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A Geo-Referenced Information System for Tourism (GeoRIST)

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ABSTRACT

This paper presents a geo-referenced information system (GeoRIST) for national and international tourists or the travelling community visiting to Agra enabling them to find their interest in city and ask for information about sights, accommodations and other places of interest which are nearby them by analyzing and displaying the tourism objects in geographic context on interactive tourist maps. The developed system is the application of Internet based Geographic Information System (GIS) which integrates spatial database, statistical data and textual information in order to develop a data model providing proper and complete information for analysis and planning. The whole system lives in a common web-based application implemented in ASP.Net with C#.Net MapScript, Ajax and exploiting MapServer for GIS functionalities and PostGIS for its connection with the PostgreSQL database containing road network, infrastructure of the area and data about hospitality, tourism activities and facilities.

Keywords: Tourism, Information System, Spatial Database, Geographical Information System (GIS), Travel Advice, MapServer.

1. Introduction

There has been a huge development in information technology recently. Both tourism and IT increasingly provide strategic opportunities and powerful tools for economic growth, redistribution of wealth and development of equity around the globe. The tide of informationization and network, which is represented by Internet, has given an excellent opportunity to the tourism industry.

As history of Agra (figure 1) is amply evident from the numerous historical monuments in and around the city, it is a leading destination for tourists. It achieved fame as the capital of the Mughal emperors from 1526 to 1658 and remains a major tourist destination because of its many splendid Mughal-era buildings, most notably the Taj Mahal, Agra Fort and Fatehpur Sikri, all three of which are UNESCO World Heritage Sites. Undoubtedly, one of the most attractive aspects of Agra's tourism is being home to one of the Seven Wonders of the World "The Taj Mahal".

The historical sites, cultural monuments, beautiful nature parks and garden are among the interesting features making it a unique destination for the national and international tourists desiring an eventful trip. Thousands of national and international tourists visit various historical monuments every day and it can be both exciting and freighting for the tourists coming to Agra. Non-availability of comprehensive real-time spatial database of city infrastructure, location-based services and lack of technology driven and demand driven approaches result in tribulations of comprehensive trip plan, travel advice, interactive searching of the places of interest and locating health or other required facilities in emergency.

