Xmax - Xmin

b = (Xmax Ymin - Xmin Ymax)/Xmax - Ymin

Where X = Input Pixel valueY = Output pixel value

X max,Xmin are the maximum and minimum in the input data values. Y max, Ymin are the maximum and minimum values in the output data values X max, Xmin values can be obtained from the scence histogram. Histograms are commonly used to display the frequency of occurrence of brightness values. Ymax, ymin are usually fixed at 0 and 255 respectively.

When y_{max},y_{min} take the values 0 and 255, the above equation reduces to

X - Xmin

Y =------------. 255

Xmax – Xmin

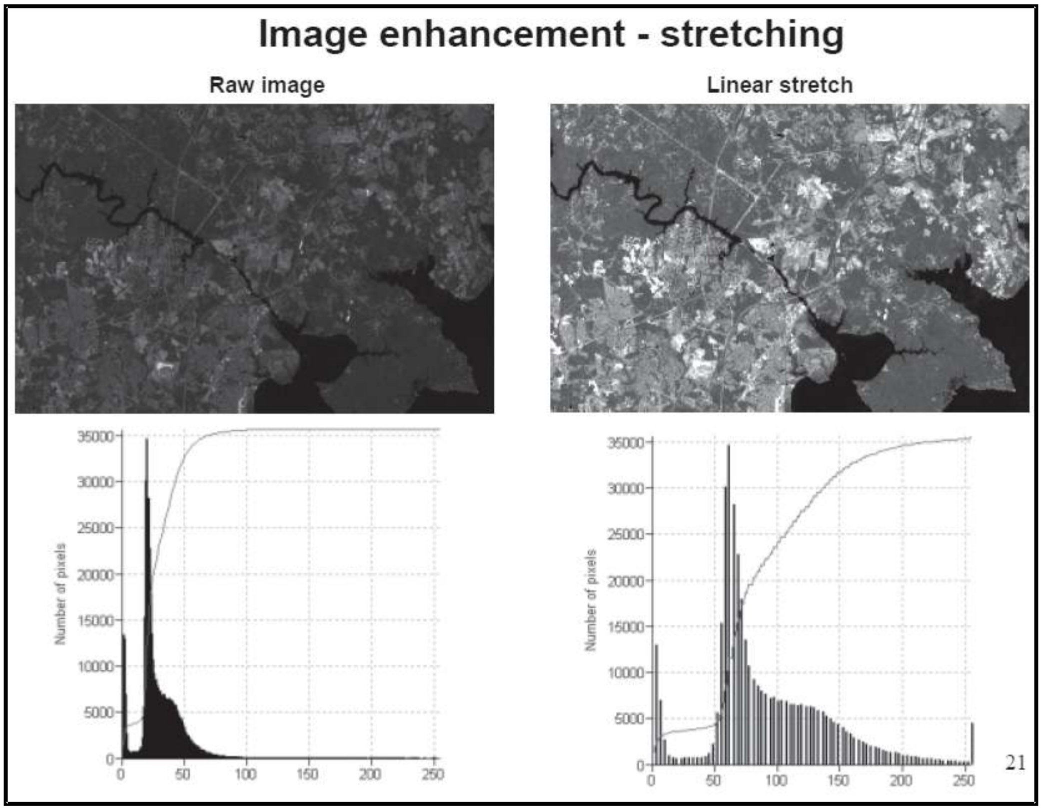


Figure 3.1Linear Contrast Stretch Operation

3.3.1.2. Non-Linear Contrast Enhancement

In these methods, the input and output data values follow a non-lineartransformation. The general form of the non-linear contrast enhancement is defined by y =f (x), where x is the input data value and y is the output data value. The non-linear contrastenhancement techniques have been found to be useful for enhancing the color contrastbetween the nearly classes and subclasses of a main class.The use of non-linear contrast enhancement is restricted by the type ofapplication. Good judgment by the analyst and several iterations through the computer areusually required to produce the desired results.

A type of non linear contrast stretch involves scaling the input data logarithmically. This enhancement has greatest impact on the brightness values found in the darker part ofhistogram. It could be reversed to enhance values in brighter part of histogram by scalingthe input data using an inverse log function. (Refer figure3.2).

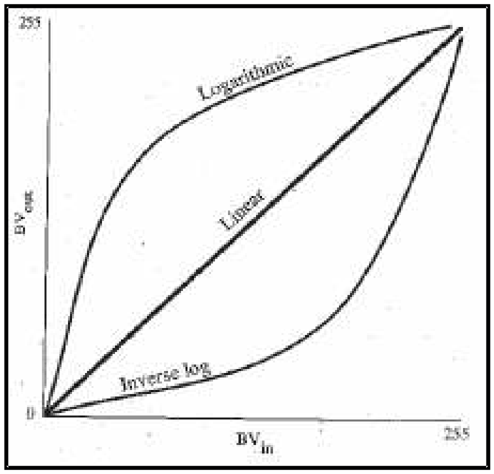


Figure 3.2 Non –Linear Logarithmic and Inverse Log Contrast Stretch Algorithms

3.3.1.3. HistogramEqualization

This is another non-linear contrast enhancement technique. In this technique,histogram of the original image is redistributed to produce a uniform population density.This is obtained by grouping certain adjacent grey values. Thus the number of grey levels inthe enhanced image is less than the number of grey levels in the original image

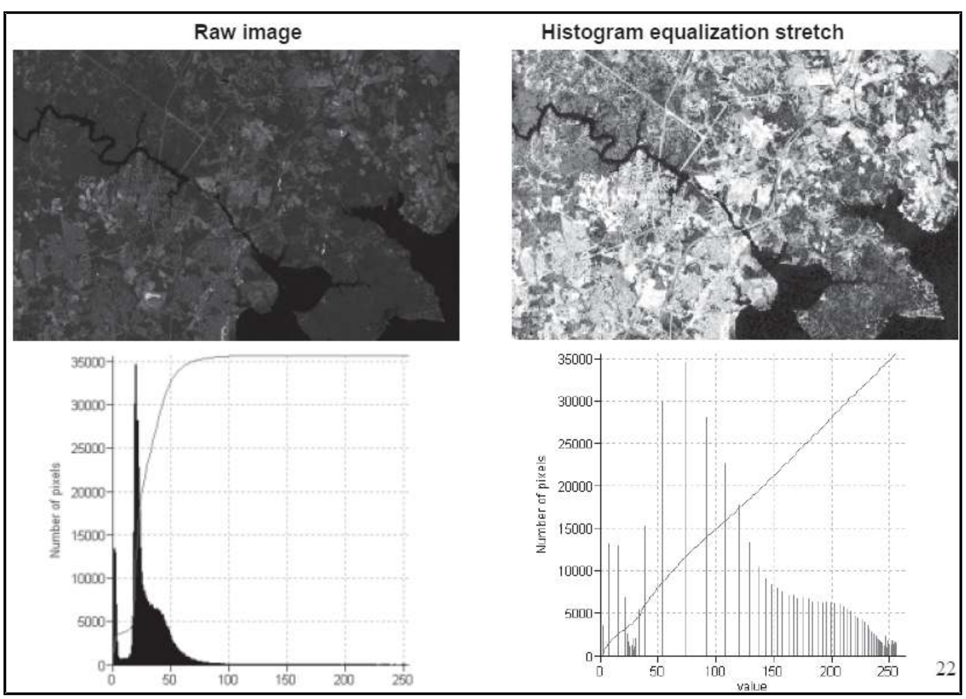


Figure 3.3 Image Enhancement-Histogram Equalization -Stretch

3.4. SpatialFiltering

Encompassesanother set ofdigital processingfunctions whichare used toenhance theappearance of animage. Spatial filters are designed to highlight or suppress specific features in an image basedon their **spatial frequency**. Spatial frequency is related to the concept of image texture. It refers to the frequency of the variations in tone that appear inan image. "Rough" textured areas of an image, where the changes in tone are abrupt over asmall area, have high spatial frequencies, while "smooth" areas with little variation in toneover several pixels, have low spatial frequencies.

3.4.1. SpatialFiltering Convolution

In convolution Procedure**,**moving a 'window' of a few pixels in dimension (e.g. 3x3, 5x5, etc.) over each pixel in theimage, applying a mathematical calculation using the pixel values under that window, andreplacing the central pixel with the new value (figure3.4) The window is moved along in both the row andcolumn dimensions one pixel at a time and the calculation is repeated until the entire imagehas been filtered and a "new" image has been generated.

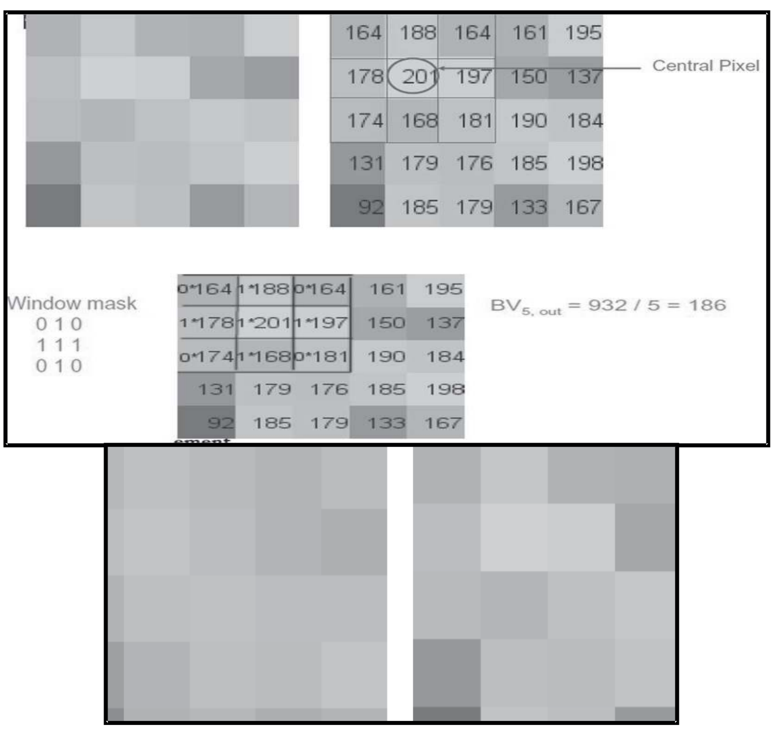


Figure 3.4Spatial Filtering Convolution Functions

3.4.2 Low-Pass Filter

A Low-pass filteris designed to emphasize larger, homogeneous areas of similar tone and reduce the smaller detail in an image. Thus, low-pass filters generally serve to smooth the appearance of an image. Average and median filters, often used for radar imagery, are examples of low-pass filters

