A Review on Application of RS & GIS in Transportation Engineering

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A B S T R A C T

Transportation system of a country represents the development stage of a country. Many countries are facing major problems of transportation management and they have been spending lots of money and putting efforts to solve them. Due to the urbanization, there has been a phenomenal increase in traffic congestion and issues related to the usage of transit services. Ultimately there is a need for application of new techniques which will be able to contribute to the transportation engineering and solve the problems by saving time and money. Remote Sensing (RS) and Geographic Information System (GIS) is one such technique which will be used various ways such as solving the traffic congestion issues, land use planning through geomorphological mapping and improving the decision-making process. It is used for urban planning, resource distribution, planning of retention, Highway Designing, land use land cover classification. These paper reviews the application of RS & GIS in transportation engineering.

Keywords: Remote Sensing (RS) & Geographic Information System (GIS), Transportation management, Geomorphological mapping

1. INTRODUCTION

1.1 General

Remote Sensing is a science of acquiring, processing, and interpreting images and related data that are obtained from ground-based, air or space-borne instruments that record the interaction between matter and electromagnetic radiation. It is the process of acquisition of data information of object or targets, which is located on the earth's surface. For this, sensors are used which are placed on the satellite.

Geographic Information System stores, analyses and displays data related to positions on Earth's surface. GIS helps in understanding spatial patterns and relationships by relating to different types of data. It can also create, manage and map all types of data. It is used in different fields such as agriculture, environment, urban planning, health care, education etc... It can also helpful in studying geological features, monitor air quality, plan transportation networks, map disease outbreaks and visualize geographic data.

Remote sensing (RS) and Geographic Information System (GIS) are linked feature extraction and analysis of ground surface data without coming in physical contact with the surface and it is used for urban planning, resource distribution, planning of water retention structures, detecting changes, hazards monitoring mapping extent and estimating the damages. Considering the maintenance, it plays a major role in inspection and preparing reports as it requires more involvement of people which costs huge amount of money. Assessment of structural cracks such as crack detection, location, pattern etc... will be done using image processing and laser scanning method.

Sustainable infrastructure planning or strategy is achieved when the spatial entity is associated with the non-spatial attributes and it acts as a key factor for applying GIS technology as a tool in supporting transportation network analysis or planning. In the GIS platform, the database of transportation network is normally extended by integrated with attribute and spatial data.

1.2 Application of RS & GIS in Transportation Engineering

RS and GIS technology is useful in management functions and decision support systems which are helpful in the planning process of urbanization and it can support a variety range of planning, analysis and decision support system operations which can make a phenomenal effect to the development of growth of urban areas. In transportation planning by using mapping tools for primary data such as Toposheets as well as the Satellite and airborne images. Various applications of GIS can be used for identification of road network area and change detection in road and it can also be used to detect the distance between one place and another place and also responsible for detecting the shortest path between two or more places. Major problems like traffic control includes this application to generate the traffic control mechanism which provides the fastest route.

Increase in the urbanization leads to the complexity of urban development which demands immediate attention and perspective physical planning of the cities and towns. It is necessary and fundamental to integrate remote sensing into urban planning and management. Traditional approaches and techniques

designed for towns and cities are inadequate when dealing with metropolis. Rather than using maps and land survey records usage of digital, multispectral images acquired by EOS and other sensors are found to be comparatively efficient.

The study of landforms on the earth is called Geomorphology. Landforms on the earth surface are expensive to map or monitor. Hence, remote sensing observations from space platforms provide a synoptic view of terrain on images. They are interpreted on the basis of interpretation element keys such as tone, texture, size, shape, color etc. and the specific information is extracted from the false color composites LISS-III sensor images. Apart from these above geomorphic units, alluvial plain, structural hills and residual hills are mapped using IRS-ID LISS-III satellite imagery using visual interpretation technique along with field check. Government authority can make a decision to land use planning for human activities based on geomorphic mapping.

Many applications like Google Earth can show the route between two selected places by using only major roads and these routes don't consider the obstacle like damage of road, accident and flood. In order to overcome this problem ArcGIS software can be used. The data collected from Google Earth and geo referenced in ERDAS will be represented using this application. The application can show the shortest path between the two points including all pros and cons of those roads. Network analysis on a line theme can be performed using Arc View to build the topology. Raster based images are georeferenced and several small images are integrated into a single image for further analysis. Application of GIS in road network analysis includes the primary data from the survey of India (map of scale 1:2000). Further the map is georeferenced using control points and digitized in ArcGIS software. After the digitizing of primary data, a network analysis task was performed and the bus routes are analyzed which helps in route tracing and also in the creating the shortest path between two or more places. A GPS receiver and GSM modem with microcontroller interface is placed in each bus and this device was used to send message to control station and modern or cell phone receives and gives input to the computer.

