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# WebGIS Application in Urban Planning Management

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**Abstract.** Significant changes have been made to both the interior and external environments of urban planning and development. With the vigorous promotion of new urbanism and the application of the precise "multi-regulation" standard put out by the state for the growth of new urbanization. The planning system must be reformed, a unified spatial planning system must be established, the urban development boundary must be set, and the urban ecological red line must be drawn. Urban planning is undergoing a crucial phase of dynamic change, and many planning agencies are implementing or contemplating changes to their management and information technology systems. The acceptance of a building planning scheme is a crucial component of thorough urban planning work and a powerful assurance of the safe and efficient running of cities. Building Information Model (BIM) and Geographic Information System (GIS) integration has become more widespread and in-depth over the past few years, and the BIM model's rich geometric and semantic information and the H-dimensional GIS's good data management and visualization analysis ability offer a more dependable solution for building planning approval. This study first discusses the context and environment of contemporary planning research, followed by an explanation of the idea and operation of the WebGL standard and an analysis of the benefits of WebGL over conventional Web 3D visualization technology. The goals of the 3D planning visualization platform are analyzed in this study together with the technological approach and overall design. The research findings are then validated through the use of a prototype system.

**Keywords:** Urban Planning · Geographic Information System · Building Information Modelling · Building Interval

## 1 Introduction

Since the reform and opening up, many rural residents have relocated to metropolitan areas to live and work, and the resulting urbanization has significantly aided in the rapid growth of China's social economy and the development of urbanization infrastructure. China's urbanization rate in 1981 was only 20.1%; by 2017, it had increased to 58.5%, and by 2020, it is projected to have increased to 60% [1]. Building clusters in cities are

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evolving into three-dimensional integrated types as China enters the stage of accelerated urban development, and the spatial planning of urban above- and below-ground areas has advanced higher management level requirements. The density of urban residents has also started to grow rapidly. The free translation of information between real-world three-dimensional data and computer information is currently not just in the theoretical stage thanks to advancements in the Internet of Things, three-dimensional simulation, and information technology.

By overcoming the limitations of spatial information visualization in the conventional two dimensional plane, three dimensional GIS technology is the current trend in GIS development. It can describe cities as three-dimensional spatial information content, displaying the spatial structure and relationships between buildings and the surrounding terrain, making the interaction between people and spatial information more convenient and intuitive, further eradicating the need for paper-based GIS. The majority of traditional GIS applications operate in client/server mode (C/S mode), which requires only the proper configuration and software installation on the local computer to be used [2]. However, when replacing the client, the C/S mode application software needs to be reconfigured and installed, which is a time-consuming process and is not conducive to updating and maintaining the GIS application system [3]. The B/S architecture is more palatable due to the rise in demand for GIS usability. A significant national development strategy, urbanization serves as a comprehensive indicator of the country's level of regional economic and social development. Currently, as the world continues to urbanize, there is a growing need for effective urban planning. However, as time goes on, urban planning issues become more complicated.

## 2 Overview of Known Data on Urban Planning

Nowadays, the majority of the basic geographic information data gathered and used in urban planning, as well as urban and rural planning data in planning outcomes data, are created using AutoCAD software, a computer drawing assist software with a wealth of drawing and auxiliary features, including entity drawing, object capturing, key point editing, and so on. In several related areas, including surveying and mapping, architecture, and planning, AutoCAD and drawing auxiliary software with the same positioning and similar usage are currently widely utilized. The digital topographic map results are created in the domestic surveying and mapping business using AutoCAD or third-party software that was secondary designed in accordance with it. Industry professionals in the fields of urban planning and design are also accustomed to using AutoCAD software for the creation of detailed control plans and urban master plans.

The open-source ArcGIS programme was created by ESRI and offers strong functions for editing, managing, displaying, and spatial analysis. It is widely used in the domestic land management and geographic information industries. ArcGIS has more spatial analysis features than AutoCAD, a full conversion mechanism for displaying geospatial coordinate systems, a wider range of richer and more varied attributes for spatial graphic data, a larger display of spatial data, and it still preserves the full topological relationship between these spatial data.