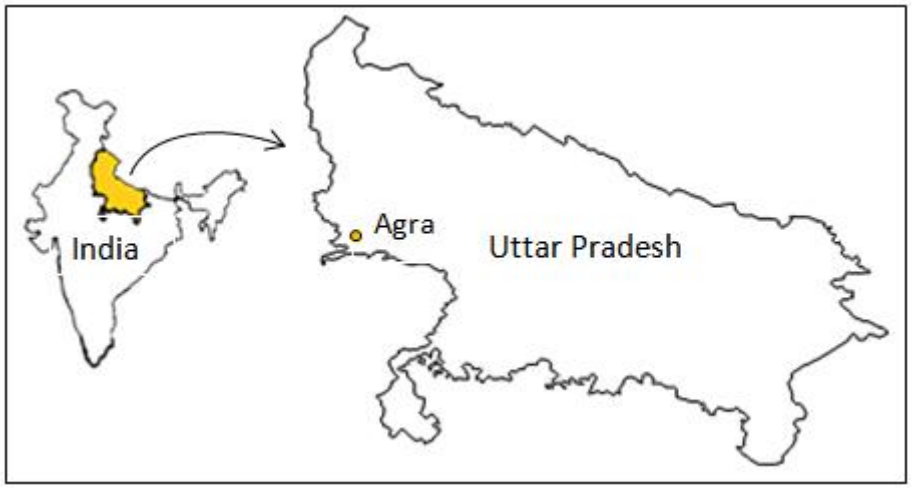

Figure 1: Study Area

Geographic Information Systems help in making effective decisions through modeling and mapping our world. GIS is a system of computer hardware, software, and procedures designed to support the compiling, storing, retrieving, analyzing, and display of spatially referenced data for addressing, planning and management problems. In addition to these technical components, a complete GIS also includes a focus on people, organizations, and standards. Internet GIS provides a perfect tool to access, disseminate and visualize tourism data. Any information that can be displayed on a digital map can be visualized using Internet GIS. The rapid growth of the Internet provides highly customized, accessible and interactive source of public information and is changing the ways that people capture and manipulate the spatial information. The implementation of Internet based GIS will provide interactive mapping and spatial analysis capabilities for enhancing public participation and collaboration in decision making processes. Also, the capabilities of Internet based GIS will made it possible to answer spatial queries using intelligent maps with integrated images, text, tables, diagrams; and showing location of hotels, tourist sites, points of interest, and so forth.

2. Literature Review

GIS is both a database system with specific capabilities for spatially referenced data as well as a set of operations for analyzing the data. The ability to develop higher level thinking and problem solving through the use of GIS gives a better understanding for decision based systems. GIS is a valuable tool for managing, decision making, analyzing, and displaying large volumes of diverse data pertinent to many local and regional planning activities (Avdimiotis and Christou, 2006). Its use in environmental planning is rapidly increasing. Tourism is an activity highly dependent on environmental resources. It is also a phenomenon, which in the event of a lack of planning and management is likely to erode its environmental base. Mcadam (1999) discussed the value and scope of GIS in tourism planning and argued that GIS brings significant added value to decision making through data analysis, modeling and forecasting.

Berger et al (2007) described an e-Tourism environment based on a community-driven approach to foster a lively society of travelers who exchange travel experiences, and recommend tourism destinations. Idris and Yahaya (2009) discussed the design and implementation of a tourism web information system by using web aggregation as the core engine. Anderson and Souleyrette (2002) recommended an approximate dynamic modeling approach to assess traveler information technology deployment by integrating a regional

travel demand model and micro-simulation package in a GIS environment. Minagawa and Nami (1999) applied GIS to locate areas suitable for tourism development at Lombok Island in Indonesia. Turk and Gumusay (2004) carried out GIS design and network analysis by taking advantages of GIS possibilities for tourism. The study was carried out in Eminonu district, where there are a lot of historical and tourist places. Othman et al (2010) addressed the use of GIS technology in developing a database and analyzing data associated with the tourist accommodations in the east coast states of Malaysia; Pahang, Terengganu and Kelantan. Feick and Hall (2000) focused on applying Geographic Information System technology within a customized software design to allow multiple participants from various sectors in West Bay District of Grand Cayman, British West Indies to designate land parcels appropriate for tourism-related development or for a competing land use. Dye and Shaw (2007) presented a GIS-based spatial decision support system (SDSS) application by integrating GIS functions and SDSS designs with easy-to-use graphic user interfaces to help visitors of Great Smoky Mountains National Park (GSMNP) choose and plan their activities more effectively to match their personal preferences and constraints.

Olafsdottir and Runnstrom (2009) developed a methodology to generate a Tourism Decision Support System (TDSS) to aid planning of sustainable tourism. A GIS model was developed based on classification of identified impact factors and variables, as well as selected classification algorithms. Bertazzon et al (1997) discussed the theoretical possibilities of using T-GIS for traditional tourism marketing purposes and also provided a detailed account of the Internet usage to incorporate GIS-based models and graphics as a marketing tool for the Alberta Ski Resort industry. By using a hedonic prices model, Yolanda and Hernndez (2011) estimated the influence of some spatial and environmental variables in the rental prices of rural houses in Gran Canaria, Spain; and recommended that this model could help to orientate the tourist diversification policies applied to the island. The mail capabilities of the GIS are to integrate large volumes of spatial and non-spatial data and enhance problem understanding through data visualization in the form of maps.

In this paper a geo-referenced information system (GeoRIST) for tourism has been developed to customize tourist's individual needs and preferences and be available to them while being on the move.

