

## **AN EDUCATIONAL AND TRAINING TOOL FOR GIS AND REMOTE SENSING**

P.Venkatachalam, B.Krishna Mohan and J.K.Suri  
Centre of Studies in Resources Engineering  
Indian Institute of Technology, Powai, Bombay- 400076, INDIA  
Tel (91-22-5767665) Fax. (91-22-5723190)  
Email : pvenk@csre.iitb.ac.in

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### **ABSTRACT**

Economic development of a country depends on a well formulated and effective strategic planning. Most of the data used for resources planning and management are spatial in nature. Geographic Information Systems (GIS) today is one of the major decision making tools in the areas of resources planning and management. Integration of high resolution satellites remote sensing technology with Geographic Information Systems has widened the potential of both these technologies. Transfer of this technology from academic and research community to hard core planners is a major and complex task. The target audience vary from senior level administrators to applications oriented personnel, technicians and computer specialists. Understanding the immense demand for remote sensing specialists and GIS professionals, many universities have introduced graduate level and doctoral level degree programmes in Remote Sensing and GIS. Research organizations and commercial companies conduct a number of tailor made training courses in these areas. Developments in Internal technology have made the GIS capabilities accessible to wider audience globally. In addition to the conventional class room based education and training, there is a good demand for the demonstration kits and self-learning tutors. These tools can provide an effective way for putting across the spatial concepts, intrinsic analytical capabilities and a range of applications. This paper discusses the details of a multimedia based GIS tutor developed at CSRE, IIT, Bombay, India. It is built using Macromedia Authorware 5.0. The topics on GIS and remote sensing are hierarchically grouped into main sections and subsections. Text materials are supported with illustrations and examples to improve the presentation and understanding. Uniqueness of this tutor is that it provides interactive exercises around in-house developed vector and raster GIS, GRAM++. This development is funded by the UNDP project 'GIS Based Technologies for Local Level Development Planning' and Department of Science and Technology, Govt. of India.

### **INTRODUCTION**

One of the spin-offs of space research is Remote Sensing Technology. Remote Sensing is always viewed as an integrated field with GIS technology. Integration of Remote Sensing with GIS can play a pivotal role in strategic efficient planning, resources monitoring, allocation and management, environmental impact assessment studies etc. India is one of the few countries that has made remarkable progress in Space Technology. A series of operational Indian Remote Sensing Satellites have been launched. Integrating Remote Sensing and GIS, a number of national level projects in the areas of natural resources management are being carried out in India. Understanding the capabilities of GIS technology, many planners and administrators are coming forward to adopt this technology in their planning process. The problem in adopting this technology is not the cost of hardware or the availability of GIS software but the acute shortage of trained manpower to handle the technology. Steps have been taken by universities throughout the world to introduce GIS and Remote Sensing technology at undergraduate and graduate level degree programmes. Although public investment in GIS research such as Regional Remote Sensing Laboratories in the (U.K.) and the National Center for Geographic Information and Analysis (NCGIA) in the (USA) has added to the pool of skills, there is still a considerable unmet demand for GIS education (Raper and Green, 1992). The efforts of NCGIA are worth noting, as it is one of the few organizations that has attempted to establish and promote GIS education with core curriculum materials. Additionally, NCGIA is facilitating the development of the Secondary Education Project, a curriculum designed to develop and pool instructional materials and disseminate them through teacher workshops. Similar efforts have been undertaken by the University Consortium for Geographic Information Science to create a standardized GIS curriculum (Baker, 2001). Several technical books and self learning demonstration kits built around commercial packages are available to strengthen GIS education. This paper discusses about an attempt made by CSRE, IIT, Bombay to build an educational and training tool for GIS and Remote Sensing.

## **REVIEW OF GIS TUTORS**

A number of GIS tutors working standalone or built around commercial GIS packages are available internationally. One of the early GIS tutors was ARCDemo developed at Birkbeck College, London, U.K. (Green, 1987). This demonstrator worked around Arc/Info GIS package and illustrated the capabilities of map editing, projection changes, map overlay, buffering and network analysis. Map Analysis Package MAP (Tomlin, 1983) was one of the earliest simple GIS tools demonstrating the raster based techniques in GIS. Many enhanced versions of MAP were released subsequently. IDRISI (Eastman and Warren, 1987) developed at Clark University, USA provided simple techniques to handle raster maps along with tutorials. IDRISI became one of the best training tools internationally for raster based GIS with recent upgrades to Windows platform. With the availability of PC based GIS packages in the Nineties, vendors started releasing self-learning demonstrators around commercial GIS products.