Remote sensing is the main source for several kinds of thematic data critical to GIS analyses, including data on land use and land cover characteristics. Land cover distribution and existing geospatial features are evaluated using Aerial and Landsat satellite images. The importance of remote sensing in GIS has expanded significantly with the introduction of remote sensing systems and image processing software. The geospatial process has become faster due to the accelerated usage of remote sensing data and techniques and accuracy assessment has become a very vital process due to the errors presented by digital imagery. Accuracy assessment establishes the information value of the resulting data to a user. Productive utilization of the geodata is only possible if the quality of the data is known. The overall accuracy of the classified image compares how each of the pixels is classified versus the definite land cover conditions obtained from their corresponding ground truth data.

2. LITERATURE REVIEW

1. "Progress and Trends in Image Processing Applications in Civil Engineering: Opportunities and Challenges" Ashwini A et al, this paper provides an up-to-date review of image processing applications in the field of civil engineering. Image acquisition that has been used in controlled indoor setup and on-site equipment is described. Developing trends towards portable devices like digital camera, UAV, and mobile camera to acquire images are noted. The applications of automation from image processing can save time and cost in some tedious jobs like material characterization in CDW, measuring strain, strength, and displacements. The future scope of the study can be considered handy tools for image acquisition, transferring and processing image data. This will help researchers to get background, challenges, and future scope of using image processing work in civil engineering.

2. "APPLICATION OF REMOTE SENSING AND GIS TECHNIQUE FOR EFFICIENT URBAN PLANNING IN INDIA" Ravindra Kumar Verma et al, this study states that planning and managing cities in the new era of globalization and economic liberalization would be a demanding task calling for new skills and approach. Indian cities will have to compete with others to attract investments and, therefore issues like quality of infrastructure, energy efficient services provision and environmental conditions in a city besides economic stability would play a significant part in such competition. Satellite remote sensing with repetitive and synoptic viewing capabilities, as well as multispectral capabilities, is a powerful tool mapping and monitoring the ecological changes in the urban core and in the peripheral land-use planning.

3. "Geomorphological Mapping Using Remote Sensing and GIS A Tool for Land Use Planning Around Shivpuri City, M.P., India" Ajay Singh Tomar et al, this paper states that land use planning is continuous process due to natural and human causes. For future land use planning, it is necessary to understand the existing geomorphic units and extents. Remote Sensing and GIS have capability to mapping geomorphic units. It provides the large view of earth surface features on the satellite and having various tools, techniques to explore the geographic features. The geomorphic units mapped from satellite image as denudational hills majorly occupying eastern and western portions, structural hills eastern parts, residual hills western and north eastern, alluvial plain and western portions of the map.

4. "Transportation Network Analysis by Using Remote Sensing and GIS A Review" Ajay D. Nagne et al, the study states that larger cities have more connected road networks, so they are more accessible. Among many networks analysis indices, the Alpha Index, Gamma Index, Beta Index is more useful. The Beta Index gives the connectivity ratio, by calculating this index it is possible to identify in which area connectivity is less, so city planner can plan according to it. It is also possible to calculate the zone wise network density of any urban area. It is more useful to compare multiple zones of city to identify the development of each zone. In the context of city planning, the road networks with high value of gamma index are well arranged in terms of redundancy of choosing roads. The strength of connectivity within road network does not accurately indicated by the Alpha Index, but gamma index overcome with disadvantage.

5. "Accuracy Assessment of Land Use / Land Cover Classification Using Remote Sensing and GIS" Sophia S. Rwanga et al, this study states that remote sensing is very important for the production of land use / land cover maps which can be done through a method called image classification. This method had huge improvements over the past decades in the following four areas for example; LULC maps production at any scale, improvement and use of

advanced classification process such as pre filed and sub pixel, classification procedures using knowledge base process and incorporation of auxiliary data into classification procedures. Individual accuracy assessment parameters are useful to access the model performance in respect of a particular category/class of specific interest for the study. The study had an overall classification accuracy of 81.7% and Kappa Coefficient of 0.722. The Kappa coefficient is rated as substantial and hence the classified image found to be fit for further research.

