Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 13 (20): 4174-4180, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.4174.4180

WebGIS Design and 3D Visualization Research for Urban Electromagnetic Environment

YanMing Chen, Wei Hu, Hao Huang, Liu Yang and JieChen Wang
Department of Geographic Information Science, Nanjing University, Nanjing, 210093, China

Abstract: With the development of urbanization, the electromagnetic radiation has become increasingly complex and dangerous. It is significant to design an interactive system for managing and distributing electromagnetic information. The study designed an information system based on WebGIS with the techniques of ArcIMS and JSP. The system can provide services for information query of public and provide technical support for decision making of relevant departments. Furthermore, techniques of 3D visualization of electromagnetic environment were developed, taking 3D visualization of electromagnetic environment in Nanjing Xinjiekou for instance.

Key words: WebGIS, Urban electromagnetic environment, ArcIMS, 3D visualization, internet of things

INTRODUCTION

Intrusion detection (Yang *et al*., 2011) is an information technology for detecting an unauthorized user who attempts to undermine the security of computer systems it is mainly through the monitoring of computer network system logs, audit information, status, behavior and system usage, to detect the user's unauthorized use and misuse behavior, these abnormal behaviors undermine the integrity and confidentiality of computer systems and the availability of resources. Intrusion detection can help system administrators investigate illegal intruders to prevent further attacks by hackers. An Intrusion Detection System (IDS) is considered to be the second security gate after firewall.

With the development of modernization, electronics, mobile phones and other electrical equipment products can be seen anywhere in our daily life. Such electronic products not only provide us abundant value-added services but also make severe electromagnetic environment pollution and electromagnetic interference (Gao and Diao, 2000). Therefore it is necessary to monitor the information of electromagnetic environment, such as electromagnetic pollution level and spatial distribution. Furthermore, how to manage the electromagnetic environment should be take into account. Aided with Geographic Information System (GIS), network techniques and mathematical models, we can make some effective solutions for monitoring and managing such ever-worsening problems of urban electromagnetic environment (Stillwell and Clarke, 2004).

The GIS technologies, such as spatial data management and spatial analysis, have been widely applied in the field of environmental monitoring and management (Levine, 1996). Correspondingly, GIS can be adopted in urban electromagnetic environment for efficient management and decision analysis and provide a quantitative method for electromagnetic research. Based on Internet technology, WebGIS enables users to browse, query and display spatial data using a web browser. Besides, WebGIS provides a powerful, logical and intuitive system to store, manipulate and analysis spatial data (Li, 2002). In this study, we designed an urban electromagnetic environment WebGIS and made some experimental research on the three dimensional visualization of electromagnetic environment.

WEBGIS DESIGN OF URBAN ELECTRO-MAGNETIC ENVIRONMENT

In recent years, serious electromagnetic radiation pollution problems reside in our life. In this study, we propose an electromagnetic monitor system, aided with GIS spatial analysis method, network technology and database technology. According to the demand of urban electromagnetic environment WebGIS system, we take ArcIMS (a maturity WebGIS platform) to develop urban electromagnetic environment Geographic Information System (GIS). The ArcIMS provides effective map service, web page design and the Web site management. There are three application modules in the system, the map server, Database servers and network communications between servers. Through such Web browser, users can visit ArcIMS application service and apply GIS function.

System architecture: WebGIS inherits parts of the GIS function, focus on sharing geographic information and spatial data processing. Such network software is based

Corresponding Author: JieChen Wang, Department of Geographic Information Science, Nanjing University, Nanjing, 210093, China

on web platform. People can use their unique spatial analysis and visualization expression for the various decision-making. WebGIS technology provides advanced tools for the expression and analysis of socioeconomic information.

Based on ArcIMS, the WebGIS of urban electro- magnetic environment is designed in a three-layer systematic architecture (Fig. 1) which contains presentation layer, logic layer and the data layer. Such three-layer systematic architecture takes advantage of stability, scalability and efficiency. It can effectively reduce network load, improve speed of database response and be convenience for system management and maintenance (Zhao *et al*., 2005; Li and Zhen, 2007).