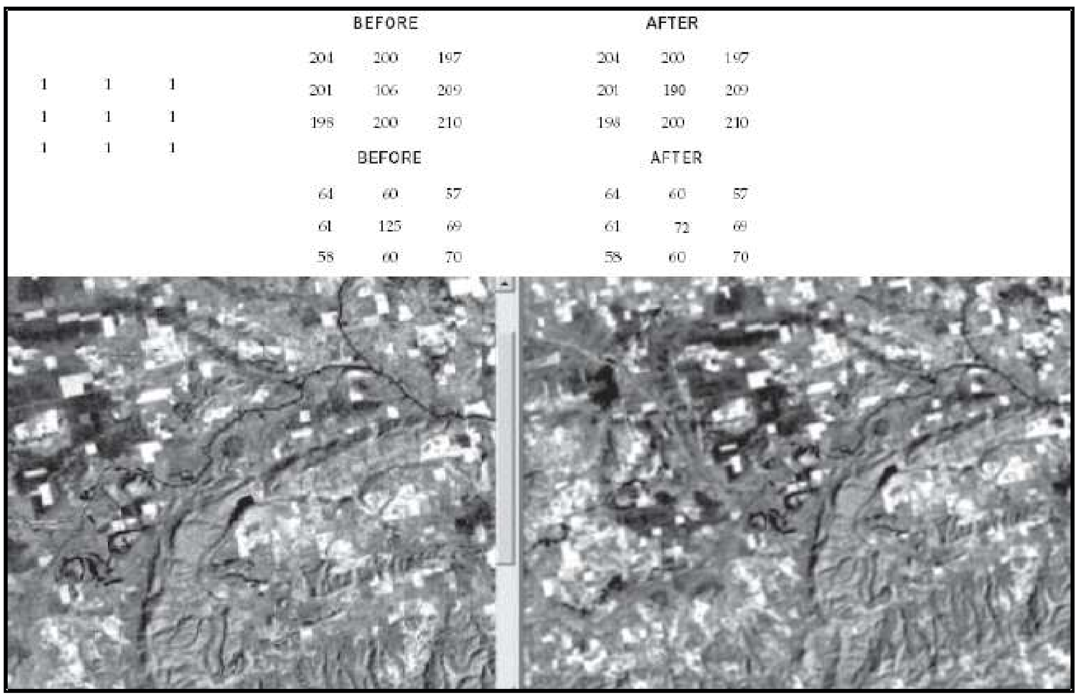


Figure 3.5.Low Pass Filter- Image Smoothing

3.4.3. High-Pass Filter

In high-pass filtersdo the opposite and serve to sharpen the appearance of fine detail in an image. One implementation of a high-pass filter first applies a low-pass filter to an image and then subtracts the result from the original, leaving behind only the high spatial frequency information. Directional, or edgedetection filters are designed to highlight linear features, such as roads or field boundaries. These filters can also be designed to enhance features which are oriented in specific directions. These filters are useful in applications such as geology, for the detection of linear geologic structures.

-1	-1	-1
-1	16	-1
-1	-1	-1

BEFORE			AFTER		
204	200	197	204	200	197
201	106	209	201	9	209
198	200	210	198	200	210

BEFORE			AFTER		
64	60	57	64	60	57
61	125	69	61	187	69
58	60	70	58	60	70

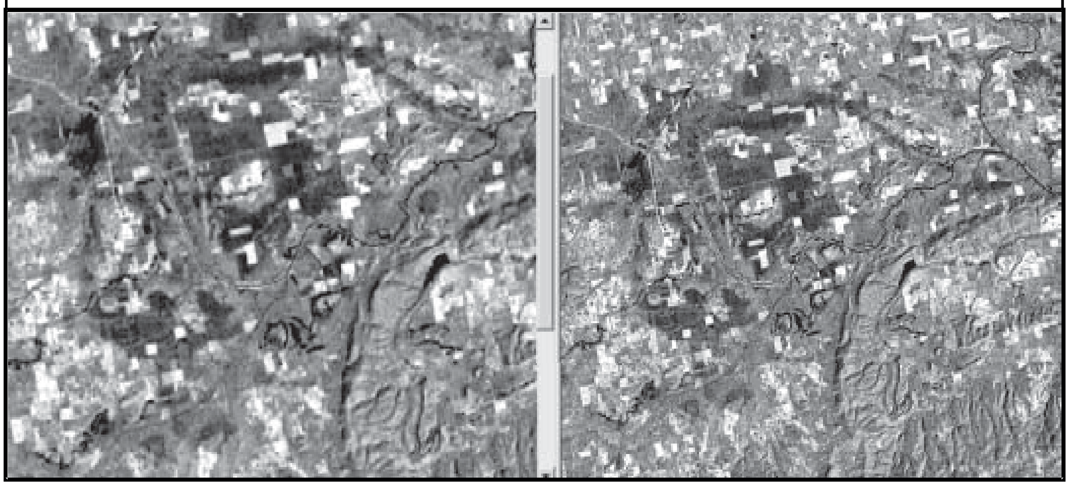


Figure 3.6(a).High Pass Kernel-ImageSharpening

-1 2 -1
-1 2 -1
-1 2 -1

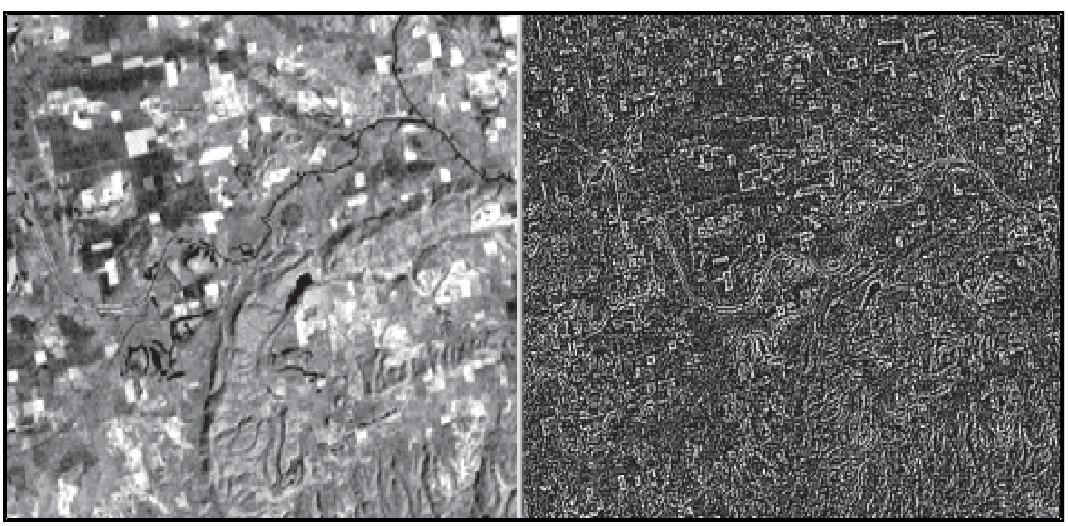


Figure 3.6(b).High Pass Kernel-Edge Detection

Check Your Progress

Q.1 What is ImageEnhancements?

Q.2 What isLow-pass filter?

Q.3 Fill in the blank.

a)Spatial filters are designed to highlight or suppress specific features in an image basedon their **…………………..**

b)In Histogram Equalizationthe original image is redistributed to produce a uniform population **…………………**

Q. 4 True false against the following:

a)Contrast generally refers to the difference in luminance or grey level values in animage and is an important characteristic.

b)A type of linear contrast stretch involves scaling the input data logarithmically

3.5. Radiometric Correction

Radiometric errors are caused by detector imbalance and atmospheric deficiencies. Radiometric corrections are transformations on the data in order to remove errors, which are geometry independent. Radiometric corrections are also called as cosmetic corrections and are done to improve the visual appearance of the image. Multiple detectors are used in the sensor system to simultaneously sense several image lines during each sweep of the mirror. This configuration requires an array of 24 detectors (6 lines x 4 bands) in case of MSS. As the detectors are not precisely equivalent in their output characteristics, their output changes gradually over time. Due to these variations there will be different output for the same ground radiance

To accomplish this, the scanner views an electrically illuminated step wedge filter during each mirror sweep. Once per orbit, the scanner views the sun to provide a more absolute calibration. These calibration values are used to develop radiometric correction functions for each detector. The correction functions yield digital numbers that correspond linearly with radiance and are applied to all data prior to dissemination. Some of the radiometric distortions are as follows

(1) Correction for missing lines (2) correction for periodic line striping (3) random noise correction (4) atmospheric correction

3.5.1.CorrectionforMissing Scan Lines (ScanLine Drop Out)

Although detectors onboard orbiting satellites are well tested and calibrated before launch,breakdown of any of the detectors may take place. Such defects are due to errors in thescanning or sampling equipment, in the transmission or recording of image data or inreproduction of CCT's. The missing scan lines are seen as horizontal black (pixel value 0) orwhite (pixel value 255) lines on the image. Techniques are available to locate these bad linesby selecting unusually large(**Figure3.7 Example of missing**

scanline)discrepancies in image values for sequential lines. The first stepin the restoration process is to calculate the average DN value per scan line for entirescene. The average DN value for each scan line is then compared with scene average. Anyscan line deviating from the average bymore than a designated threshold value is identifiedas defective. Once detected, they may be cosmetically corrected in three ways:

3.5.1.1.Replacement by Preceding or Succeeding Line

This is the simplest method for estimating the pixel value along a dropped scan line, itInvolves replacement of the value of the missing scan line by the value of the correspondingPixel on immediately preceding or succeeding scan line

$V_{i,j} = V_{i,j-1}$ or $V_{i,j} = V_{i,j+1}$

Where $V_{i,j}$ = missing pixel value of pixel i scan line j

$V_{i,j-1}$ = pixel value of pixel i and scan line j-1 (preceding), and

$V_{i,j+1}$ = pixel value of pixel i and scan line j+1 (succeeding)

3.5.1.2.Averaging Method

The missing scan line is replaced by the average value of the corresponding pixel on Immediately preceding and succeeding line.

$V_{i,j}=V_{i,j-1} + V_{i,j+1} / 2$

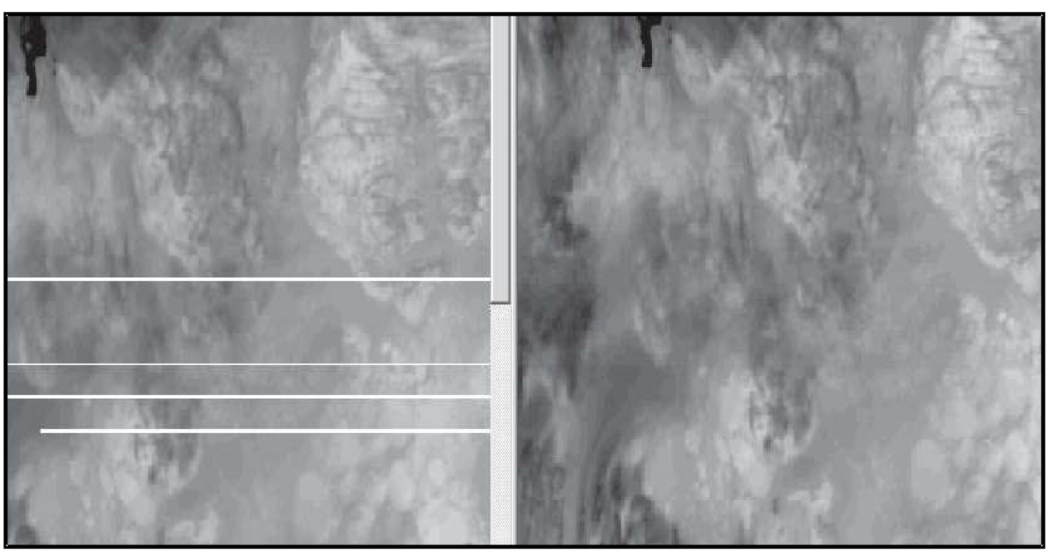


Figure3.8.DNs of Bad Lines Are Obtained As Average ofthe Neighbouring DN

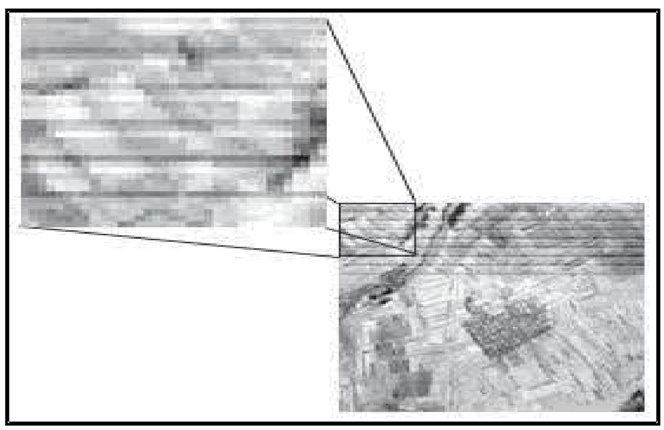
3.5.1.3. Replacement with Correlated Band