6. "Integrated evaluation of urban development suitability based on remote sensing and GIS techniques: contribution from the analytic hierarchy process" Ahmed M. Youssef et al, this paper has been attempted to describe the various ways in which GIS and AHP can be used in integration between different types of data for a preliminary site investigation between different types of data for a preliminary site investigation in civil engineering and particularly in the field of risk assessment. Hazard and vulnerability data, which are both spatial and non-spatial in nature, can be stored in GIS databases. Risk assessment programs can be called within the GIS to access these data and evaluate zones of potential risks. The AHP approach was used to create appropriate weights for the different factors affecting the suitability of the site for urban development.

7. "Application of GIS in Transportation Engineering" R.A. Ganorkar et al, this study states that there are ample evidences of applying the recent advances in satellite based remote sensing and GIS technology in various fields of civil engineering. India's space programmed ensuring continuous availability of RS data and launching of future satellites carrying high spatial and spectral resolution sensors can go a long way in providing useful information required for civil engineering applications. There are lot of advantages for using GIS in Transportation Engineering such as the ability to produce more quickly, repeatable, they can be used with visualization tools commonly found in GIS to found customized maps and tables and effective road network. GIS has some obstacles such as, high development cost is that both GIS databases and simulation models and obstacle hydrologists have to become GIS experts to solve problems.

8. "Remote Sensing and GIS Applications in Highway Designing" Debashis Bose et al, this study states that the significance of remote sensing data for landform and drainage pattern analysis for safety of infrastructural designs in the planning stage itself. Usage of remote sensing and GIS technologies may be considered as the essential prerequisite for careful physical spatial planning to make optimum use of the roads as communication links for all seasons as a great amount of money are invested in planning and construction activities of the roads. Appropriate integration of different spatio-thematic information with aspatial data in GIS environment demand human resources development for handling and processing of the database of multidisciplinary nature to conclude on user orientation.

9. "TransCad analysis and GIS techniques to evaluate transportation network in Nasiriyah city" Zaynab Qasim et al, this study states that through the application of System Optimum method for the analysis of the road network and also through traffic surveys that have been applied to the entrances of the city and some of the points in the city center was observed that the concentration of traffic congestion occurs in the city center which is a crowded market and most of the government state departments and this has resulted through the analysis in the program TransCAD where black color appeared clearly that represents the ratio (v/c > 1.0) in many links almost 100 links specially in city center and which have the type of services of the type F between emerged after the other of the ratios (v/c) then gradually generally in the road network of the Nasiriyah city is the type of service level B which represents the ratio (v/c) of (0.40-0.70).

10. "Applications of GIS and Remote Sensing in Highway Project: A Review" Devraj Dhakal et al, this study states that the planning studies, project development, detailed design, construction, and operation management of highways phase consume a lot of time and hence affect the duration and cost of the highway projects. The current research work was an attempt to provide possible solutions to both factors by connecting RS and GIS in highway projects to bridge the gap between global scale and detailed spatial data. There is a great potential for RS and GIS in highway applications from its planning stage to detailed construction and even in the operation and maintenance of roads.

3. CONCLUSIONS

1. Image processing will help researchers to get background, challenges and future scope of using image processing work in civil engineering.

2. Incorporation of land-use transportation models, water distribution network analysis, simulation of urban activities to evaluate different urban development alternatives in the GIS framework needs to be explored for added advantage.

3. Based on mapped geomorphic units local and government authority can make decision to land use planning for human activities.

4. The road networks with high value of gamma index are well arranged in terms of redundancy of choosing roads. The strength of connectivity within road network does not accurately indicated by the Alpha Index, but gamma index overcome with this disadvantage.

5. The AHP approach was used to create appropriate weights for the different factors affecting the suitability of the site for urban development.

6. GIS and simulation models have contributed to the identification and evaluation of potential solutions for transportation problems during the past decade.

7. The significance of remote sensing data is considered for landform and drainage pattern analysis for safety of infrastructural designs in the planning stage itself.

8. Application of System Optimum Method for the analysis of the road network and also through traffic surveys to observe the concentration of traffic congestion is effective.

9. Combination of RS and GIS with Artificial Intelligence (AI) techniques will evaluate various features of highway projects.

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