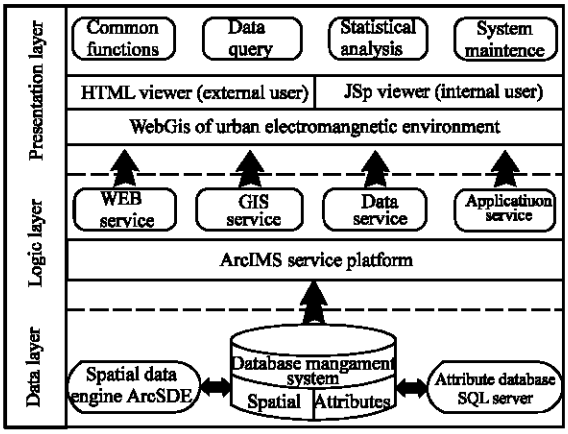

Fig. 1: Architecture of electromagnetic environment WebGIS

The system's main structural and workflow are summarized as below: (1) Presentation Layer which is the ArcIMS client, used to show, inquiry and analysis geographic data. And the layer contains two types of client, HTML viewer for external users and JSP viewer for internal users. (2) Logic Layer which is the core GIS functions, including application server connector, application server and space server. (3) Data Layer which include the entire data source divided into spatial data and attribute data.

Database design: The database of urban electromagnetic environment WebGIS can be divided into spatial database and attribute database. Attribute database include monitoring database, electromagnetic radiation related database, population socio-economic database, historical information database and data management database (Fig. 2). As the core of GIS application systems, spatial database is designed in a mixed-model structure, contains thematic database and basic database (Fig. 3).

In the WebGIS system, we use spatial data engine ArcSDE to integrate spatial data and attribute data into SQL Server. Aided with powerful database management functions, SQL Server can manage both spatial data and attribute data efficiently. Furthermore, the database uses a unified Relational Database Management System (RDBMS) to storage space and attributes data. Such construction of the database would be faster in accessing spatial data access and easy to ensure the integrity between spatial data and attribute data.