This method relies on the fact that spectral bands in the same region of the spectrum arehighly correlated. For e.g. Landsat-3 MSS band 4[green] and band 5[red] are highlycorrelated. The missing pixels in band k is estimated by considering contributions from theequivalent pixels in the same band in another highly correlated band and neighbouring pixelsin the same band. If highly correlated band were denoted by subscript r then algorithm canbe represented by

$$V_{i,j,k} = M [V_{i,j,r} - (V_{i,j+1,r} + V_{i,j-1,r}) /2 + (V_{i,j+1,k} - V_{i,j-1,k}) /2]$$

Where M =□k /□r

3.5.2. Correctionfor Line Striping (De-Stripping)



A sensor is called ideal when there is a linear relationship between input and the output. Although all the detectors are well calibrated prior to the launch, the response of some ofthe detectors may shift towards lower or higher end. The presence of a systematichorizontal banding pattern is frequently seen on images produced by electronic scannerssuch as MSS sixth line banding and on TM sixteenth line banding.**(Figure3.9 Example of Line stripping)** Banding is a cosmeticdefect and it interferes with the visual appreciation of the patterns and features on theimage. Hence corrections for these bandings are to be applied to improve the visualappearance and interpretability of the image. Two methods of de-stripping are considered,both these methods are based upon the shape of the histograms of pixel values generatedby the individual detectors in a particular band

3.5.2.1. Linear Method

This method uses a linear expression to model the relationship between input and outputvalues. It assumes that mean and standard deviation of data from each detector should besame. Detector imbalance is the only factor producing the differences in means andstandard deviations. To get rid of this effect due to detector imbalance, the means andstandard deviations of the six (MSS) histograms are equalized i.e. forced to equal thestandard deviation of the whole image

The overall standard deviation is given by

$$\sigma = \sqrt{\frac{\sum n_i (\bar{x}_i^2 + v_i)}{\sum n_i} - \bar{x}^2}$$

Where

$\bar{x}$ = overall mean ($\sum \bar{x}_i / 6$)

$\bar{x}_i$ = mean of detector i

v_i = variance of detector i

n_i = no. of pixels processed by detector i

3.5.2.2. Histogram Matching (Non Linear)

In some images it appears that different gain and offsets are appropriate for different scene radiance images i.e. the sensor transfer curves are non linear. If the relationship between the input and output values is non-linear then histogram matching method should be applied. This method uses the shape of the cumulative frequency histogram of each detector to find an estimate of the non-linear transfer function. The cumulative frequency histogram of each detector and one target are computed. Then the shape of the individual cumulative histogram is matched to the target histogram as closely as possible. The first values in the target histogram to equal or exceed the values in detector histogram are taken as output reference and the corresponding input value is taken as output value.

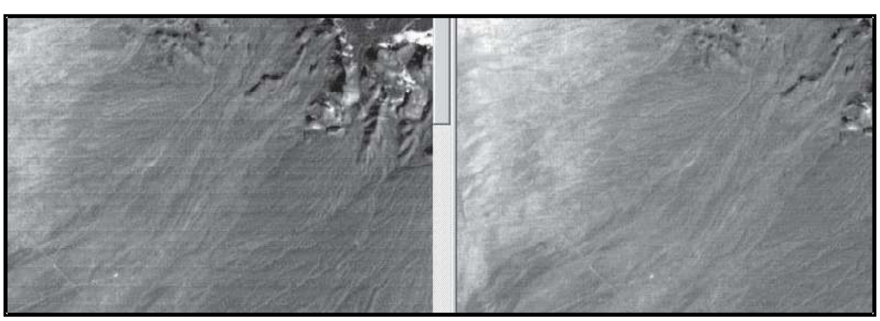


Figure3.10DNs of bad lines are adjusted so as histogram of the bad line matches that of the good lines

3.5.3.Random Noise Correction

Random noise means pixels having offset values from the normal. It can be easily corrected By means of a smoothing filter on the data

Figure3.11Noise Arise Mean Filter

3.5.4. Atmospheric Correction

The value recorded at any pixel location on the remotely sensed image is not a record of the true ground-leaving radiance at that point; for the signal is attenuated due to absorption and its directional properties are altered by scattering. Figure3.13 depicts the effects the atmosphere has

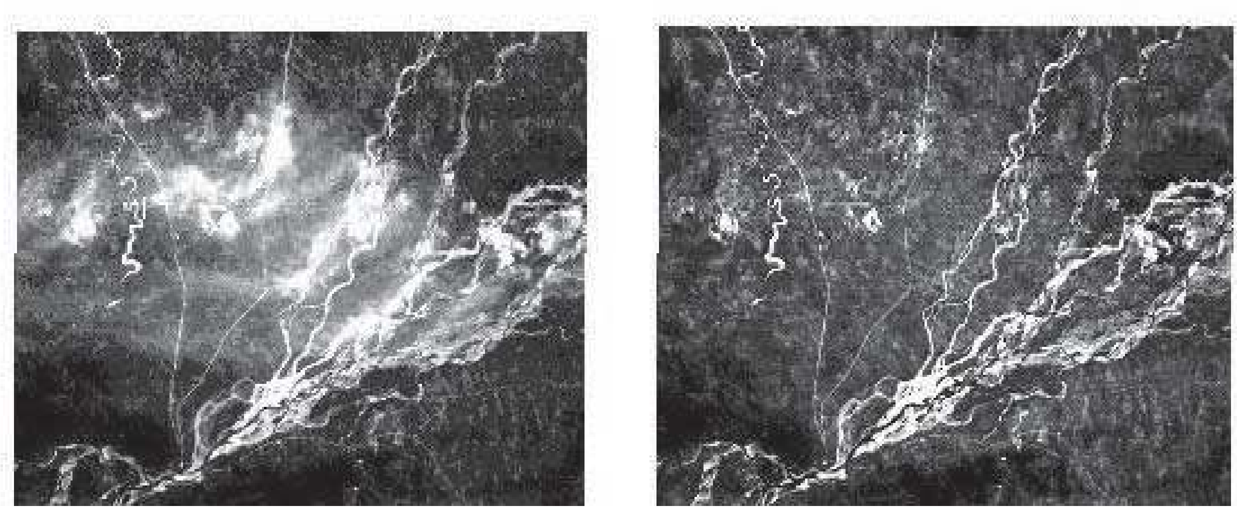


Figure 3.12Before Correction After Correction

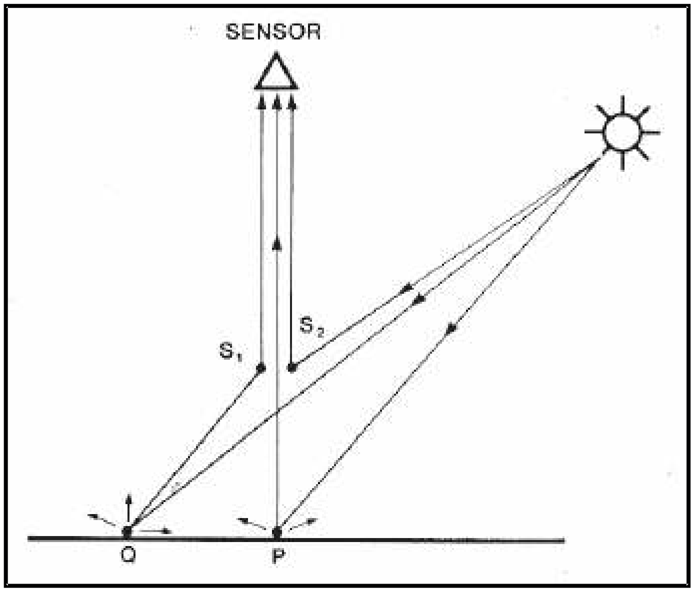


Figure3.13 Components of the signal received by satellite mounted sensor

Scattering at S2 redirects some of the incident radiance within the atmosphere in the field of view of the sensor (the atmospheric path radiance) and some of the energy reflected from point Q is scattered at S1 so that it is seen as coming from P. To add to these effects the radiance from P and Q is attenuated as it passes through the atmosphere. Other difficulties are caused by the variations in the illumination geometry (Sun's elevation and azimuth angles).

The relationship between radiance received at a sensor above the atmosphere and the
Radiance leaving the ground surface can be given as

$$L_s = H_{tot}\,\rho\,T + L_p$$

H_{tot} = total downwelling radiance in a specified spectral band
ρ = reflectance of the target
T = atmospheric transmittance
L_p = atmospheric path radiance

The path radiance Lp varies in magnitude inversely with wavelength for scattering increasesas wavelength decreases. Atmospheric path radiance introduces haze in the imagerywhereby decreasing the contrast of the data. In order to remove the haze component twosimple techniques are discussed here

3.5.4.1.Histogram Minimum Method (Dark Pixel Subtraction Technique)

In this method an assumption is made that there is a high probability that there are someareas in the image with low reflectance (clear water, deep shadow etc). These pixels willhave values very close to zero in the short wave infrared band. Any values greater than zerois assumed to be a haze contributionthe histograms of all the bands in the image arecomputed for the full image. The lowest pixel values in the histograms of all the bands aretaken as the first approximation of the atmospheric path radiance and these minimumvalues are subtracted from the respective images.

The atmospheric effects correction - algorithms is

$$I^{\circ}(i,j) = I(i,j) - Bias$$

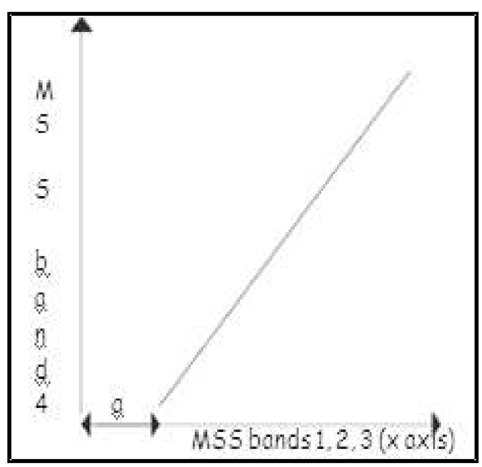
Where, I (i,j) = input pixel value at line i and sample j

I° (i.j) = Enhanced pixel value at same location (i,j)

The bias is the amount of offset for each spectral band

3.5.4.2. Regression Method

In this method the pixel values corresponding to regions having low reflectance (water,deep shadow) in the short-wave infrared regions are plotted against the pixel values of theother spectral bands in turns and a best fit (least squares) straight line is computed usingstandard regression methods. The offset a on the x-axis in



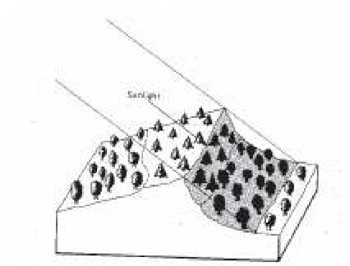
different bands is theatmospheric path radiance and hence has to be subtracted from the respective images

