

# Review of GIS Technology and Its Applications in Different Areas

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**Abstract.** The 21st century, with the rapid development of information technology (IT), digital life gradually penetrated into every aspect of production and life. To investigate the use of digital life, each country throughout the world, including of China, started planning for digital nation and digital city project. Effective information tools, such as geographic information system (GIS), help to deal with spatial data and complex interactions in city and nation construction. In order to systematically realize the goal of urban planning and constantly promote the level of urbanization, this literature is reviewed for the applications of GIS in the past, of land management, urban and rural planning, traffic management and environmental management. Besides, it puts forward the digital nation expect of GIS applications in the future.

## 1. Introduction

At present, our society has stepped into the new development situation, in such a background, the city development has made considerable achievements. It is the geological information system connecting the computer science and practical improvement of digital city construction that works no matter in the city management or the city design. Therefore, one of what matters to Urban and rural planning, environmental management etc., is reviewing the applications of geographic information system in the past and proposing the expect of GIS applications in the world in the future.

According to a lot of studies before, we can conclude that GIS has taken an indispensable participation everywhere in our world. Notably, GIS and spatial analysis can be powerful tools to understand, prevent, and help organize cities development strategic. For example, from the view of land management, as a visualization aid, GIS software can be used with multivariate analyses (principal component analysis (PCA), redundancy analysis (RDA) combined with forward selection of variables and cluster analysis) to investigate links between land-use pattern and water quality in the KRB (Kharaa River Basin) [1]. So, we exactly can have a spectacular blueprint on digital city in the world to use this for reference.

For this article, mainly from the introduction of geographic information system technology content, such as the concept, characteristics and functions, firstly set out for discussion of geographic information system technology which is applied to digital nation and digital city theory support points. Moreover, review current global geographic information system on the digitalization construction of typical applications, especially around land management, urban and rural planning, traffic management and environmental management. Besides, personally location of the geographic information system technology in the construction of digital expectation in the future is put forward.



## 2. GIS Technology

This section is discussed the concept, characteristics and functions of geographical information system, to strengthen the extent of the combination of theoretical knowledge and practical application, which is conducive to a better understanding of the relation between construction of digital and geographic information system.

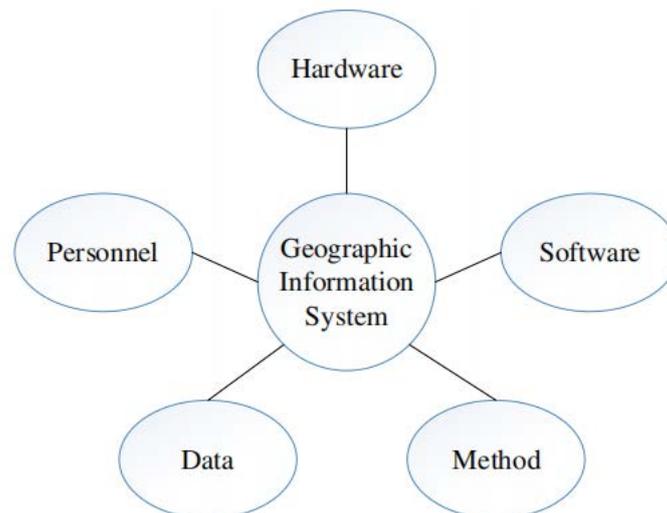
### 2.1. Geographic Information Systems (GIS)

Geographic Information Systems (GIS) are systems designed to store, manage and display spatial data and aid in analysis and interpretation of spatial data [2] [3]. It is a frontier technology discipline based on information theory, cybernetics, computer science, system engineering, and artificial intelligence [4]. The system can enable geoscientific researchers, management, and production departments of various industries to obtain timely and accurate geographic (spatial) information with high accuracy related to regional analysis, scheme optimization, strategic decision-making, etc. [5]. In the process of practical application, GIS, under the circumstances of a cooperation of every discipline, can provide a scientific and systematic service to construction of digital nation and digital city.

### 2.2. Characteristics and Functions of Geographical Information System Technology

Geographic information system (GIS) technology, namely spatial geographic information system, can output geospatial information through its own ability of spatial data processing and analysis, and achieve the effect of data spatial visualization [6][7][8]. With the development of computer, GIS, as a common technique, has provided a new way to realize, organize and use geographic information.

To conclude the basic features of GIS technology, it should be illustrated to 5 points including cross-disciplines, variety of data type, complex data structure, widely-use application and mainly based on spatial analysis [9]. Take the second point for instance, GIS technology uses huge amounts of data, mainly comes from two aspects, one is the geographic data, which is the object managed by GIS; the other is derived data, mainly from spatial data analysis. These various types of data for GIS bring a series of conveniences in the system operation, data organization and network transmission. Meanwhile, they also come with many problems in these fields above.



**Figure 1.** The Figure that Shows the Basic Composition of GIS

The basic composition of GIS generally includes five main parts, which are hardware, software, data, personnel, and methods. The specific relationship is shown in Fig. 1. Therefore, within the components of GIS, the functions of GIS technology include data acquisition and editing, mapping, spatial database management, and spatial analysis [10]. For data acquisition, there are many facilities

helping to collect data conducive to digital city construction, such as digitizer, scanners, photography measurement equipment, etc.

### **3. GIS Application**

This section is discussed the applications of GIS in the past, of land management, urban and rural planning, traffic management and environmental management. Besides, personally location of the geographic information system technology in the construction of digital expectation in the future is put forward in this section.