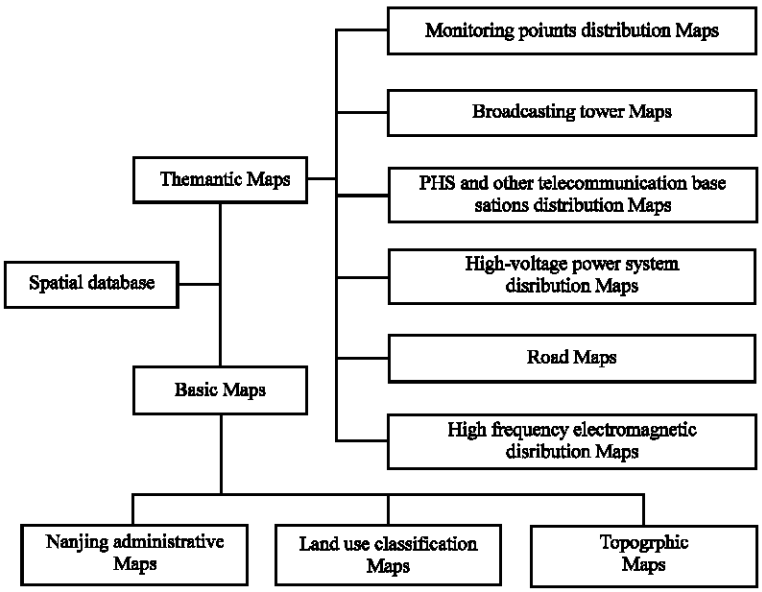

Fig. 2: Attribute database of electromagnetic environment system

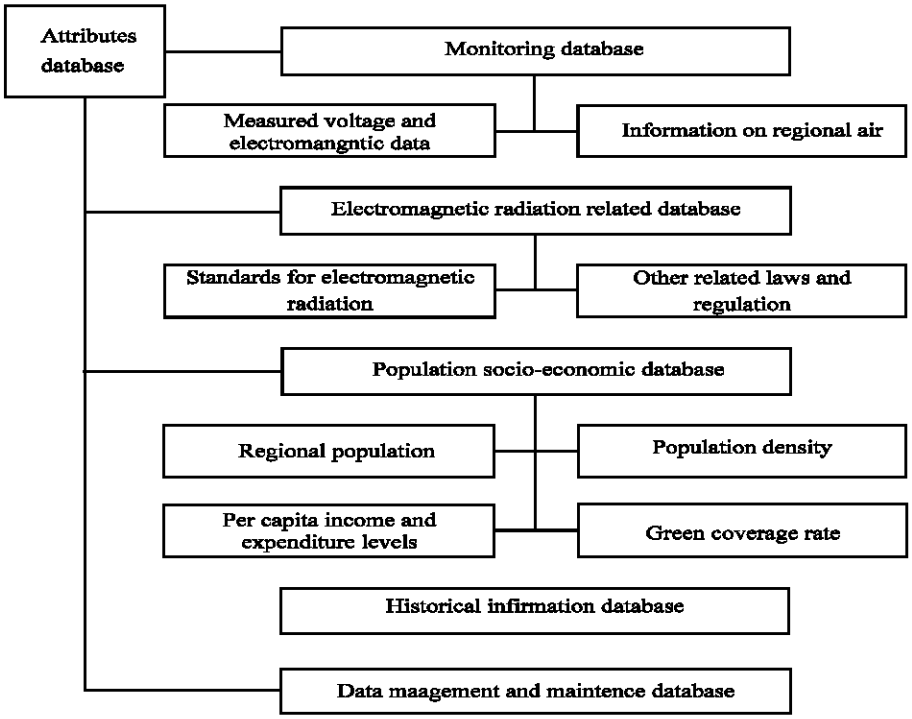

Fig. 3: Spatial database of electromagnetic environment system

System function design: In analyzing the demands of such WebGIS system, we give the functions of the system design as four aspects: Common function, data query, statistical analysis and system maintenance. The common function and system maintenance can be considered as general function in GIS. The conventional functions include those operations such as map objects' selecting, full-screen, zooming in, zooming out, roaming, recognizing, data inquiries, ranging, scale-setting and printing. The system maintenance includes user authentication, access permission setting, data input and authorized user can use the internet to achieve the updating of electromagnetic monitoring data and then check these data to ensure that the input data to the database server can be dynamic update.

Data query functions concludes: Electromagnetic radiation monitoring sites inquiries, electromagnetic monitoring information inquiries and electromagnetic environmental assessment and standard inquiries. Among them, Electromagnetic radiation monitoring site inquiry includes two query ways: One uses attributes to achieve graphics inquiries by using attributes mainly refer to regional administrative inquiries, that is to query the monitoring sites based their locations (city, streets, etc.,). The second inquiry method mainly refers to selecting the monitoring sites by using mouse to draw a rectangle, round and any other polygons and to select the sites in the shape region. Electromagnetic monitoring information inquiry is based on the monitoring indicators and evaluation indicators of the sites selected. Under the authority, the inquiries information includes electromagnetic monitoring data, electromagnetic statistics (average, the value of the water quality under different frequency) and electromagnetic assessment data (water categories). And the statistical results require to be expressed in the form of table and histogram (or pie slice). Electromagnetic environmental assessment and standard inquiry can achieve the electromagnetic environment evaluation, make statistics on different monitoring sites at the same moment and then calculate the percentage.

Statistical analysis function includes spatial dimensional statistics and analysis, comparative analysis of the temporal dimension and trend analysis. The managers can also achieve the dynamic update of the statistical data. Among them, spatial dimensional statistical analysis can make statistics on the wholly or partially site in the region, including maximum, minimum, average and so on, as well as make statistics on the various pollutants and on the basis of street use different color-depth to express the number of pollutants. Temporal dimensional comparative analysis is to compare the

average and the standard value of the monitoring data which describe the same indicator of a local site in different times and to express the comparison in histogram. Still the function can compare the averages of the monitoring data which describe some indicator of a local site in the same period time of different year and to express this comparison in dogleg map. Trend analysis includes spatio-temporal evolution module and forecast warning module. Spatio-temporal evolution module is mainly used to provide the changes of urban electromagnetic radiation monitoring data and meanwhile provide the changes of the five main pollutants in recent decades and draw them into urban electromagnetic environment changes maps or the form of changes curves. In this way, users can understand the main trends of urban electromagnetic environment changes easily; forecast warning module is based on the electromagnetic radiation data and the electromagnetic radiation standards at home and abroad and forecast electromagnetic radiation safety by some levels.