Figure 3.14

3.6. Spectral Ratioing

Image division or **spectral ratioing** is one of the most common transforms applied to image data. Image Ratioing serves to highlight subtle variations in the spectral responses of various surface covers. Ratio images are enhancements resulting from the division of DN values in one spectral band by the corresponding values in another band. A major advantage of ratio image is that they convey the spectral or color characteristics of image features, regardless of variations in scene illumination conditions. This concept is illustrated in figure ….. Which depicts two different land cover types (deciduous and coniferous trees) occurring on both the sunlit and shadowed sides of a ridge line. DNs observed for each cover types are substantially lower in the shadowed area than in the sunlit area. However, the ratio values for each cover types are nearly identical, irrespective of the illumination condition. Hence, a radioed image of the scene effectively compensates for the brightness variation caused by the varying topography and emphasizes the color content of the data

Ratios for Elimination of Topographic Effect

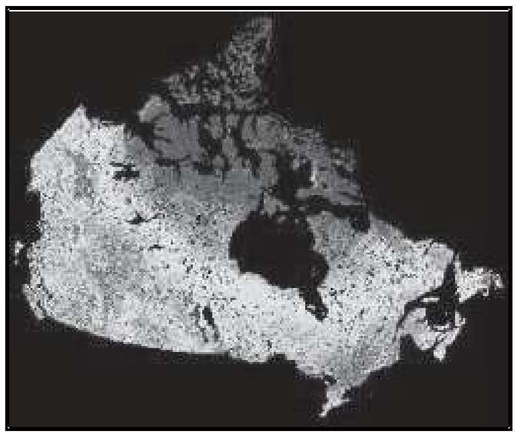


Landcover/ Illumination	Digital Number		Ratio
	Band A	Band B	
Decidous			
Sunlit	48	50	.96
Shadow	18	19	.95
Coniferous			
Sunlit	31	45	.69
Shadow	11	16	.69

- Same cover type
- Radiance at shodow is only 50% of radiance at sunlit
- Ratio nearly identical

Figure 3.15.Reduction of Scene Illumination Effects through Spectral Ratioing (Adapted From Sabins, 1997)

Another example illustrates the concept of spectral ratioing. Healthy vegetation reflects strongly in the near-infrared portion of the spectrum while absorbing strongly in the visible red. Other surface types, such as soil and water, show near equal reflectances in both the near-infrared and red portions. Thus, a ratio image of Landsat MSS Band 7 (Near-Infrared - 0.8 to 1.1 mm) divided by Band 5 (Red - 0.6 to 0.7 mm) would result in ratios much greater than 1.0 for vegetation, and ratios around 1.0 for soil and water. Thus the discrimination of vegetation from other surface cover types is significantly enhanced. Also, we may be better able to identify areas of unhealthy or stressed vegetation, which show low near-infrared reflectance, as the ratios would be lower than for healthy green vegetation



Another benefit of spectral Ratioing is that, because we are looking at relative values (i.e. ratios) instead of absolute brightness values, variations in scene illumination as a result oftopographic effects are reduced. Thus, although the absolute reflectances for forest coveredslopes may vary depending on their orientation relative to the sun's illumination, the ratio oftheir reflectances between the two bands should always be very similar. More complex ratiosinvolving the sums of and differences between spectral bands for various sensors have beendeveloped for monitoring vegetation conditions.

Commonly used Vegetation Indices

- Vegetation Index or Ratio Vegetation

Index (RVI) = IR / R

- Normalized Differential Vegetation Index

(NDVI) = (IR - R)/(IR + R)

- Transformed Vegetation Index (TVI)

= {(IR - R)/(IR + R) + 0.5}1/2 x 100

But one of the widely used image transform is the NDVI

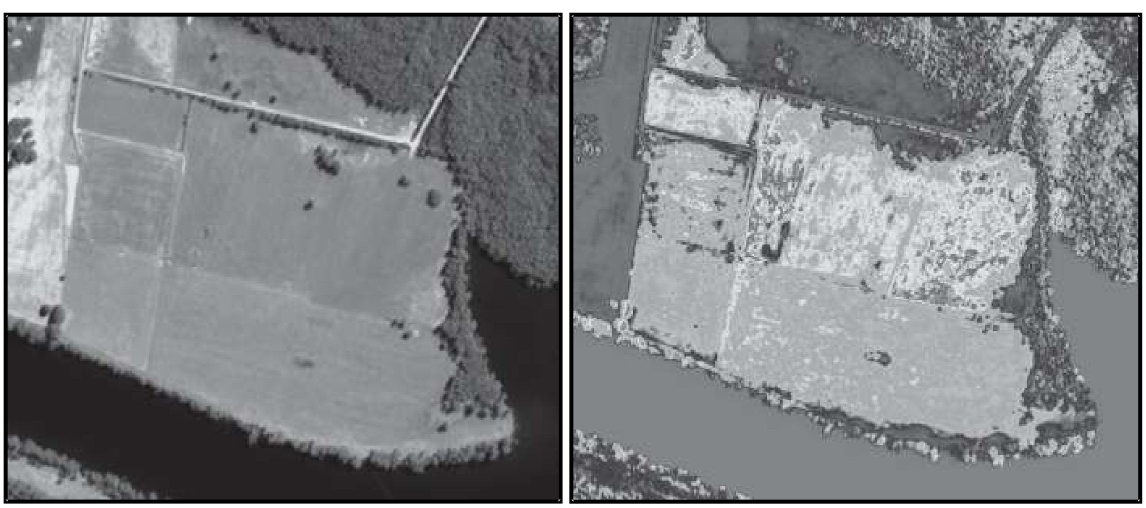
3.6.1. Normalized Difference Vegetation Index (NDVI)

The most popular method of vegetation analysis uses the Normalized Difference Vegetation Index (NDVI) algorithm to measure plant material. NDVI is used to measure and monitor plant growth, vegetation cover and biomass production using any multispectral sensor which has both a Visible Red and Near Infra-Red bands.

$$NDVI = \frac{(NIR - VIS)}{(NIR + VIS)}$$

Where VIS and NIR stand for the spectral reflectance measurements acquired in the visible (red) and near-infrared regions, respectively

Figure 3.16



False color processed image Here, the brighter highlight more vigorous and healthy plant

NDVI processed image of the same area shows not reds only the extant of vegetation health ,but also densitygrowth

3.6.2. Principal Component Analysis

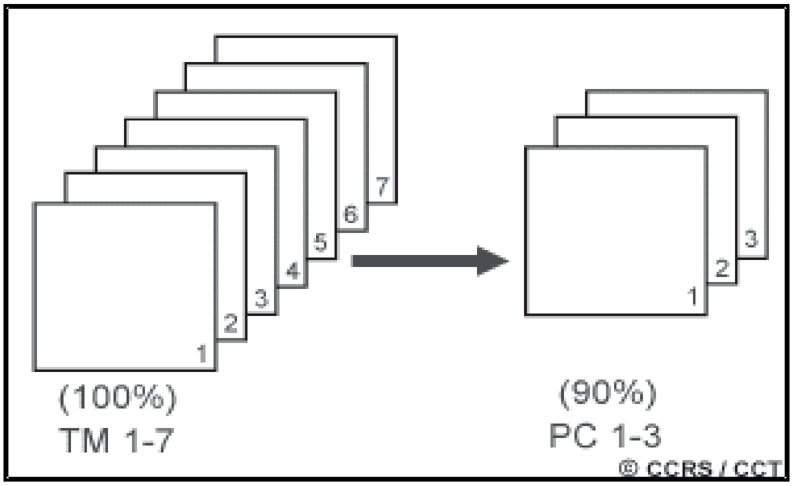


Figure 3.17

Image transformation techniques based on complex processing of the statistical characteristic of multi-band data sets can be used to reduce this data redundancy and correlation between bands One such transform is called principal components analysis. The objective of this transformation is to reduce the dimensionality (i.e. the number of bands) in the data, and compress as much of the information in the original bands into fewer bands. The "new" bands that result from this statistical procedure are called components. This process attempts to maximize (statistically) the amount of information (or variance) from the original data into the least number of new components. As an example of the use of principal components analysis, a seven band Thematic Mapper (TM) data set may be transformed such that the first three principal components contain over 90 percent of the information in the original seven bands. Interpretation and analysis of these three bands of data, combining them either visually or digitally, is simpler and more efficient than trying to use all of the original seven bands. Principal components analysis, and other complex transforms, can be used either as an enhancement technique to improve visual interpretation or to reduce the number of bands to be used as input to digital classification procedures

3.7. Summary

This unit discuss on Digital image processingin which we introduce various image enhancement techniques, before use satellite image for analysis, we have to correct image through differentmethods like radiometric, atmospheric corrections, some time data quality not good (line strip,dropline) then we use spatial correction method spectral ratioing very effective transforms method . How ndvi extract vegetation information through satellite image

3.8Gloassary

- **Calibration-**Process of comparing an instrument's measurements with a standard.
- **Contrast Enhancement-**Image-processing procedure that improves the contrast ratio of images. The original narrow range of digital values is expanded to utilize the full range of available digital values.
- **Electromagnetic Radiation-**Energy propagated in the form of and advancing interaction between electric and magnetic fields. All electromagnetic radiation moves at the speed of light.
- **Image Striping-**A defect produced in line scanner and push broom imaging devices produced by the non-uniform response of a single detector, or amongst a bank of detectors. In a line-scan image the stripes are perpendicular to flight direction, but parallel to it in a push broom image.
- **Noise**-Random or repetitive events that obscure or interfere with the desired information.
- **Non-directional Filter**-Mathematical filter that treats all orientations of linear features equally.
- **Periodic Line Dropout-**Defect on Landsat MSS or TM images in which no data are recorded for every sixth or sixteenth scan line, causing a black line on the image.
- **Polarization-**The direction of orientation in which the electrical field vector of electromagnetic radiation vibrates.
- **Principal Component Analysis-**The analysis of covariance in a multiple data set so that the data can be projected as additive combinations on to new axes, which express different kinds of correlation among the data.

3.9. Answer to check your progress/Possible Answers to SAQ

Ans.1 Enhancements are used to make it easier for visual interpretation and understanding ofimagery Image enhancement is attempted after the image is corrected for geometricand radiometric distortions. Image enhancement methods are applied separately to eachband of a multispectral image

Ans.2.A Low-pass filter is designed to emphasize larger, homogeneous areas of similar tone and reduce the smaller detail in an image. Thus, low-pass filters generally serve to smooth the appearance of an image.

Ans.3 Fill in the blank.

(a)Frequency(b)Density

Ans. 4 True false against the following:

(a) True **(b)** False

3.10. References

1. faculty.ksu.edu.sa/74534/.../11-radiometric%20correction.ppt

3. Http://xweb.geos.ed.ac.uk/~rharwood/teaching/msc/adv_ip/princcpt.pdf

4. http://www.stats.org.uk/pca/pca.pdf

5. www.una.edu/.../remote_sensing/...

6. http://giswin.geo.tsukuba.ac.jp/sis/tutorial/gisseminar_Kondwani_manual_2010July1.pdf

7. http://remotesensing.schools.officelive.com/spectralrationing.aspx

8-fundamentals-of-remote-sensing.-by Noam Levin ,November 1999

3.11. Suggested Readings

1. Introductory digital image processing (John R. Jensen)

2. Introductory Remote Sensing Digital Image Processing and Application (Paul Jude Gibson, Clare H. Power

3.12.Terminal Questions

Q1.How Non-Linear Contrast Enhancement

Q2Different between Low Pass Filter and High Pass Filter

Q3.What Is Radiometric Correction

Q4. Explain Regression Method (Atmospheric Correction)

Q5 For What Purpose NDVI Method Is Use?