#### *3.1. Application of Land Management*

GIS spatial database management function is of great significance to realizing the high integration and comprehensive application of land resources and management. Obviously, as we all know, managing land properly is the first and vital step to realize the digital city and digital nation.

One of applications of land management on the realization of digital nation is that we need to manage cadastral reasonably, such as number, location, purpose, ownership, quality, etc [11]. And when it comes to the ownership of land, it seems harder because it refers to not only record in first time but also change of registration. However, within the use of GIS, collecting and analysing the data and material about cadastral management has been easier than before. Meanwhile, inserting the function of searching information in GIS does help to count the statistics and analyse the nowadays information to more useful information and resource, referring to derived data, which enable GIS to help people to correctly orient this land use promoting to its digitization. Step by step, each part of land in a city even in a whole country can be translating to the data on GIS then be organized appropriately.

Considering in the future way using GIS to realize digital city, with the development of mobile GIS technology, land resource information system can be set on mobile phone, flat computer and some other mobile devices that the related manager will have a more convenient way to glance over and search the data about land use no matter when and where. The staff can also apply this data to work more efficiently, such as carrying out thematic layer statistics and selecting site for any land use [12].

#### *3.2. Application of Urban and Rural Planning*

Urban and rural planning reflects one city's development and changes, so a system which can make everything from not only a space level but also a time level to truth is in need. Be sure, GIS is an essential tool to be used on urban and rural planning. Otherwise, it can be applied with other intelligence systems in order to construct a digital city.

Building information modelling (BIM) and geographical information systems (GIS) provide digital representation of architectural and environmental entities. BIM focuses on micro-level representation of buildings themselves, and GIS provide macro-level representation of the external environments of buildings [13]. Studies have shown that the Industry Foundation Classes (IFC) substantial model used in BIM can be converted into a GIS superficial model by transferring high-level geometric and semantic information obtained from BIM to a geospatial environment [14][15]. Specifically, it can be effectively integrated into a software architecture based on a GIS-based facilities management system [16]. The above means that Geographic information system has promoted the trend of the management of the urban and rural planning, broken through the planning business of each phase in the relatively "independence", promoting the business process data sharing, so as to realize the overall lifecycle management of digital city.

Because the use of big data is versatile and adaptable and may generate new information, we should make full use of BIM and GIS data to optimise solutions and planning decisions [17]. So as for the expect of GIS use in the future, we hope geographic information system can be finer and more quantified. For example, when it comes to handle problems about different types of data, such as conflict between power lines planning, housing location planning and spatial, GIS can refine these to overlay analysis, find out the conflict area, and automatic adjustment of the region.

### 3.3. Application of Traffic Management

In recent years, the number of studies about the tools for analysing accidents and road design has increased considerably. Among these tools, Geographical Information Systems (GIS) stand out for their ability to perform complex spatial analyses [18].

Some Chinese department of traffic construction management geographic information system made some beneficial development research attempt, such as western Hubei transportation construction management system, which uses the Mapx as the GIS development platform. And based on the consideration of the network environment, C/ SJ/ S three layers architecture is adopted, which can meet the requirement in the application of traffic construction management. Meanwhile, it used Web Service distributed technology as a means of the realization of the remote data access [19].

With the development of mobile cloud technology, cloud GIS is a new direction to develop. As we all know, cloud computing is a process in which computers at the nodes of the network work together to realize powerful computing power at a low cost, thus providing shared resources, software and information to terminal devices as needed. Therefore, CGIS (Cloud Geographic Information System) can highly integrate richer spatial data with more complex computer functions, which can greatly improve GIS application. And CGIS truly has a much more visible foreground in traffic management.

### 3.4. Application of Environmental Management

In China, we often say that green mountains are mountains of gold and silver. And the application of geographic information system can overall grasp the characteristics of ecology and environment, so as to scientifically protect and improve the ecological environment of the related areas and realize the target of building intelligent and digital city at the same time.

For the aspect about GIS application of environment management, spatial data management and analysis functions of GIS contribute to the scientific management of auxiliary environmental function zoning, for instance, many GIS techniques were used to integrate social and ecological data including: descriptive maps, site prioritisation techniques, and predictive modelling [20]. For example, in the forest quota cutting management, with the help of GIS, we can make detailed cutting plan, determine the cutting purpose, location, species, area, storage, and cutting method and update measures [21].

And these years, with the surge of big data, relevant environmental management data will be effective and reasonable. So, we can analyse unlimited data from different latitudes to achieve the goal of complete digitalization of environmental management.

## 4. Summary

In the process of effectively promoting the application of actual geographic information system and the planning and design of digital city and digital country, it is very important to have a detailed understanding of the application of previous geographic information system. In this process, make full use of geographic information system, keep up with the pace of the new technology, and constantly innovate the traditional management mode and management method of each department and work of the city and the country, so as to better avoid unnecessary waste of resources no matter of land management, urban and rural planning, traffic management or environmental management.

In conclusion, we ought to cherish resources, apply geographic information system, rationalize management process, and constantly seek a harmonious ecological development path.

## 5. Acknowledgements

The research was financially supported by the Scientific and Technological Research Program of Chongqing Education Committee (No. KJ1732436) and the Chongqing Natural Science Foundation Program (No. cstc2019jcyj-msxmX0291), the supports was gratefully acknowledged

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