3D VISUALIZATION OF URBAN ELECTROMAGNETIC ENVIRONMENT

The constructed urban electromagnetic environment WebGIS can help the public realize the electromagnetic information query and provide appropriate services and technical support for the government to make the management decisions. Aided with symbol method, color based method, chart method and so on, the WebGIS can give out two-dimensional visualization of urban electromagnetic environment on the map. The system can ensure users handle the information about distribution of urban electromagnetic environment and the change law in a visual manner. However, faced with such a complex and continual electromagnetic environment, the system cannot fully support the visualization of three-dimensional space, such as to display Electromagnetic Field (EMF) direction, electromagnetic changes in different height. Therefore, the study makes a further discussion about GIS application and electromagnetic simulation technology, providing technical support for constructing 3D urban electromagnetic environment WebGIS.

Technical framework: To achieve the overlay of 3D visualization and the output of scene rendering, 3D visualization of urban electromagnetic environment involves three aspects, that is, space topographical, urban architectural complex and electromagnetic environment. In aspect of space topographical and urban architectural complex, this study utilizes the superior advantages of spatial data processing for the 3D reconstruction of urban space. Then the stimulation result of electromagnetic thematic data is overlaid on the reconstruction result, thus achieving the goal of 3D visualization of electromagnetic environment in urban scenes which can afford comprehensive decision basis for the monitoring and managing of urban electromagnetic environment. Upon on all above the technical framework is designed as Fig. 4.

The construction of 3D urban model: In this study, we take Zhujiang Road in Nanjing as the experimental area. The area is the central portion of Nanjing city, where is densely populated and highly motorized. The whole region is bordered on the north by Beijing Xilu to Beijing Donglu, on the west by Shanghai Road, on the south by Hanzhong Road, on the east by Jinxianghe Road, the perimeter of the region is about 5.5 km, the dimensions is about 1.7 km^2. The research data in this paper mainly includes: IKONOS false color composite image (Fig. 5) and 1:500 CAD topographic map (Fig. 6).

During the construction of building models, useful information layers (e.g., height layer, floor layer, building contour layer and etc.,) are selected from CAD data and they are classified and merged into two classes: Building layer and height layer. Then floor properties are added to building layers, by which means the building contours are endowed with height information. Finally we can extrude the planar building contour data in a certain height for its 3D visualization.

During the construction of terrain models discrete height points extracted from CAD files are interpolated into DEM and radiometric correction and geometric correction are done for IKONOS images. Then supplemented by RPC (Rational Polynomial Coefficients) model parameters ortho rectification and match are done in ENVI, generating terrain 3D models with terrain texture feature.

The construction of electromagnetic environment model: In this research, we take simulated electromagnetic data to construct electromagnetic model. And in dealing with measured electromagnetic data, such as the charge and current distribution of the electromagnetic sources, we can simulate electromagnetic field (EMF) by numerical method based on the physical theory of electromagnetic field, such as solving Poisson equation of field intensity distribution.

When we deal with the stimulated electromagnetic data, in view of its inhomogeneous distribution in Euclidean space, the traditional method would be hard to describe the spatial distribution of the electromagnetic value. Therefore, we take the rendering method of volume pixel to depict the spatial entities and use ray tracing method to generate the characteristic of inner space. The