UNIT 4: FUTURE GEOINFORMATICS

OPEN GIS

4.1. INTRODUCTION

Open GIS is the full integration of geospatial data into mainstream information technology. What this means is that GIS users would be able to freely exchange data over a range of GIS software systems and networks without having to worry about format conversion or proprietary data types.

Open GIS seeks to facilitate the exchange of information not only between individual GIS systems but also to other systems, such as statistical analysis, image processing, document management, or visualization. Especially with the proliferation of geo-based websites, the networking component of GIS systems with other data processes is becoming more important.

4.2 Objectives

After going through this unit the learner will able to learn:

What is Open Gis?

Uses of Open Gis Software

How NDSI Work

How to use free Web Gis

4.3.1 Difference between Open Gis and Licence (Commercial)GIS Software

- Open source software is free; you don't have to purchase it and you can freely distribute it to anyone else, as opposed to proprietary software which you must purchase and typically cannot share with anyone (since it's copyrighted).
- The source code, or actual computer programming, that was used to create the software is transparent, as opposed to proprietary software where the code is hidden and encrypted.
- Under the open source model the programming code is transparent and you are free to change and make improvements to it; this is strictly prohibited with proprietary software.

4.3.2. Open GIS Consortium (OGC)

The OGC is a consensus-based association of public and private sector organizations to meet these three objectives. Its purpose is to create and manage an industry-wide architecture for interoperable geoprocessing. OGC was founded in 1994 as a not-for-profit membership organization for the purpose of addressing the lack on interoperability among GIS systems and between these systems and mainstream computing systems.

By engaging key players in the GIS Industry such as software companies, governmental agencies, private businesses and academia , the OGC is bringing standardization of geographic data as is already found in other information systems. The end goal is to adopt widespread technology standards and business processes in an effort to support georeferenced data throughout the global community.

Other groups have joined the effort for an Open GIS system. GIPSIE is one such effort. An acronym for GIS Interoperability Project Stimulating the Industry in Europe, the project's goals are to stimulate European GI communities' involvement in the worldwide Open GIS specification process and thus increase the European GIS industry's competitiveness.

4.3.3Open GIS Programming Languages

Open source projects typically are worked on by a community of volunteer programmers. Open source GIS programs are based on different base programming languages. Three main groups of open source GIS (outside of web GIS) in terms of programming languages are: **"C" languages, Java, and .NET**.

The first group would be the group that uses **"C"** language for its implementation. This is the more mature of the groups of open source GIS, probably for the simple reason that is the group that has been working on GIS software applications the longest and has a long history of reuse of code. The libraries in the "C" group, from the base infrastructure, and include some capabilities like coordinate reprojection that make them very useful and popular. Popular "C" based open source GIS software applications include GRASS, a project started in 1982 by the US Army but is now open source, and QGIS (otherwise known as Quantum GIS).

The second group of Open Source GIS would be the ones that use **JAVA** as the implementation language. JTS, central library for the Java GIS development, offers some geospatial functions that allow to compare objects and return a Boolean true/false result indicating the existence (or absence) of any questioned spatial relationship. GeoTools, Geoserve, and OpenMap, are among the most popular open source GIS in this group of JAVA tools.

The third most influential group of Open Source GIS would be the one that integrates applications that use "**.NET"** as the implementation language. SharpMap and Worldwind are the most popular of these applications.

Outside of the three major language groups, open source web mapping is another group. Population open source web mapping includes OpenLayers and MapBuilder, widely used due to their simplicity and accessibility.

- Listed here are available open source GIS based applications you can download written for a variety of platforms and in various languages

4.3.4Different Tribes Use Different Tools

- **C/C++ Tribe**

  MAPSEVER, GRASS, MAPGUIDE, QGIS, POSTGIS, OGR/GDAL, PROJ4, FDOTERRALIB
- **Java Tribe**

GeoTools, Geoserver, uDig, DeeGree jump, gvSIG

- **Web tribe**

MapBender, Open Layers, Ka-map

- **.Net Tribe**

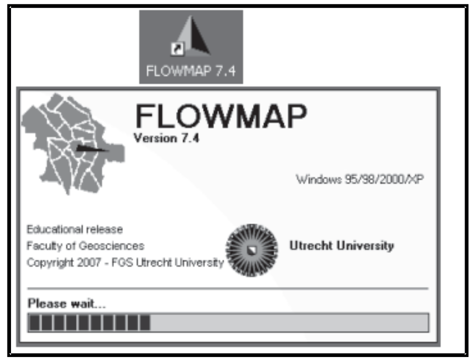
SharpMap, Worldwind, Mapwindow

4.3.5. Open Source Desktop GIS Software

4.3.5.1 Flow Map

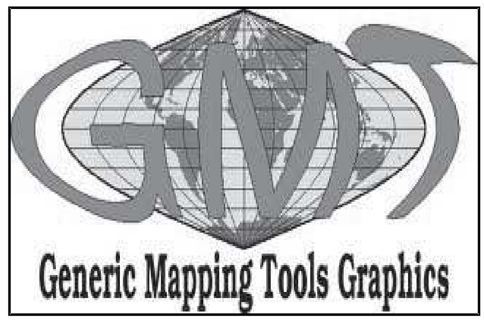
Flow map is a freeware application designed to analyze and display flow data. This application was developed at the Faculty of Geographical science of the Utrecht University in the Netherlands

Platforms: Window OS



4.3.5.2. GMT MAPPING TOOLS

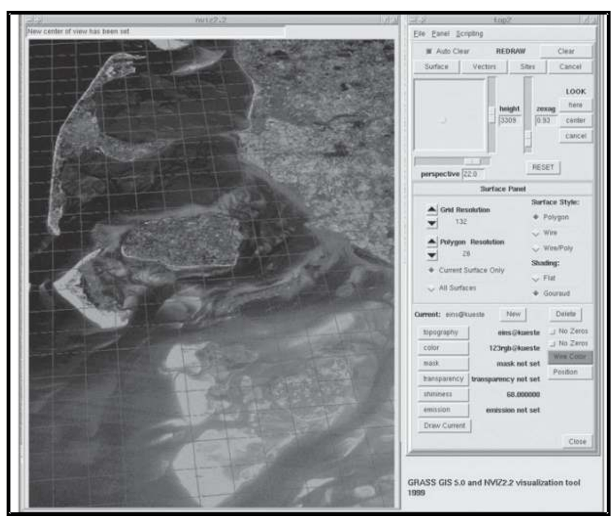
GMT**Generic mapping tool** is a free, public-domain collection of ~60 UNIX tools that allow users to manipulate (x,y) and (x,y,z) data sets (including filtering, trend fitting, gridding, projecting, etc.) and produce Encapsulated PostScript File (EPS) illustrations ranging from simple x-y plots through contour maps to artificially illuminated surfaces and 3-D perspective views in black and white, gray tone, hachure patterns, and 24-bit color.



Platforms: UNIX, Macintosh

4.3.5.3. GRASS

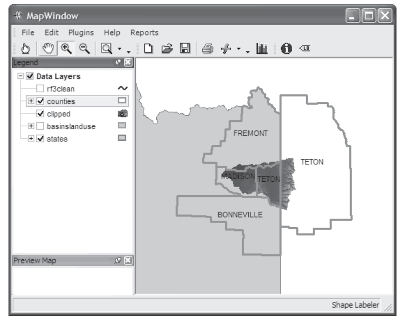
Geographic Resources Analysis Support System (GRASS) is the public domain GIS software application originally developed by the US Government. GRASS is probably the most well-known open source and original GIS software applications. GRASS is a raster-based GIS, vector GIS, image processing system, graphics production system, data management system, and spatial modeling system. GRASS can be downloaded for free.



Platforms: Linux, Macintosh, Sun Solaris, Silicon Graphics Irix, HP-UX, DEC-Alpha, and Windows OS

4.3.5.4. MapWindow GIS

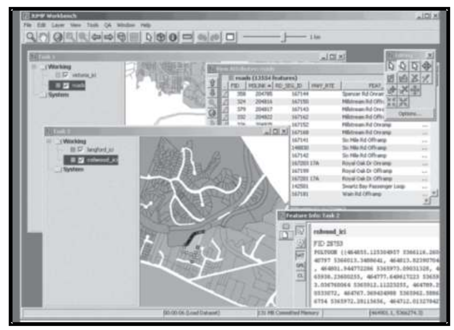
MapWindow GIS is open source GIS application that can be extended through plug-ins. The application is built using Microsoft's .NET



Platforms: Windows

4.3.5.5. Open JUMP GIS

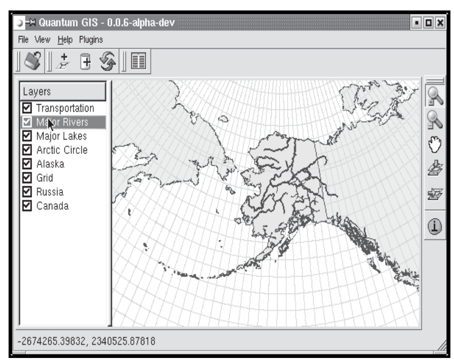
Open JUMP GIS is an open source GIS written in Java through a collaborative effort by volunteers. Formerly known as JUMP GIS, the application can read Shapefiles and GML format files.



Platforms: Windows, Macintosh, Linux, UNIX

4.3.5.6. Quantum GIS

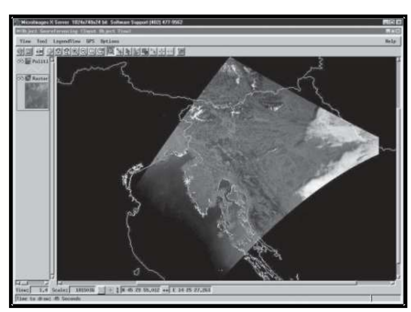
Also referred to as QGIS, Quantum GIS is an Open Source Geographic Information System (GIS). More: Getting Started With QGIS: Open Source GIS



Platforms: Linux, UNIX, Mac OSX, and Windows

4.3.5.7. TNTLite

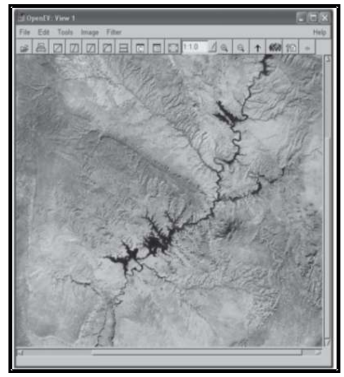
Tntlite Micro Images, Inc. Provides tntlite as a free version of tntmips, the professional software for geospatial data analysis The free tntlite product has all the features of the professional version, except tntlite limits the size of Project File objects, and tntlite enables data sharing only with other copies of tntlite (export processes are disabled). Can either be downloaded or ordered on CD.Platforms: Windows



4.3.5.8. OpenEV

Openev is a software library and application for viewing and analysing raster and vector geospatial data is used by private companies, universities, governments and non-profit organizations around the world. Openev is both:

- An application for displaying and analysing geospatial data
- Developer library from creating new applications



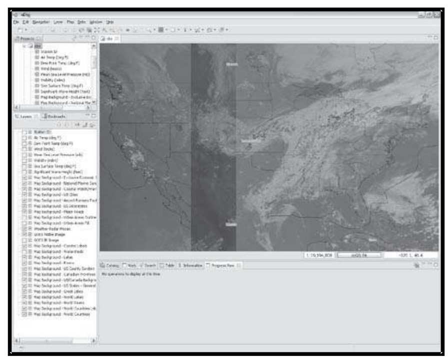
Openev is released under the gnu lgpl license open source license

Platforms: for windows, linux, sun solaris, and sgi irix operating systems

4.3.5.9. UDig GIS

UDig GIS is a free, open source GIS desktop application that runs on Windows, Linux and Mac OS. UDig was designed to use OGC's OpenGIS standards such as WMS, WFS and more. One-click install allows you to view local Shapefiles, remote WMS services and even directly edit your own spatial database geometries.