The first comprehensive computer aided learning tool for GIS was created in the Department of Geography, Birkbeck College, London, U.K. (Raper and Green, 1989) and was named GISTutor. This tutor ran standalone on a PC without the need for a full fledged GIS package, presented an overview of GIS functions, provided illustrations through animations and had a flexible structure for all types of users. Detailed descriptions of GISTutor version I and II are given in (Raper and Green, 1992). GISTutor II is a hypertext based system allowing a user to explore a series of linked screens of information covering the basic and advanced topics. A review of GISTutor II has been given in (Stuart, 1995). Geocube 1.5 is one of the well-developed GIS tutors in France by Michel Bernard at SIAGE SABM, and Frame and Phillipe Miellet at Ted-Aliter in 1996. It provides an interactive introduction to GIS and gives a clear understanding of GIS technology. GeoCube is an application developed with Tool book version 3.0 hypermedia authoring system. (Tool Book is a product of Asymetrics Corporation and a run time version of Tool book is provided along with GeoCube.) GeoCube runs on MS DOS and Windows. The topics are categorised under Geographic Information, GIS functionality, GIS Implementation and GIS Technology. GeoCube is very well organized with graphical illustrations, icons and help functions. Clicking on a cube and moving it along the panel to a desired level can control the speed of the illustrations and animations. Some of the texts contain hyperwords, which are highlighted. By clicking on them one can get detailed information on these words. The hypertext approach used in GeoCube provides a framework in which a range of tools can be used to create dynamic teaching material to educate users about GIS.

Geocal is a Windows based GIS tutor developed by Roy Alexander and group at CIT, Centre for Geography, Geology and Meteorology, Dept. of Geography at the University of Leicester, U.K. It is a good tutor for the beginners in the field of GIS. The tutor comprises four units - Introduction to GIS, GIS for utilities, GIS for business and GIS in agriculture. The number of illustrations and examples are very few but self-explanatory with hypertext links for detailed information. After every unit/subunit a simple quiz is provided on important aspects of the topic. Introduction to GIS is given in detail but the other three application units do not provide complete understanding of GIS capabilities.

Keeping into view the need for GIS training in India and the availability of indigenous GIS tool GRAM++, an attempt has been made to build a GIS training tool around GRAM++.

### **GRAM++ GIS**

Under the Natural Resources Data Management System project (NRDMS) launched by Department of Science and Technology, Govt. of India, a PC based GIS package GRAM (Georeferenced Area Management) was developed to handle spatial and attribute data relating to resources management. A module was also provided to process digital remote sensing satellite data. Taking into new the developments in Computer technology, windows operating system environment and standardized graphical user interfaces, decision was taken to upgrade GRAM and build a new version GRAM++ in Windows platform. Object oriented methodology was adopted during the software design and visual programming tools are used for easier usage. GRAM++ package has the functionalities for data import/export, on screen digitization, topology creation, nonspatial data attachment, rasterization, vector query, raster analysis, terrain modelling, watershed mapping, network analysis, digital remote sensing data analysis and cartographic layout.

### **DEVELOPMENT OF GIS TRAINING TOOL**

The GIS training tool has been designed taking into view the requirement of wide range of users. The system has been made fully interactive and the users can proceed step by step. GIS theory is explained through a series of technical topics. Under each technical topic, text materials are explained supported by graphical illustrations, quiz and hands on exercises. Context sensitive help has been provided on technical words for

understanding further details. A few GIS applications are given as show cases explaining the data used, methodology and the results. In addition to spatial theory, a few GIS functions such as network analysis, data base query etc. are explained through graphical animations. A bibliography covering GIS related literature and GIS glossary are also provided. Macromedia Authorware 5.0 Attain has been used in the development of the training tool as it supports hyperlinks between topics, display of graphical images and text and embed animations. The spatial data theory is categorized under 17 broad sections and each section has a series of subsections. At every level graphical illustrations and examples are given to enhance the presentation and understanding. The technical layout and the hierarchical structure adopted in the GIS training tool is presented below.