# 3 Data Standards for Urban Planning Master Plans

## 3.1 Regulation Standard of GIS for Urban Planning

With reference to the pertinent national norms and regulations, planning and content approval by the local planning management department autonomy are produced. These are then coupled with the unique local conditions to develop a thorough consideration. The quantitative audit content for the audit indicators, which are divided into economic and technical indicators and single-unit area indicators, is one example of the quantifiable audit content that can be extracted for the department to which this project belongs, Changsha City Planning Management Information Service Center. However, not all the review contents can be computerized with current technical means. The audit contents quantified for the project's general plan design plan are the economic and technical indicators, and the approval contents quantified for the project's single unit design plan are the single unit area indicators [4].

These three are required contents because state regulations mandate that the project master plan's planning permission be subject to an audit of the project's building density, floor area ratio, and green area ratio. Additionally, a thorough audit is necessary for pertinent attributes, such as total land area, base area, green area, total building area, and residential and non-residential areas of buildings on the master plan, to ensure that the values of these indicators are equal to the values of the pertinent graphics on the drawings. This prevents dishonest builders from misrepresenting indicators. The single design plan's indicators will be examined to make sure they all match the master plan's indicators and those that have been reported one by one. Standardized and defined approval material can increase the severity of planning approval while minimising the impact of human factors in the approval process.

## 3.2 Spatial Data Coordinate Conversion

Urban planning currently uses data on planning approvals and results from a variety of departments, and these entities frequently utilize multiple coordinate systems for their spatial data. The coordinate systems used in these data typically fall into two categories: geographic coordinates and projection coordinates. Geographic coordinates are spherical coordinates with latitude and longitude as the coordinate units, using the earth's ellipsoid as the reference plane. Projection coordinates are planar coordinates with standard units of measurement like meters and kilometers, which can measure length and distance. Through various projection techniques, the same geographic coordinates can provide many projection coordinate systems. Beijing 1954 coordinate system, Xi'an 1980 coordinate system, WGS84 coordinate system, and others are frequently used in Chinese planning. Among these, the WGS84 coordinate system employs UTM projection, as do the Beijing 1954 and Xi'an 1980 coordinate systems [5].

# 4 Planning Management Application System Features

1. Stability and prosperity. The system utilizes technologies like multi-level-of-detail model (HLOD) and parallel computing to support multi-layer textures and boost system performance. The system runs steadily and dependably.

2. High precision model from experimental system map data to be used to recreate the original 3D scene.
3. Scalability and utility. The system allows for integrated access to video and other forms of video surveillance, and the material is extremely scalable. It also fully considers the comfort and adaptability of human-computer interaction.
4. Multi-source data integration. Two and three dimensional multi-source data can be put into the system and combined on the same platform for storage management.
5. Compatibility. Internal and external data interfaces should be standardised and unified in the system implementation to consider compatibility with common browsers and operating systems. The software system also supports network solutions and supports the standard configuration of computers, so that users in various industries can share in accordance with the set permissions to facilitate the sharing and exchange of future data.

## 5 System Requirement Analysis and Design

The 3DTiles fine realistic model data is applied to urban development and construction from the actual demand, combined with the open source 3D digital earth engine Cesium framework, using the B/S architecture to load the real 3D scenes of the city in the browser end, through the vector, site photos, and videos provided by the developer. This helps to better solve the problem of demolition of unauthorized buildings and reconstruction of related land in the process of urban development.

### 5.1 Server Implementation

User management, fundamental layer service, and planning data management are the three main functional components that make up backstage management. Users with administrator access are in charge of adding new users and managing the existing user list, and the user management module is primarily able to view the basic information of existing users. The basic map layer service module is primarily in charge of controlling the 2D thematic base map data displayed in the front-end visual interface by configuring the base map service api interface information and managing the base map service (WMS service, WFS service, etc.) of the front-end visual map display [6]. The management of the spatial planning vector data that has been entered into the system database is the responsibility of planning data management.