Platforms: Windows, Linux, Macintosh



Check Your Progress:

Q 1: What is Open GISProgramming Languages?

Q 2: Full Forms

a.GRASS

b. GMT

c. OGC

NSDI

4.4. INTRODUCTION

An Indian NSDI was created by the Government of India via a resolution in June 2006. The NSDI is for the purpose of acquiring, processing, storing, distributing and improving utilization of spatial data which would be a gateway of spatial data being generated by various agencies of the Government of India; and where as the data producing agencies of the Government of India shall be initially the contributing agencies to the NSDI.

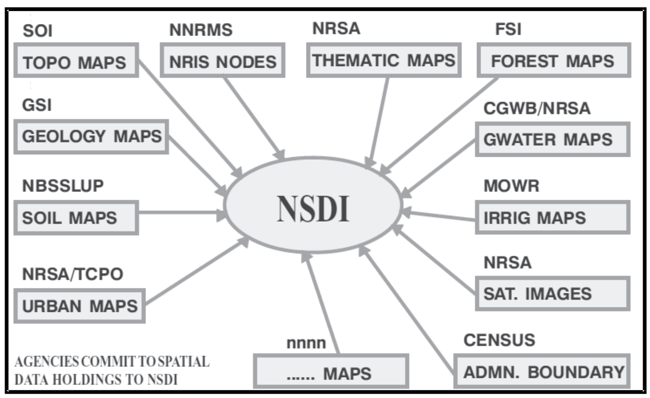
It is possible to combine spatial data and services from different sources across the Community in a consistent way and share them between several users and applications. It is possible for spatial data collected at one level of govt./public authority to be shared between all the different levels of govt./public authorities; and spatial data and services are made available under conditions that do not restrict their extensive use. It is easy to discover available spatial data, to evaluate their fitness for purpose and to know the conditions applicable to their use.

4.4.1 Proposed Framework of NSDI

- The NSDI would aim to have a de-centralized approach to:
- Develop and maintain Standard digital collections of spatial data
- Develop common solutions for discovery, access, and use of spatial data in response to the needs of diverse user groups
- Build relationships among organizations to support the continuing development of the NSDI
- Increase the awareness and understanding of the vision, concepts, and benefits of the NSDI

4.4.2. NSDI Contents

To start with, the rich collection of spatial data available in the countryshould form the foundation data for NSDI, as shown in Fig



1. National coverage of topographical maps on scales of 1:250000, 1:50000and 1:25000 and any other data of the Survey of India (SOI) toposheets

2. National coverage of geological maps on 1:50000 scales and other maps/data of the Geological Survey of India (GSI)

3. National coverage of soil maps on 1:250000 and 1:50000 scales and other maps/data of the National Bureau of Soil Survey and Land use Planning (NBSSLUP)

4. National coverage of forest maps on 1:50000 scale of the Forest Survey of India (FSI)

5. National coverage of the hydrology maps on all scales of the Central Ground Water Board (CGWB)

6. National coverage of land use maps on 1:50000 scale; wasteland maps on 1:50000 scale; urban maps on 1:50000 scale; ground water potential maps on 1:50000 scale and other thematic maps of National Remote Sensing Agency (NRSA);

7. NRIS Nodes of the NNRMS Programme involving District and State Natural Resources databases on 1:50000 scales;

8. Command area maps of Central Water Commission (CWC)

9. National coverage of coastal land use maps on 1:50000 and 1:25000scale of Ministry of Environment and Forests (MoEnF)

10 .Census maps and census data of the Census Department

11. NATMOs national atlases on 1:1000000 and other scales

12. National coverage of Satellite images of different resolutions

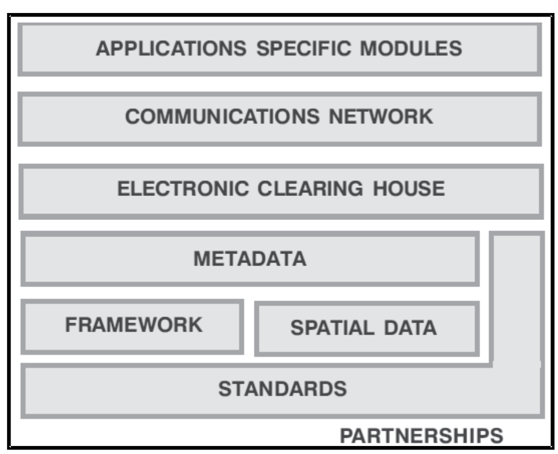
13.Hydro graphic data of the National Hydrographic Department

14. To this set of basic data, addition of India Meteorological Department's weather information and Department of Ocean Development's Ocean information (at smaller scales) could also beadded

15.Non-spatial data of the Bureau of Economics and Statistics, National Council for Applied Economic Research etc – which could be linked to the spatial features and become a part of the NSDI.

4.4.3. NSDI – Design Elements

The NSDI elements, as illustrated in **Fig**, would be:



4.4.3.1. NSDI Standard

NSDI standard defined and agreed to national agencies and defining content and schemas, design and process, network protocols, exchange and transfer. Standards are the crux of the NSDI and would be of relevance to database standardization - formats, exchange and interoperability; Networks-gateways and protocols Communication equipment, software standards, etc. Standards enable applications and technology to work together. Tools, applications, and data affect each other, and processes for developing standards must consider these interactions.

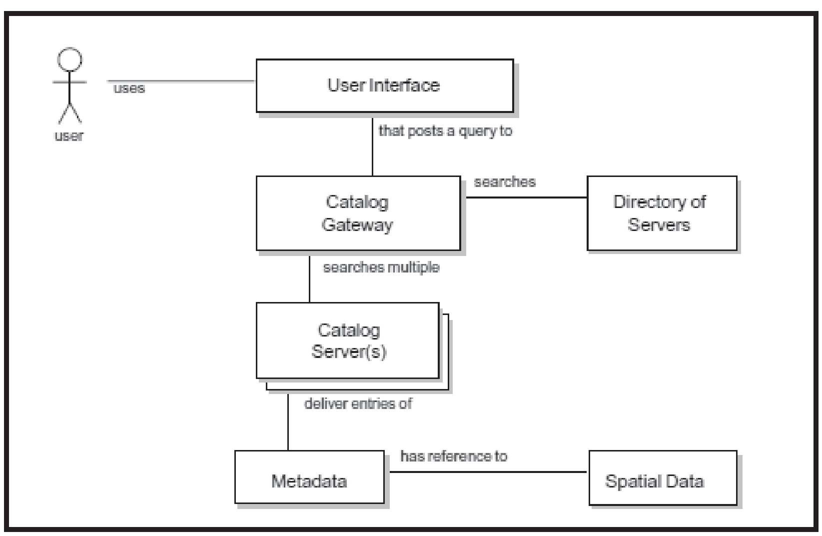
4.4.3.2. NSDI Servers

The NSDI would a network of servers that, in unison would the successful performance of NSDI goals objectives. The following 3 NSDI elements envisaged

NSDI Web-Server: The NSDI Web-Server would be the front-end interface to NSDI. The Web-Server would provide the open access to NSDI information and “secure” entry to NSDI Metadata and NSDI Agency Servers. The DNS for the NSDI web-server would bewww.nsdi.gov.in

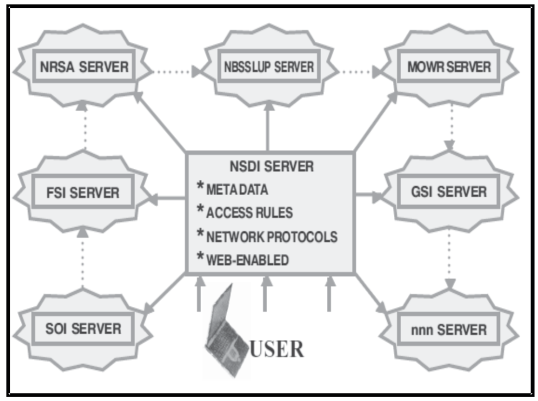
NSDI Metadata Server: The NSDI Metadata Server would maintain the NSDI metadata content. At a higher level, it would be linked to NSDI Web-Server and lower-level it would be linked through NSDI Server Catalogue to NSDI Agency Servers.

NSDI Agency Server: The NSDI Agency Server (or Servers) would hold the actual spatial data of the NSDI Agency



4.4.3.3. NSDI Gateway and Internet

The NSDI would evolve and expand with the participation of committing agencies and it is envisaged that SOI, NRSA, GSI, FSI, CGWB, NNRMS/NRIS, CWC, MoEnF, NATMO, NBSSLUP, CGWB, Census department, IMD,DOD, BES, NCAER etc would be the first committed agencies to the NSDI..Each agency would commit to establish a GIS database server as a NSDINode. The NSDI would enable development of new relationships that allow organizations and individuals from all sectors to work together to share spatial data. **Fig**shows the overall framework of NSDI

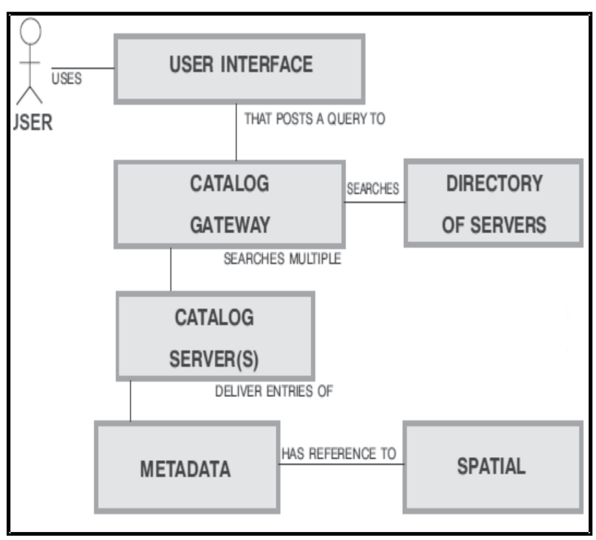


4.4.3.3.1. NSDI Nodes

NSDI nodes and GIS servers of the actual spatial information- in conformity of the NSDI Standard the NSDI Nodes would be mainlyGIS based spatial databases and development oriented information systems servers - all integrated and linked to basic spatial/geographic units. The value of NSDI would be to aid as a decisionmakingtool and more in the context of assisting planning fordevelopmental activities.

4.4.3.3.2. NSDI Search and Access Protocols

That would enable search and location of spatial information. The protocols would provide the gateway for users to access NSDI. The basic issue in the operation of the NSDI is the backbone on which the information travels from one point to another. The backbone carrier will be high-speed carrier capable of providing bandwidth on demand to intermediate levels of the NSDI and to users of the NSDI.



4.4.3.3.3NSDI Electronic ClearingHouse

The NSDI Clearinghouse would be the mechanism to provide access to the metadata and finally to the actual data sets. The clearinghouse has to have systems toauthenticate data requests and requests spatial data volumes are usually large and download through networks may not be feasible. In such cases, the system should be able to generate media bearingthe requested data for transmission by mail. The clearinghouse should also store information about the applications and availability of application specific modules that could be reused by other users. The clearinghouse would use the NSDI Search and access Protocols engines to look for and discover data and information.