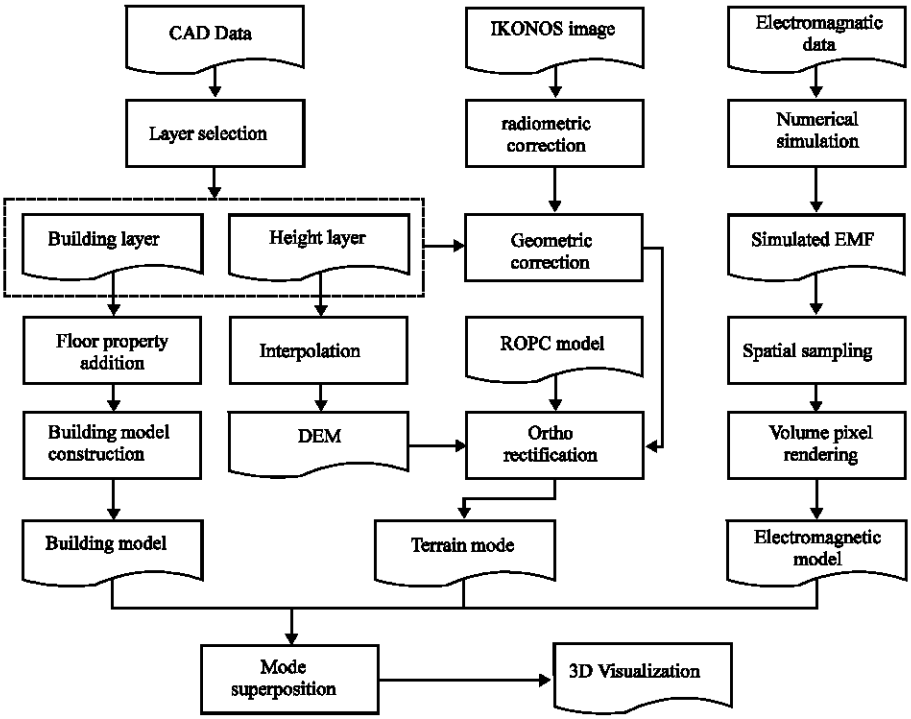

Fig. 4: Technical framework of 3D visualization

Fig. 5: IKONOS image

Fig. 6: 1:500 CAD map

reflections and refractions of ray-traced material generates are more accurate than those produced by the Reflect/Refract map. Furthermore, the implementation of algorithm for rendering ray-traced objects is based on hardware acceleration (Kruger and Westermann, 2003), with the help of such hardware-based rendering method,

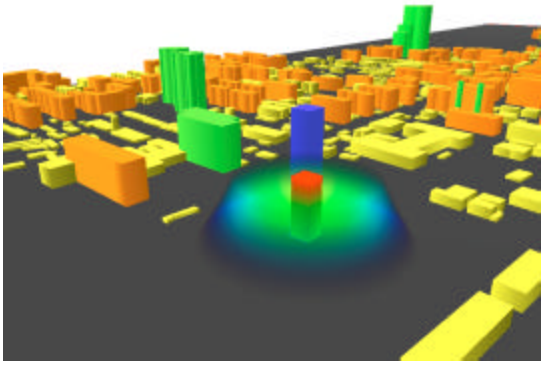

Fig. 7: 3D visualization of urban electromagnetic environment

GPU takes the charge of graphic display which would be calculated by CPU and the method not only increases the rendering efficiency but also has a higher quality export scene.

In the process of ray-traced rendering, we calculate ray by sampling method in forward direction from the point of ingoing to the point of outgoing. The sampling data would be read from the preset three dimensional textures, when the sampling point is outside of the point of outgoing or on the surface of buildings, terminate the computation process, the return value is the color of the point, after the digital imaging process such as rendering pipeline, we get the color value of pixels, after all of these processes, export the result of one frame on the screen. The rendering result of electromagnetic field is based on the terrain of city and the building model, the rendering result is shown as Fig. 8. It should be noted that the spatial data of structure is without any color information and we should set different color to distinguish different intensity of electromagnetic radiation by the user interaction handler.

By overlaying the building model, terrain model and electromagnetic field model, a 3D visualization of urban electromagnetic environment would be shown as Fig. 7.