### **I Introduction**

- Definition
- Components
- Contributing Disciplines
- History
- Why to use GIS
- Data Integration
- Applications

### **II Representation of the World in GIS**

- Map model
- Nature of spatial data
- Map scale
- Co-ordinate system
- Map projection
- Basic Map design

### **III Attributes of Spatial Data**

- Data base models
- Spatial query
- Model based query
- Logical query

### **IV Spatial Data Model**

- Nature of spatial data
- Components of geographic features
- Raster data model
- Vector data model
- Topological structure
- Comparison of models
- Raster data encoding

### **V Data Input**

- Data flow
- Input devices
- Data sources
- Methods of data input

### **VI Data Conversion**

- Spatial data exchange format
- Interoperability
- Raster-Vector conversion
- Geo-registration

### **VII Data Edit**

- Map preparation/scanning
- Map registration
- Onscreen registration
- Error removal
- Topology creation
- Rasterization
- Database creation
- Data verification

### **VIII Data Viewing & Tabular Analysis**

- Analysis of nonspatial data
- View attributes of spatial data objects
- Thematic maps generations
- Statistical map generation

### **IX Spatial Analysis**

- Classification functions
- Measurement functions
- Overlay operations
- Neighbourhood operations
- Connectivity functions
- Cartographic modelling

### **X Digital Terrain Modelling**

- Terrain representation
- Spatial interpolation
- Triangulated Irregular Network
- Visualization
- Intervisibility
- Watershed generation

### **XI Spatial Statistics**

- Descriptive Statistics
- Point based statistical measures
- Area based statistical measures
- Spatial patterns
- Gravity model

### **XII Network Analysis**

- Network model
- Attributes of network
- Connectivity
- Routing
- Location and Allocation

### **XIII Remote Sensing**

- Principles
- Data sources
- Pre-processing
- Enhancement
- Classification
- Integration of Remote Sensing with GIS

### **XIV Output**

- Output devices
- Map design
- Interactive output
- Tables and charts
- Cartographic Map generation