4.4.3.3.4. NSDI User Interface

That would be the front-end interface for userqueries and access of spatial information. With regard to design ofNSDI much depends upon the level of penetration and upper-end levelof applications and services available on it. For a completely ubiquitous

NSDI, the penetration will have to reach public domain and thecapabilities will include online access of information applications.

4.4.3.3.5. NSDI Metadata

Metadata of the NSDI content and information availability The NSDI Metadata would get evolved from the NSDI Standard and as digital spatial information is populated. As a part of NSDI, one of the critical steps would be the development of a metadata standard and development of metadata files.There are different levels that metadata may be used for:

1. Search and Location - What data sets hold the sort of data of interest? This enables organizations to know and publicize what data holdings they have.

2. Analysis metadata - Do the identified data sets contain sufficient information to enable a sensible analysis to be made for my purposes? This is documentation to be provided with the data to ensure that others use the data correctly and wisely.

3. Access metadata – What is the process of obtaining and using the data that are required? This helps end users and provider organizations to effectively store, reuse, maintain and archive their Data holdings

Check Your Progress:

Q3: What is Meta Data?

Q 4: Full Forms

a.SOI __________

b. NSDI __________

c. GSI __________

NAVIGATIONS SYSTEMS

4.5 INTRODUCTION

A navigation system is a (usually electronic) system that aids in navigation. Navigation systems may be entirely on board a vehicle or vessel, or they may be located elsewhere and communicate via radio or other signals with a vehicle or vessel, or they may use a combination of these methods.

Navigation systems may be capable of:

- containing maps, which may be displayed in human readable format via text or in a graphical format
- determining a vehicle or vessel's location via sensors, maps, or information from external sources
- providing suggested directions to a human in charge of a vehicle or vessel via text or speech
- providing directions directly to an autonomous vehicle such as a robotic probe or guided missile
- providing information on nearby vehicles or vessels, or other hazards or obstacles
- providing information on traffic conditions and suggesting alternative directions

4.5.1 Types of Navigations Systems

4.5.1.1 Automotive Navigation System

An automotive navigation system is a satellite navigation system designed for use in automobiles. It typically uses a GPS navigation device to acquire position data to locate the user on a road in the unit's map database. Using the road database, the unit can give directions to other locations along roads also in its database. Dead reckoning using distance data from sensors attached to the drive train, a gyroscope and an accelerometer can be used for greater reliability, as GPS signal loss and/or multipath can occur due to urban canyons or tunnels.

4.5.1.2 Road Database

The road database is a vector map of some area of interest. Street names or numbers and house numbers are encoded as geographic coordinates so that the user can find some desired destination by street address (see map database management).

Points of interest (waypoints) will also be stored with their geographic coordinates. Point of interest specialties include speed cameras, fuel stations, public parking, and "parked here" (or "you parked here").

Contents can be produced by the user base as their cars drive along existing streets (Wi-Fi) and communicating via the internet, yielding a free and up-to-date map

.

4.5.1.3 Map Formats

Formats are almost uniformly proprietary; there is no industry standard for satellite navigation maps, although Navteq are currently trying to address this with S-Dal (see below).

The map data vendors such as Tele Atlas and Navteq create the base map in a standard format GDF, but each electronics manufacturer compiles it in an optimized, usually proprietary format. GDF is not a CD standard for car navigation systems. GDF is used and converted onto the CD-ROM in the internal format of the navigation system.

4.5.1.4 CARIN

CARIN Database Format (CDF) is a proprietary navigation map format created by Philips Car Systems (this branch was sold to Mannesman VDO, VDO/Dayton in 1998, to Siemens VDO in 2002, and Continental in 2007.) and is used in a number of navigation-equipped vehicles. The 'carin' portmanteau is derived from Car Information and Navigation.

4.5.1.5 SDAL

This is a proprietary map format published by Navteq, who released it royalty free in the hope that it would become an industry standard for digital navigation maps. Vendors currently using this format include:

(1) Microsoft**(2)**Magellan**(3)**Pioneer**(4)**Panasonic**(5)**Clarion**(6)** InfoGation

4.5.2GPS Navigation Device

A **GPS navigation device** is any device that receives Global Positioning System (GPS) signals for the purpose of determining the device's current location on Earth. GPS devices provide latitude and longitude information, and some may also calculate altitude, although this is not considered sufficiently accurate or continuously available enough (due to the possibility of signal blockage and other factors) to rely on exclusively to pilot aircraft. GPS devices are used in military, aviation, marine and consumer product applications.

GPS devices may also have additional capabilities such as:

- containing maps, which may be displayed in human readable format via text or in a graphical format
- providing suggested directions to a human in charge of a vehicle or vessel via text or speech
- providing directions directly to an autonomous vehicle such as a robotic probe
- providing information on traffic conditions (either via historical or real time data) and suggesting alternative directions
- Providing information on nearby amenities such as restaurants, fuelling stations, etc.

In other words, all GPS devices can answer the question "Where am I?", and may also be able to answer:

- Which roads or paths are available to me now?
- Which roads or paths should I take in order to get to my desired destination?

- If some roads are usually busy at this time or are busy right now, what would be a better route to take?
- Where can I get something to eat nearby or where can I get fuel for my vehicle?

4.5.2.1 Dedicated GPS navigation devices

Dedicated devices have various degrees of mobility. Hand-held, outdoor, or sport receivers have replaceable batteries that can run them for several hours, making them suitable for hiking, bicycle touring and other activities far from an electric power source. Their screens are small, and some do not show color, in part to save power. Cases are rugged and some are water resistant.

Other receivers, often called mobile are intended primarily for use in a car, but have a small rechargeable internal battery that can power them for an hour or two away from the car. Special purpose devices for use in a car may be permanently installed and depend entirely on the automotive electrical system.

Manufacturers include:

- Navman products
- TomTom products
- Garmin products
- Mio products
- Navigon products
- Magellan Navigation consumer products
- TeleType products

4.5.2.2 Mobile phones with GPS capability

Due in part to regulations encouraging mobile phone tracking, including the majority of GPS receivers are built into mobile telephones, with varying degrees of coverage and user accessibility. Commercial navigation software is available for most 21st century smart phones as well as some Java-enabled phones that allow them to use an internal or external GPS receiver. Some phones with GPS capability work by assisted GPS (A-GPS) only, and do not function when out of range of their carrier's cell towers. Others can navigate worldwide with satellite GPS signals as a dedicated portable GPS receiver does, upgrading their operation to A-GPS mode when in range. Still others have a hybrid positioning system that can use other signals when GPS signals are inadequate.

The system uses gps one technology to determine the location, and then uses the mobile phone's data connection to download maps and calculate navigational routes. Other products including iPhone are used to provide similar services. Nokia gives Ovi Maps free on its smart phones and maps can be preloaded. GPS navigation applications for mobile phones include Waze and Google Maps Navigation. Google Maps Navigation included with Android means most smart phone users only need their phone to have a personal navigation assistant.

4.5.3 Commercial Aviation

Commercial aviation applications include GPS devices that calculate location and feed that information to large multi-input navigational computers for autopilot, course information and correction displays to the pilots, and course tracking and recording devices.

4.5.4Radio Navigation

A radio direction finder or RDF is a device for finding the direction to a radio source. Due to radio's ability to travel very long distances "over the horizon", it makes a particularly good navigation system for ships and aircraft that might be flying at a distance from land.

Rdfs works by rotating a directional antenna and listening for the direction in which the signal from a known station comes through most strongly.

In navigational applications, RDF signals are provided in the form of radio beacons, the radio version of a lighthouse. The signal is typically a simple AM broadcast of a morse code series of letters, which the RDF can tune in to see if the beacon is "on the air". Most modern detectors can also tune in any commercial radio stations, which is particularly useful due to their high power and location near major cities.

Decca, OMEGA, and LORAN-C are three similar hyperbolic navigation systems.

Decca was a hyperbolic low frequency radio navigation system that was first deployed during World War II when the Allied forces needed a system which could be used to achieve accurate landings. As was the case with Loran C, its primary use was for ship navigation in coastal waters. Fishing vessels were major post-war users

The OMEGA Navigation System was the first truly global radio navigation system for aircraft, operated by the United States in cooperation with six partner nations. OMEGA was developed by the United States Navy for military aviation users. It was approved for development in 1968 and promised a true worldwide oceanic coverage capability with only eight transmitters and the ability to achieve a four mile (6 km) accuracy when fixing a position.. Later, it was found useful for submarines. .

LORAN is a terrestrial navigation system using low frequency radio transmitters that use the time interval between radio signals received from three or more stations to determine the position of a ship or aircraft. The current version of LORAN in common use is LORAN-C, which operates in the low frequency portion of the EM spectrum from 90 to 110 khz.

4.5.5 Radar Navigation

When a vessel is within radar range of land or special radar aids to navigation, the navigator can take distances and angular bearings to charted objects and use these to establish arcs of position and lines of position on a chart. A fix consisting of only radar information is called a radar fix.

Types of radar fixes include "range and bearing to a single object, two or more bearings, tangent bearings, and "two or more ranges.

Parallel indexing is a technique defined by William Burger in the 1957 book The Radar Observer's Handbook. This technique involves creating a line on the screen that is parallel to the ship's course, but offset to the left or right by some distance. This parallel line allows the navigator to maintain a given distance away from hazards.

Special technique, known as the Franklin Continuous Radar Plot Technique, involves drawing the path a radar object should follow on the radar display if the ship stays on its planned course. During the transit, the navigator can check that the ship is on track by checking that the pip lies on the drawn line.

4.5.6 Micro Computers

Microcomputer, an electronic device with a microprocessor as its central processing unit (CPU).Microcomputer was formerly a commonly used term for personal computers, particularly any of a class of small digital computers whose CPU is contained on a single integrated semiconductor chip. Thus, a microcomputer uses a single microprocessor for its CPU, which performs all logic and arithmetic. The system also contains a number of associated semiconductor chips that serve as the main memory for storing program instructions and data and as interfaces for exchanging data of this sort with peripheral equipment—namely, input/output devices (e.g., keyboard, video display, and printer) and auxiliary storage units. Smaller microcomputers first marketed in the 1970s contain a single chip on which all CPU, memory, and interface circuits are integrated.

High-performance microcomputer systems are used widely in business, in engineering, in "smart" or intelligent machines employed in the factory and office, and in military electronics systems.

In the early 1990s, small computers that fit in a pocket yet provide the power of a desktop personal computer were introduced. These pocket, or palm-sized, computers, commonly known as personal digital assistants (pdas), are distinguished by their high portability, enhanced performance, and low cost. Similarly, microprocessors began finding their way into cellular telephones and portable MP3 music players.

As personal computers started including multiple processors in the 2000s,microcomputer began to be relegated to descriptions of small "embedded" computers found in various electronic devices.

There are many generations of particular design and technical specification from the start of this particular design

1. Super computer 2.Mainframes 3.Minicomputers

4. Microcomputer 5.Termials 6.Embedded computer

The ranking of a micro is as you can see on the low end of computing but very popular and easy to use

Notebooks

- Notebooks, among the smallest microcomputers, can weight less than a kilogram. These ultra-portable units allow for easy setup in a classroom; they connect to the Internet via a cable or integrated Wi-Fi terminal. Most notebooks, these days have built-in microphones and webcams for video conferences.

Laptops

- Laptops are slightly bigger and heavier than the notebooks. Although laptops and notebooks have similar performance, the laptops have larger screens and are more convenient for longer work. The advantage of the laptop comparing to other microcomputers is its portability and easy access to the Internet. Many companies have problems with their laptop batteries. Some are not durable and can overheat and sometimes even explode.