3. Development of Geo-Referenced Information System for Tourism (GeoRIST)

Geographical information system (GIS) and tourism share a common characteristic, that is, both cross the boundaries of disciplines and application areas. As tourism destinations are characterized by three different landscape features: points, lines, and polygons, the system uses point features for individual tourist attractions, for example, a campground in a park, or a historic site along the highway. Coastal beaches and resorts often follow a linear pattern, while big theme parks or natural parks are characteristics of a polygon feature. These locational attributes are essential to a geographic information system. The developed system (GeoRIST) will strengthen tourism planning by integrated GIS and will help in extracting different sets of information from a map and use them as required. Figure 2 demonstrates that how the tourist will interact with the developed system.

3.1 System Architecture

There are basically two types of architectures followed by the geographical information system applications: client-side and server-side.

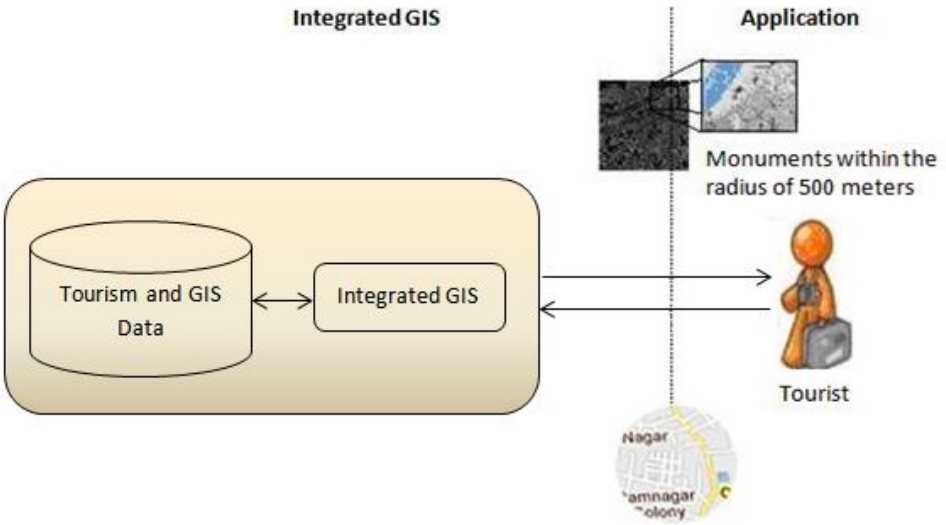

Figure 2: Interaction between tourist and GeoRIST

- Server-side architecture allows users (clients) to submit request for data and analysis to a web server. Server processes the request and returns data or solution to the remote client.
- Client-side architecture allows the user to perform some data manipulation and analysis locally on their machines.

GeoRIST is a server-side application following three-layer architecture with user interface layer, logic layer and data layer. The user interface layer translates task to help tourists easily know the information related to tourism. This topmost level of application structure interacts with other layers by providing results to all other layers in the computing network. The logic layer controls the operation of the application by processing commands, evaluating and calculating specific data. The information from user interface layer is later stored in the database servers of the data layer and this stored information is then transferred back to the logic layer for further processing and ultimately to the user's computer system.

This architecture absorbs the substantial loads from the network since a lot of requests do not reach the server but the different layers which are loosely coupled with each other and changes made in one do not hamper performance of others and assists the users in performing their jobs efficiently and effectively.

3.2 Database Design

The geographical information system data involves both the spatial data and attribute data; the spatial data being a database that is in some way referenced to locations on the earth that describes the spatial properties of the objects and attribute data consisting of additional information like images, texts etc to the spatial data. GIS can be regarded as the high technology equivalent of map in the field geography. An individual map contains a lot of information which is used in different ways by different individuals and organizations. Map represents the means of locating oneself in relation to the world reference point. In the traditional form, a map suffers from a number of problems. Firstly maps are static and therefore difficult and expensive to keep to date. Secondly maps exist at discrete sheets and therefore the areas of interest of a map use lies on the corner of the four adjacent. Thirdly, maps are often very complex and may require an expert to extract a particular data which are of interest.