### **XV GPS in GIS**

- GPS data generation
- Role of GPS in GIS
- Applications

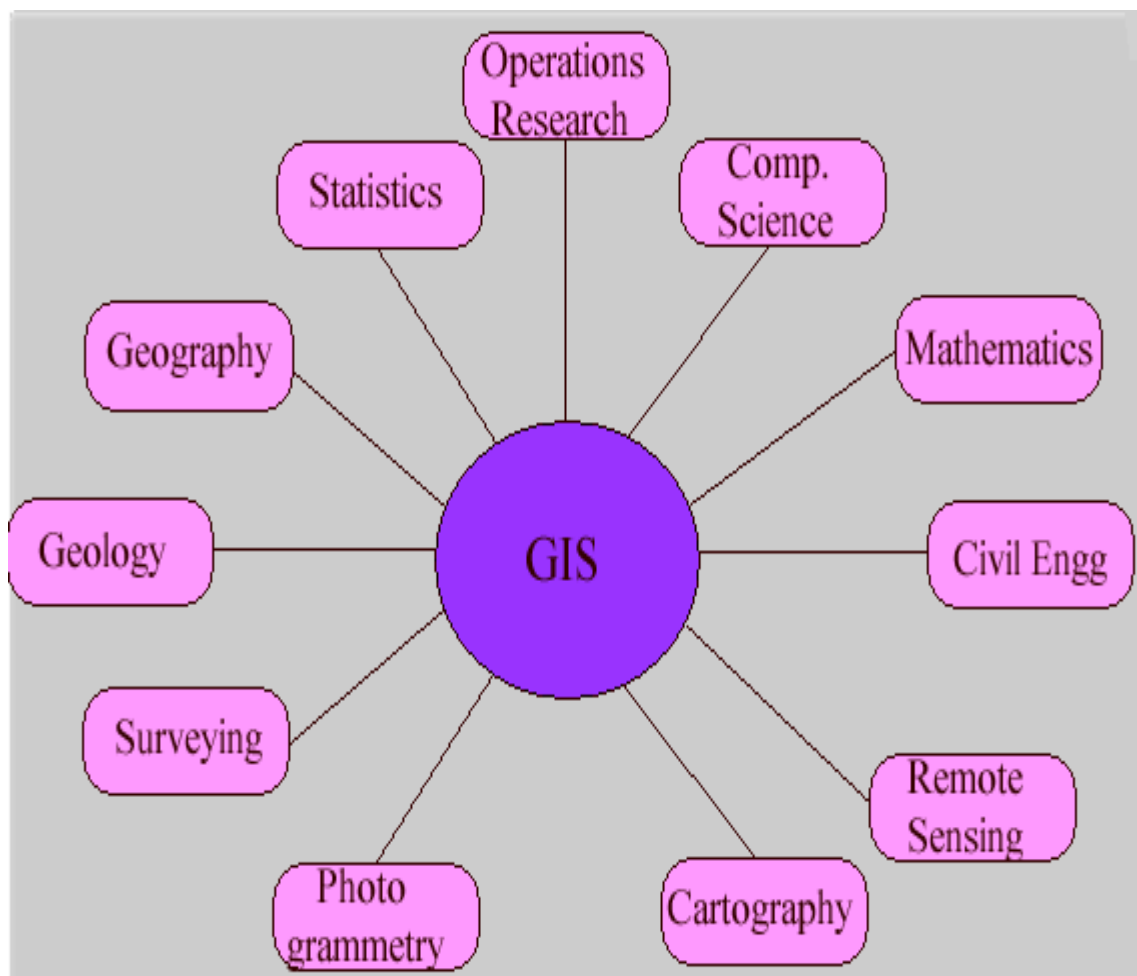
### **XVI Data Quality**

- Sources of errors
- Accuracy test
- Meta data base

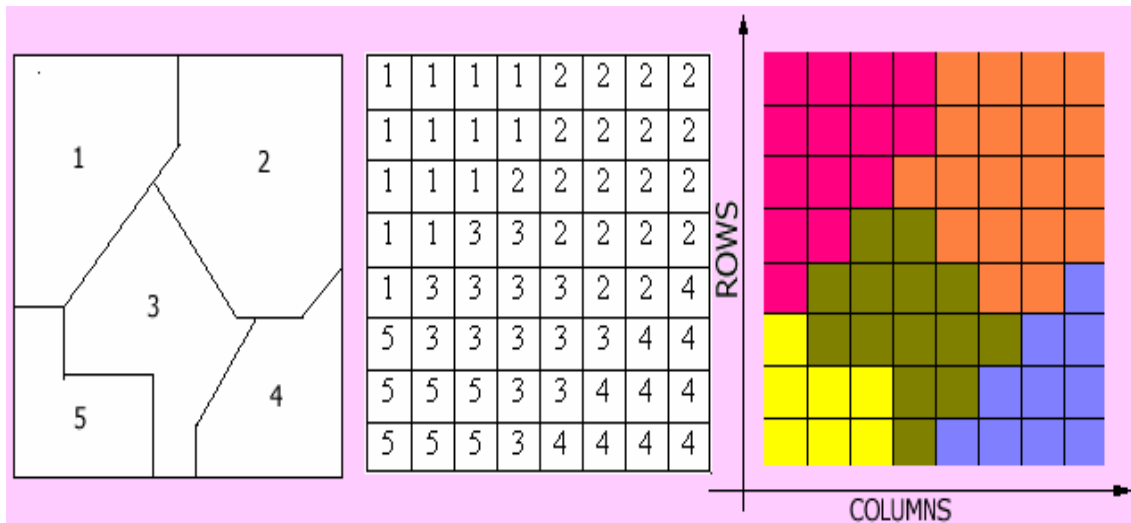
### **XVII Spatial Decision Support System**

- Definition and concept
- Applications

Each technical section is explained briefly with examples highlighting the technical words and assisted with graphical illustrations. (Figure 1 & 2)



**Figure 1 – Contributing Disciplines of GIS**



**Figure 2 - Rasterization**

Some of the functionality is also explained through animations. Quiz and hands-on exercises with test data sets are provided to the users to enhance their understanding on GIS functionality. Following the technical sections case studies on waters resources management, rural land management and spatio-temporal analysis are given as show cases. The training tool also covers a list of GIS journals, books, magazines and www GIS resources and a glossary on GIS terminology.

## CONCLUSION

GIS applications are growing rapidly. With the availability of high resolution remote sensing data, desk top GIS and Internet based GIS, awareness is increasing among the user community on the capabilities of GIS technology. The development of a Multimedia GIS training tool provides immediate exposure to the technology minimizing the initial learning curve. The tool can become a powerful motivator for understanding and using GIS technology in varied applications.

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