Desktops

- Desktops are bigger and can perform more complex operations than notebooks and laptops. These microcomputers have separate components -- the system unit, keyboard and monitor. Desktop microcomputers are generally cheaper than laptops or notebooks. The desktops tend to be reliable and easy to repair. If a component fails to work, you can replace it more easily than you could its counterpart in a laptop or notebook.

Tower Computers

- Tower minicomputers have their power supply, motherboard and mass storage device stacked on the top of each other in a cabinet. In contrast to desktop minicomputers, wherein components are packed into a more compact box, tower computers offer the main advantage of having fewer space constraints for easier additional installation. Mini-tower microcomputers have system units that stand beside the monitor, while full-tower microcomputers have higher and wider units.

Check Your Progress:

Q 5: What is GPS Navigation?

Q 6: Fill in the blanks:

a. ____________ is a terrestrial navigation system using low frequency radio transmitters

b. Garmin is the type of ________ Device

C. is a device for finding the direction to a radio source

Q 7: Full Forms

a. CDF __________

b. GPS __________

WEB ENABLED GIS & RS MAPPING

4.6.1INTRODUCTION

The integration of GIS and Internet technologies is allowing GIS professionals to solve one of the most important problems inhibiting information utility: How to provide access to information and data without burdening end users with complicated and expensive software.

Internet is a perfect means of GIS data accessing, analyzing and transmission.

The World Wide Web, FTP (file transfer protocol) and HTTP programs make it convenient to access and transfer data files across the Internet. The Internet provides GIS users easy access to acquire GIS data from diverse data source in distributed environment. GIS users can use and download the data by sending the request through web browser application.

Open source web mapping provides people to digital geospatial data and teach them how to collect, manage and analyse these data to produce useful information. Some understanding of geography or earth science is advantageous and basic computing skills are required. New knowledge gained will include how to process digital imagery of Earth's surface and how to operate a GIS efficiently.

4.6.2Internet/web Environment

The internet is a vast communications network that today links together more than 4 million computers all over the world. Krolcoined the term "Internet", to a global network of computers connected through communication devices to one another for information sharing;

All computers on the Internet communicate with one another using the Transmission Control Protocol/Internet Protocol suite, abbreviated to TCP/IP. Computers on the Internet use client/server architecture;

The World Wide Web (WWW) is a system of Internet servers, which was developed in 1989 by Tim Berners-Lee of the European Particle Physics Lab (CERN) in Switzerland

4.6.3Web GIS Can do....

The World Wide Web is fast becoming a standard platform for Geographic Information System (GIS). It is a means for GIS users to exchange GIS data, conduct GIS analysis and present GIS output in the form of maps.

Internet has facilitated three major changes in GIS:

- Access to data;
- Transmission of data; and
- GIS Data analysis.

The Internet GIS applications provide all or almost all functionalities of traditional GIS software. In addition, it has additional functions that take advantage of the Internet and its associated protocols. The user of Internet GIS application can use traditional GIS tools for

Analyzing their data without having any specific GIS software

4.6.4Components of web GIS mapping

A client/server application has three components:

- Client,
- Server, and
- Network

The client sends a request to the server, which processes the request and returns the result to the client, the client then manipulates the data and/or results and presents to the user. Internet GIS applies the client/server concept in performing GISanalysis tasks.

4.6.5Web GIS Basic Properties

- Web GIS technology is dynamic, for example, once any client (s) or database administrator updates the data or information at server end, it will available for all the clients on web at the same time.
- The Internet GIS can also link with real time information, such as satellite images, traffic movements and accident information by real time connection with the relevant information sources.
- The applications developed are cross-platform and accessible through any web browser.
- The Internet GIS applications can categorize into two major categories'.Server-side applications and client-side applications. Server-side applications rely on GIS server

(usually reside on a remote server) to perform all GIS analysis, while client-side applications perform GISanalysis and processing in the Web browser on the user's local machine.

4.6.6Types of Internet GIS Applications

- Data Sharing and disseminations; Raw GIS data, requires installed software & expertise to use
- Geospatial Information Sharing and publishing Often includes cartographic representations Can produce single purpose human-readable images
- Web Data Services Produce machine-readable geospatial information
- Distributed Analysis Functions (GIS Anywhere);
- Interoperable GIS Web Services (GIS Anyone Anywhere).
-

4.6.7Open Source Web Mapping

1) **OpenLayers**
JavaScript library that is open source for displaying GIS data within a browser environment. OpenstreetMap uses openlayers for its main map display (aka the "Slippy Map")

2) **TileMill**
Built on open source libraries (Mapnik, node.js, backbone.js,express and code mirror). The Chicago Tribune included tilemill in a series entitled *Making Maps* using postgis, Mapnik, tilemill, and Google Maps

3) **Geomajas**

Geomajas is an enterprise-ready open source GIS framework for the web. It has client-server integration for displaying and editing of geographic data.It is compliant with OGC standards such as WMS, WFS, etc and also supports spatial databases.

4) **Geoserver**

Geoserver is an open source software server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards.
.GeoServer is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high

performance certified compliant Web Map Service (WMS). GeoServer forms a core component of the Geospatial Web.

5) **MapGuide**

MapGuide Open Source is a web-based platform that enables users to develop and deploy web mapping applications and geospatial web services. MapGuide features an interactive viewer that includes support for feature selection, property inspection, map tips, and operations such as buffer, select within, and measure. MapGuide includes an XML database for managing content, and supports most popular geospatial file formats, databases, and standards. MapGuide can be deployed on Linux or Windows, supports Apache and IIS web servers, and offers extensive PHP, .NET, Java, and JavaScript APIs for application development. MapGuide Open Source is licensed under the LGPL.

6) **MapFish**

Mapfish is a flexible and complete framework for building rich web-mapping applications. It emphasizes high productivity, and high-quality development.

Mapfish is based on the **Pylons** Python web framework. Mapfish extends Pylons with geospatial-specific functionality. For example mapfish provides specific tools for creating web services that allows querying and editing geographic objects.

Mapfish is compliant with the **Open Geospatial Consortium** standards. This is achieved through openlayers or geoext supporting several OGC norms, like WMS, WFS, WMC, KML, GML etc...

7) **MapServer**

Map Server is an Open Source platform for publishing spatial data and interactive mapping applications to the web. Originally developed in the mid-1990 at the University of Minnesota, mapserver is released under an *MIT-style license*, and runs on all major platforms (Windows, Linux, *and Mac OS X*).

Check your progress:

Q 8: What is Map server?

Q 9: Fill in the blanks:

a.Geoserver is an open source software server written in ________

b. All computers on the Internet communicate with one another using the Transmission Controlsuite ______

c.includes an XML database for managing content, and supports most popular geospatial file formats,

4.7 Summary

This unit elaborate about Future Geoinformaticsand explain how in future Gis become total usersfriendly, you can download open source gis software even you can edit and update your database online , you don't need to create maps or database you can download free from internet.

4.8 Glossary

- **Data**-- Any collection of related facts arranged in a particular format; often, the basic elements of information that are
- **Database -- L**ogical collection of inter related information, managed and stored as a unit, usually on some form of mass storage system such as magnetic tape or disk. A GIS database includes data about the Spatial locations and shape of geographic features recorded as points, lines, pixels, grid cells or tins as well as their attributes.
- **Data element** -- a logically primitive item of data.
- **Metadata**-- Data about the content, quality, condition, and other characteristics of data.
- **Spatial --** An adjective applied to objects that vary in space in two or three dimensions.
- **Radiowaves**are a type of electromagnetic radiation with wavelengths in the electromagnetic spectrum longer than infrared light.
- **XML** Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is bothhuman-readable and machine-readable
- **HTTP**The Hypertext Transfer Protocol (HTTP) is an application protocol for distributed, collaborative, hypermedia information systems.[1]HTTP is the foundation of data communication for the World Wide Web.
- **Linux**is a Unix-like operating system that was designed to provide personal computer users a free or very low-cost operating system comparable to traditional and usually more expensive Unix systems
- **Dot Net**The Microsoft .Net Framework is a platform that provides tools and technologies you need to build Networked Applications as well as Distributed Web Services and Web Applications.

4.9 Answer to check your progress/Possible Answers to SAQ.

Ans 1. Open source projects typically are worked on by a community of volunteer programmers. Open source GIS programs are based on different base programming languages. Three main groups of open source GIS (outside of web GIS) in terms of programming languages are: “C” languages, Java, and .NET

Ans 2.a. Geographic Resources Analysis Support System, **b.**Generic mapping tool , **c.**Open GIS Consortium

Ans 3. Metadata of the NSDI content and information availability The NSDI Metadata would get evolved from the NSDI Standard and as digital spatial information is populated

1. Search and Location - What data sets hold the sort of data of interest? This enables organizations to know and publicize what data holdings they have.

2. Analysis metadata - Do the identified data sets contain sufficient information to enable a sensible analysis to be made for my purposes? This is documentation to be provided with the data to ensure that others use the data correctly and wisely.

3. Access metadata – What is the process of obtaining and using the data that are required? This helps end users and provider organizations to effectively store, reuse, maintain and archive their Data holdings

There are different levels that metadata may be used for:

Ans 4a. Survey of India, **b**. National Spatial Data Infrastructure, **c**. Geological Survey of India

Ans 5.A navigation system is a (usually electronic) system that aids in navigation. Navigation systems may be entirely on board a vehicle or vessel, or they may be located elsewhere and communicate via radio or other signals with a vehicle or vessel, or they may use a combination of these methods.

Ans 6a. LORAN**, b**. GPS**, c.** RDF

Ans 7aCarin Database Format, b. Global positing system

Ans 8 . Map Server is an Open Source platform for publishing spatial data and interactive mapping applications to the web. Originally developed in the mid-1990 at the University of Minnesota, mapserver is released under an *MIT-style license*, and runs on all major platforms (Windows, Linux, *and Mac OS X*).

Ans 9 a. Java,**b**. Protocol/Internet Protocol,**c.** MapGuide

4.10Reference

1. http://www.nsdiindia.gov.in/nsdi/nsdiportal/questionnaire/THE.pdf

2. http://nsdiindia.gov.in/nsdi/nsdiportal/images/NSDI%20Metadata%20Standard%20Vern-2.0.pdf

3. http://en.wikipedia.org/wiki/Navigation_system

4. To learn GIS using open source software, read Sid Feygin's article *How to Go from GIS Novice to Pro without Spending a Dime* which provides tips and resources.

5. http://gislounge.com/open-gis/

6. http://gislounge.com/open-source-gis-applications/

7. http://www.geomajas.org/

8. http://geoserver.org/display/GEOS/Welcome

9. http://mapguide.osgeo.org/

10. http://mapfish.org/

11. http://mapserver.org

12. http://openlayers.org/

13. http://mapbox.com/tilemill/

14. http://www.isprs.org/proceedings/XXXVIII/part6/papers/Tuohy/ISPRS_CVI_Tuohy[1].pdf

4.11. Suggested Readings

1. Desktop GIS: mapping the planet with open source tools Gary E. Sherman - 2008

2. Encyclopedia of GIS Shashi Shekhar, Hui Xiong - 2007

3. GIS for everyone: exploring your neighborhood and your world with .David Edward Davis - 2003

4.12. Terminal Questions

Q1.Difference Between Open Gis And Licence (Commercial) Gis Software?

Q2.Open GIS Consortium?

Q3.Wright the name of opengis software coming under java tribes.

Q4.what is Grass?

Q5. Explain automobile navigation

Q6. What is NSDI Electronic ClearingHouse?