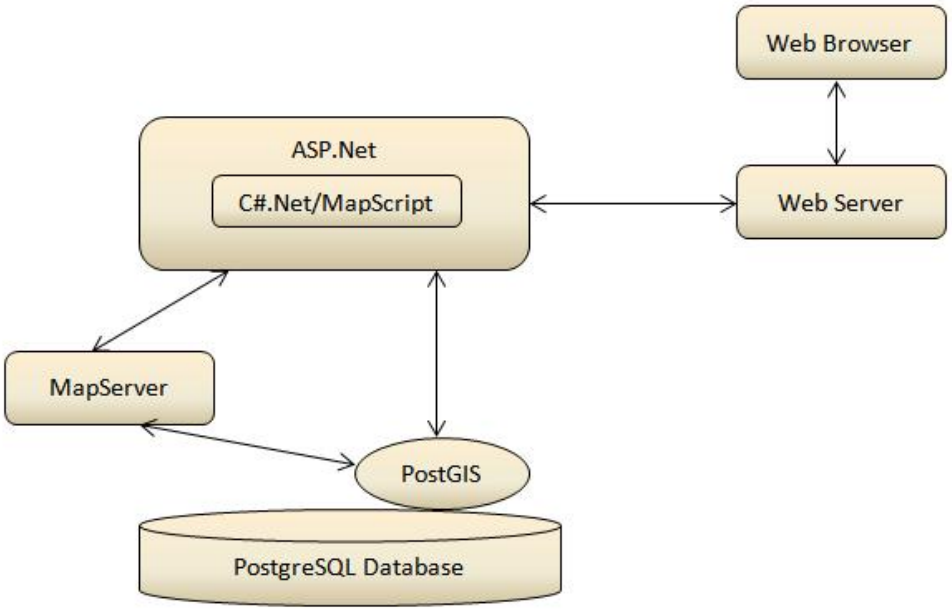

Figure 3: Organization of Geo-Referenced Information System (GeoRIST)

In order to overcome the above problems of maps, the digital maps are developed in the form of shape files for various tourism facilities like hotels, points of interests, roads, and historical monuments using DIVA-GIS and Quantum GIS (open-source GIS for mapping and geographic data analysis) to provide enhanced cartographic representation. Quantum GIS provides flexibility, allowing a paper map to be quickly produced which exactly meets the needs of the user. Using PostGIS loader these shape files are converted to their corresponding tables in a PostgreSQL database which is structured to follow a relational database model format. The attribute information relating to these map layers and tourism facilities is linked to their respective spatial features.

3.3 User Interface

The user interface design makes the user's interaction as simple and efficient in terms of accomplishing user goals. It allows the users to select and input the query criteria in order to view the required tourism data. In the GeoRIST, which is developed using ASP.Net with C#.Net Mapscript (a scripting interface for MapServer), Ajax and MapServer (open source web mapping), the user interface is made up of a series of ".aspx" files, which are rendered to the browser using standard HTML. Designing the user interface is the process of:

- Deciding which pages are required and in what sequence it is required
- Populating those pages with the appropriate controls

Figure 4 demonstrates one of the views of GeoRIST's user interface with functionalities of zooming, panning, querying, layer selection on map and various navigational links on it enabling the users to view the tourism map and associated data with adjustable scale.

Figure 4: User Interface with Map

3.4 System Components

GeoRIST is formed by five different component programs:

- Minnesota MapServer 6.0.1 GIS engine;
- Internet Information Server (IIS) 6;
- A browser;
- PostgreSQL 8.4 DBMS;
- PostGIS 1.5 DB spatially enabling support.

Normally a web-based GIS can be implemented using GIS engine, web server and web browser but PostgreSQL and PostGIS are used to store the data as database tables in particular.

