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Interactive Road Information System of a Modern City: A GIS and GPS-Based Approach

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Abstract This paper conveys the suitability and applications of GIS and GPS technology in the development of an interactive Road Information System (RIS) for a modern city, which will help the planners and administrators to identify the problems associated with rural road development activities, location and provision of appropriate facilities, monitoring and maintenance management of the assets created in the rural areas. This RIS provides an interactive information database that consists of a range of available utility services within the selected road network. This interactive system provides the end-users a list of query-based services. These query-based services include the road connectivity between any two selected points, informations about distances and accessibility, buffering-based information bank and related proximity analysis etc. It will also provide necessary details about different network analysis-based route information (e.g., alternate route, shortest possible route, finding closest facility etc.) in any selected area during various emergency situations.
Keywords *Information Database; Interactive Road Information System; Query-Based Services; Road Information System; Utility Services*

1. Introduction

In modern day world, there is a requirement of creating a live, up-to-date & well-managed digital database of Road Information System (RIS) for the planning of proper infrastructure building in any modern city. This digital database can be used for understanding and verifying proper and updated road connectivity in a modern city. It can also check the accessibility of the available road network with various public utility services. This system can enhance the efficiency of end-users to monitor and to manage the available road network and thereby, helping them to plan and develop the existing road network of a modern city.

A recent technical report [3] suggests that Remote Sensing (RS), Geographic Information System (GIS) and Global Positioning System (GPS) are now being used as alternate technology for the inventory survey, planning and management of natural resources and monitoring of environmental

change. Data acquired with RS technology would provide information over a large area about urban environment and land use changes. It is necessary that spatial resource information derived from RS techniques should be suitably integrated with the data generated through conventional methods and fields survey. A recent study [1 & 2] concluded that GIS facilitates an environment, where RS data can be integrated with other spatial and non-spatial information and provides various GIS functionalities for analysis of various planning purposes with these integrated information.

The objectives of this study are identified as follows:

(a) Preparation of GIS maps of National Highway, Major and Other District Roads and Urban Roads.

(b) Preparation of location-specific GIS maps for different public utility services (e.g., hospital and medical facilities, banks, police stations, fire-service stations, educational institutes, market places, post-offices, airports, railway stations, bus-stations, etc.), showing their connectivity and accessibility within the existing road network.

(c) Development of query-based services based on buffering and related proximity analysis; and network analysis-based route information (e.g., alternate route, shortest possible route, finding closest facility etc.), that can be used efficiently during different emergency situations (e.g., natural calamities, movement of civil authorities during election etc.).

2. Study Area

Agartala [5] is the capital of Tripura, as well as the district headquarter of West Tripura district. West Tripura is one of the four districts of Tripura. Agartala is located at 23.84° N 91.28° E and has an average elevation of 16 meters. City has a total population of 1,89,998 (census 2001), which covers a total geographic area of 58.84 Sq.km.

3. Data Used

Data used for the study are divided into three categories. They are: (a) Spatial data, (b) Non-spatial data and (c) Ground truth data. Spatial data includes (i) Remote Sensing data, (ii) Topographic maps (1975), (ii) Land Record maps/PWD road maps. For Remote Sensing data, IRS-P6 L4 MX with a spatial resolution of 5.6m used for the map preparation of transportation network, drainage, amenities, locations, bridges etc. Topographic maps (1975) of 1:50,000 & 1:250,000 scale have been used for the preparation of base maps for obtaining base line information such as transportation network, drainage, bridges, locations etc. for the entire study area. Recent updated land record map and PWD road map (2005) is used as a reference for the updation of base map. Non-spatial data includes (i) Census data (2001), (ii) Socio-Economic data, (iii) recent PWD road register [6] and (iv) recent transportation data.

For Ground truth data, Differential GPS (DGPS) has been used for the collection of Ground Control Points (GCPs). DGPS and other single handed GPS have been also used for road survey and data collection of various public amenities like Educational institute, Medical facilities, Post Office, Fire Service, Police Station and Places of Interest etc.

4. Methodology

The methodology of this study uses the design standard of parameters and database, defined by [4]. For base-map preparation, scanned Land record and PWD maps were registered to the available topographic maps (1:50,000) and necessary details were extracted. Satellite image of IRS-P6 L4 MX (multi spectral; resolution of 5.8m) of the study area has formed the core of the 1:12,500 mapping of

RIS. It was geometrically corrected and registered with reference to LANDSAT ETM (2006) data. Finally all the remote sensing data were corrected based on Ground Control Points (GCPs) collected with the help of Differential Global Positioning System (DGPS). Necessary image enhancement techniques were used for better interpretation of roads, drainages and other land use features in the satellite imagery. During the field survey, hardcopy map of Road Network overlaid with Drainage and Settlement layers has been carried into the actual ground along with the PWD road map. Necessary spatial layers such as road network, drainage network, locations, amenities, and bridges were generated from remote sensing, topographic maps and PWD road maps. After ground truth verification, all the thematic maps were corrected as per field survey data and finalized the thematic mapping. Integration of spatial and non-spatial information has been done under GIS environment.

5. Results and Discussion

In this section, the main results and observations of the study are summarized point-wise, as follows:

(a) Total area of study (i.e., of Agartala City) is 58.84 Sq. Km, which has a total PWD road length of 264.846 Km, as per PWD road register of 450.12 Km/100 Sq. Km. road density.

(b) The city has a part of the Assam-Agartala National Highway No. 44, with total road length of 6.169 Km, which is a completely blacktop road. Agartala City has 239.856 Km of urban road, out of which 96.897 Km is un-metalled. About 91 % of total roads in Agartala City are falling under Urban Road category. National highway comprises only 2 % of the total roads in the city, whereas major & other district roads in the city area are only 3 % & 4 % respectively. About 63 % of total roads in Agartala City are bituminous roads and well maintained, whereas Brick-soled & Mud roads in the city area are only 28 % & 9 % respectively.

(c) Agartala city has a total drainage network of about 15.642 Km. Both of the drainage comes under the category of Perennial River. Howrah River flows through the southern part of the city, where as Katakhal river passes through the city in the north. There are 16 major bridges over the Howrah River and Katakhal River.

(d) Various query-based services (e.g., distance, connectivity and accessibility of various public amenities from a given isolated place, road connectivity between any two points) have been developed during this study, considering existing road network of Agartala city. For example, only one medical facility is connected by the National Highway, whereas 54 nos. of educational institutes in the city are connected by the urban road. Although this study implies that Agartala has a very good connectivity and accessibility to the various public amenities, utility services, tourist spots etc. by well-maintained road.

(e) Apart from thematic mapping of road infrastructure, following value-added services based on user query are also incorporated into this study – (i) Proximity analysis for road connectivity and distance accessibility between any two points. (ii) Network analysis for alternate route finding or finding out closest facility based on time impedance.

6. Conclusion

RIS of any modern city can serve as an efficient tool for decision making with respect to any urban development programme. Various value-added services, such as query capability, like road connectivity between any two points, distance and accessibility (of various amenities from a given isolated place), information bank based on buffering and proximity analysis, route information like shortest route, alternate route etc. in the existing road network have been incorporated. The interactive

digital database of RIS can be further developed by incorporating updated information as and when it is available to the system.

This study has confirmed the need for road network planning in the city, in an organized manner and this is the first step towards the development of the city. RIS developed under GIS environment has efficiency in monitoring, management, planning and subsequent development of the road network in the Agartala City.

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