DISCUSSION

The web visualization techniques for GIS-based three-dimensional electromagnetic environment of cities utilizes the underlying GIS platform to support the management of geospatial data, the generation of city and electromagnetic scene, the positioning of models, the space analysis of models and so on, thus helping users to monitor and manage the electromagnetic environment. As for the complex electromagnetic space consisted of various electromagnetic components such as sound, light, electricity, magnetism and the visualization needs for the state of electromagnetic distribution, the direction and intensity of electromagnetic propagation in the two and three dimensional space, complex spatial electromagnetic models are involved. To this end, a server for the settlement of electromagnetic components can be built on the basis of spatial information system so as to calculate the frequency and intensity of radio, direction and intensity of magnetic field. At the same time, the inversion and analysis of the electromagnetic environmental pollution source can be done according to the measured electromagnetic environment data.

IOT (Internet of Things) is the third wave of the world information industry after computer and internet. IOT acting as a new calculation mode based on the deep integration of calculation process and physical process can perceive information comprehensively, transmit information reliably and process information intelligently, thus controlling and managing things intelligently (Yang *et al*., 2011). The WebGIS system for urban electromagnetic environment has introduced the IOT technique. In this system, the sensor devices are fixed in various electromagnetic radiation sources such as radio and television transmission towers, communication radar, navigation transmitting equipment, high voltage electrical equipment, transportation systems and equipments for industry, research and medical, then they are connected into a network realizing the mark of electromagnetic radiation sources. Based on this, electromagnetic data in cities can be perceived and collected relying on the advanced techniques in the WebGIS system for urban electromagnetic environment such as sensor, RFID, multimedia information collection, two-dimensional code, real-time location, as a result of which realizing the intelligent identification, positioning, tracking, monitoring and managing of complex electromagnetic environment. If IOT technique can be used as a means for electromagnetic information collection in the WebGIS system for urban electromagnetic environment, an active role will be played for the fast, accurate, real-time update of electromagnetic information. Besides, IOT technique can provide accurate and effective decision-making basis, contributing to the monitoring, managing and protecting of the urban electromagnetic environment.

CONCLUSION

In this study, WebGIS technique is introduced into the management of urban electromagnetic radiation. The full use of technical advantages of WebGIS can help us release information timely and accurately, afford a

powerful analysis tool for decision makers and create conditions for the public to grasp urban electromagnetic pollution state timely. This system has perfect function, easy operation, strong practicality, convenient interaction and etc. With this system electromagnetic environment can be expressed intuitively. Based on above, this study fatherly studies the 3D visualization of urban electromagnetic environment and affords practically technique framework of 3D visualization. Finally, 3D visualization of urban electromagnetic environment is done in Xinjiekou Area in Nanjing. The continuous development of IOT promotes the effective collection of electromagnetic data and it has become a new trend for urban electromagnetic environment system.

ACKNOWLEDGMENTS

This work is supported by the Priority Academic Program Development of Jiangsu, National Natural Science Foundation of China (No. 40401046) and Research and Innovation Project for College Graduates of Jiangsu Province (No. CXLX11_0025).

REFERENCES

Gao, Y. and Q. Diao, 2000. The harmfulness of electromagnetic environment to ecology and its protection. Basic Med. Sci. Clin., 20: 1-7.

Kruger, J. and R. Westermann, 2003. Acceleration techniques for GPU-based volume rendering. IEEE Visualization, 3: 287-292.

Levine, N., 1996. Spatial statistics and GIS: Software tools to quantify spatial patterns. J. Am. Plann. Assoc., 62: 381-391.

Li, F. and Z. Zhen, 2007. Platform analysis and application research on WebGIS based on ArcIMS. Comput. Digital Eng., 09: 67-70.

Li, H., 2002. Researches on WebGIS and its application to urban environment. Acta Geosicientia Sinica, 2: 189-192.

Stillwell, J. and G. Clarke, 2004. Applied GIS and Spatial Analysis. Wiley Online Library, New York, ISBN-13: 9780470844090, Pages: 406.

Yang, Q., F. Gao and P. Wu, 2011. Research on application of internet of things in earthquake rescue. J. Catastrophol., 4: 116-121.

Zhao, P., G. Liu, X. Zhang and M. Li, 2005. A method to develope WebGIS based on ArcIMS and application. Appl. Res. Comput., 5: 258-260.