3.4.1 MapServer

MapServer 6.0.1 is an open source geographic data rendering engine (program) created by University of Minnesota and now it is a project of OSGeo (Open Source Geospatial Foundation). It can run as a Common Gateway Interface (CGI) program or via MapScript which support several programming language and C#.Net in particular. It acquires and processes requests coming from the users and returns them output results. The heart of the MapServer is a Mapfile which defines the relationships between objects; points MapServer to where data are located and defines how things are to be drawn. It is implemented using MapServer software's built-in object oriented scripting language with which it is possible to

design how to create and use the maps and their layers. In particular, layer objects, paths and connection types for data loading are specified in the Mapfile.

3.4.2 Interaction of PostgreSQL and PostGIS with MapServer

Because the tourism and GIS data has been stored in PostgreSQL database tables, PostgreSQL becomes an indispensable system component from which the GeoRIST loads data to be displayed in the maps.

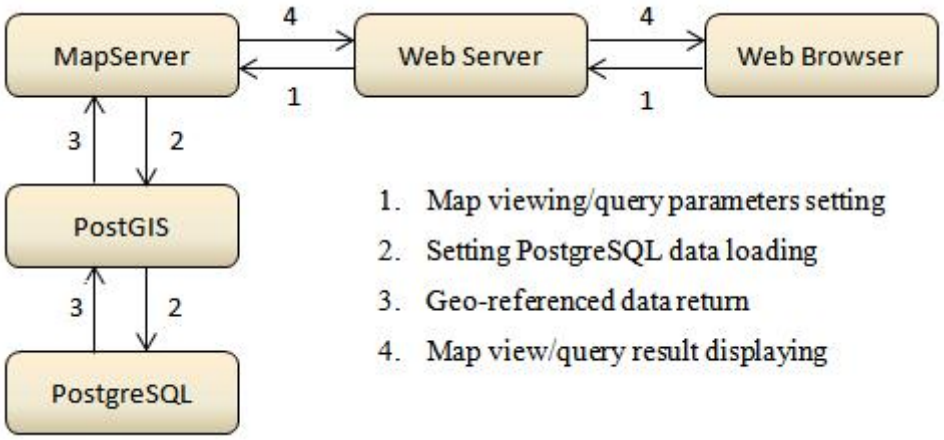

Figure 5: Interaction of PostgreSQL and PostGIS with MapServer

This loading is possible only when the tables are geo-referenced. For this each PostgreSQL table has been provided with a geometry column, in which every record has its spatial description. This geometry column has been added using the PostGIS functions making a table as spatial tables. These tables are called by MapServer using the Mapfile PostGIS connection. Therefore, for loading spatial tables it is enough to specify in a Mapfile layer object: the PostGIS connection; the connection parameters; the name of the spatial table and its geometry column and the loading filter (SQL query). In this way MapServer accesses PostGIS/PostgreSQL data like any other PostgreSQL client and it can display PostgreSQL table's features using PostGIS as spatial enabling support. The coupling of MapServer to PostgreSQL/PostGIS enables the tourists to manipulate or query the spatial tables and be able to see the results using MapServer maps.

4. Results and Discussion

The developed system is a geo-referenced information system based on Internet that is capable of answering questions about where facilities and resources are located and thus represents enormous benefits. It will provide the tourists to answer the fundamental questions that affect much of human endeavor like: "*Where is it? How do I get there*?" by:

- Displaying map layers with associated information with adjustable scale
- Interactive searching of the places of interest like hotels, cinemas, offices, parking lots etc. on map
- Proximity analysis (locating closest available facility such as offices, hospitals etc. on map)
- Providing a cost effective means to disseminate useful geographically referenced information to the target users

- Accessing through a wide range of Internet enabled electronic media like desktop computer at home, offices and shops, pocket PCs, and smart phones
- Providing a standard way to access to GIS data and functions across the network, from any location and by any user, without the need to buy expensive GIS software

The implementation of such a system for tourism will provide almost unlimited access to information to everybody, who has technical possibilities to connect with the Internet helping them in taking better decisions to plan their itinerary in Agra.

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