### 5.2 Functional Module Design

The system display module has features including integrated display of images, movies, and attribute data in addition to 3D scene roaming and 2-3D linking [7]. It can be used to improve the current state of urban planning, query the status of important urban locations and associated attribute data using multimedia and pre-existing geospatial data, assist management departments in bettering the overall control of urban planning work, increase productivity, and encourage better and more rapid urban development. The auxiliary analysis module primarily makes use of 3D GIS spatial analysis techniques,

**Table 1.** Planning site list of experimental ecological community

| Type of land use | Planning area/$m^2$ | Area share |
|---|---|---|
| Residential land | 1 612 078 | 35.60% |
| Public Facilities | 321 339 | 7.10% |
| External Transportation | 2 300 | 0.05% |
| White space | 1 180 442 | 26.05% |
| Public Green Space | 290 572 | 6.41 |
| Roads and Plazas | 932 899 | 20.59% |
| Water | 190 370 | 4.20% |
| Total | 4 530 000 | 100% |

including inundation analysis, viewable area analysis, profile analysis, skyline analysis, sunlight analysis, etc., to determine whether an illegal structure has an impact on urban planning and development, whether it blocks space for public amenities, whether it affects the flow of floodwaters and roads, and other factors [8]. It cannot be converted into a legal building if doing so compromises the city's overall safety; otherwise, it may be converted. For instance, skyline research can serve as a foundation for design guidelines for new residential structures, enhance the aesthetics of the city as a whole, and highlight its distinctive style [9].

### 5.3 ArcGIS and SWMM Model Introduction

Geographic Information System (GIS) is a technical system for capturing, storing, managing, computing, analyzing, displaying, and describing data about geographic distribution in the whole or part of the Earth's surface space with the support of computer hardware and software (Table 1]. ArcGIS is a comprehensive and scalable GIS platform that fully integrates GIS with databases, software engineering, artificial intelligence, network technologies, and other mainstream computer technologies. It includes spatial positioning data, graphical data, remote sensing image data, attribute data, etc., and can be used to analyze and process various phenomena and processes distributed in a certain geographic area [8]. The SWMM model is a dynamic precipitation-runoff simulation model developed by the U.S. Environmental Protection Agency and includes different calculation and service modules (Fig. 1).

### 5.4 Cliental Implementation

In accordance with the type of data, the visualization platform's data can be classified into spatial planning data and map base data. The raster basis map can be changed in the front-end, and the vector data are summarized in the front-end in the form of layer lists. You can inspect the layer style and layer attribute information using the right-click extension function menu for the layer. The user can transfer the planning and approval data to the background in real time for conversion and display in the front-end, and at

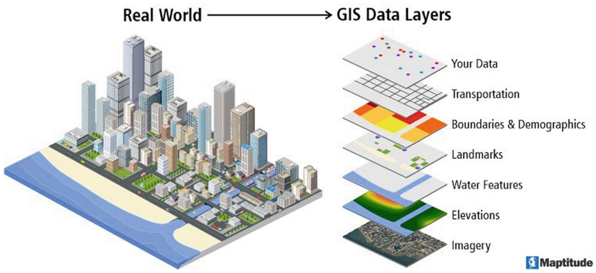


**Fig. 1.** GIS Data Layers

the same time, the data can be browsed and scaled in any angle in the 3D scene. The platform can manage these data in the background management interface to determine the front-end visualization content [10].

## 6 Conclusion

In order to address the limitations of the traditional 3D GIS client in terms of scalability and cross-platform, this paper introduces the rapidly evolving front-end technology and WebGL visualization technology. It then analyses the benefits and drawbacks of the current widely used WebGL visualization libraries and the unique requirements of urban planning work for visualization technology, choosing the Mapbox-gl technology based on WebGL technology to address the browser-side 3D problem.

This paper proposes the research content of this paper, based on the flexible and convenient 3D open source earth engine Cesium framework, combining the tilt photogrammetry technology and 3D WebGIS technology, according to the actual demand, the key technologies of 3D data loading, visualization rendering and spatial analysis, etc. Based on the framework of Cesium, a versatile and practical 3D open source earth engine, in conjunction with tilt photogrammetry and 3D WebGIS technology, and in accordance with the actual needs, the 3D data loading, visualization rendering, spatial analysis, and other critical technologies are thoroughly studied, and a 3D realistic map information experimental system for urban planning and management applications is developed. The system is created and put into use for the application functions and general technological architecture.. It also provides strong technical support for reasonable management and development in urban planning construction by utilizing the system's auxiliary 3D analysis tools to realize the application value of 3D realistic map. This technology can be utilized to create new features that will help the 3D realistic map information system better and more widely serve the urban planning sector and advance urban information development.

The statistical function of this system is rather simple, but it should be feasible to conduct more complex and diversified statistical analyses by including attribute information about entities, such as: the change in household type, the demand for schools, the analysis of traffic pressure, and the statistics and analysis of basic data like parking lots and landmarks.

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