Research on the application of Mobile GIS in the intelligent protection of historical buildings

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Abstract. Aiming at the protection and management of urban historical buildings, this paper studies the methods of historical building information management and utilization based on mobile GIS to improve the accuracy, timeliness and scientificity of historical building protection and management. This article introduces the use of mobile GIS terminals to quickly collect and manage historical building attribute information, multimedia information, historical archive information, and spatial information. It also supports 3D scene browsing, information analysis, and thematic map production. The historical architecture culture was demonstrated, and the applicability and advancedness of the method were verified through the practical experience of intelligent management of historical buildings in Guangzhou.

1. Introduction
Historic buildings are of great cultural, research and aesthetic value, and they can reveal past events and developments \[1\]. For a long time, due to the bias in understanding of historical and cultural values, China's urban historical buildings have been severely damaged. Due to the differences in protection and utilization concepts between the surviving historical buildings, a large number of commercial developments and low-level repairs have caused many historical buildings to be restored to new man-made landscapes or places of business, and thus continue to be man-made.

In the context of the new normal, the protection of historical buildings is an inevitable requirement for the implementation of new-type urbanization. The state requires "strengthening the inheritance and reasonable use of cultural heritage, protecting ancient sites, ancient buildings, and modern historical buildings", and completing all historical and cultural blocks Delineation and identification of historic buildings. At the same time, the protection of historic buildings is an important content of urban work in Guangdong Province. Not only the establishment of a historical building information management system, but also a systematic and complete historical building protection system and a long-term management mechanism should be formed.

2. Current Situation
In response to the central and provincial requirements for the protection of historic buildings, most cities in our province have launched a survey of historic buildings. So far, 14 cities such as Guangzhou and Meizhou have published a total of 4,619 historical buildings. Among them, 9 cities have listed 1,477 historical buildings that have been announced, as shown in Table 1. However, through field surveys, in recent years, with the rapid economic development and population increase, the protection of historical urban areas, historical and cultural districts and historical features, historical and cultural towns and villages, traditional villages, and historic buildings is facing severe challenges.
## Table 1 Statistics on conservation of historical buildings

| No | City      | Number | Number of protected lists | Number of Historic building signs | Number of historic buildings in the provincial catalog | Establish the information system or not |
|----|-----------|--------|---------------------------|----------------------------------|--------------------------------------------------------|----------------------------------------|
| 1  | Guangzhou | 566    | 566                       | 395                              | 0                                                      | Yes                                    |
| 2  | Shenzhen  | 1945   | 1087                      | 122                              | 12                                                    | Yes                                    |
| 3  | Zhuhai    | 181    | 23                        | 0                                | 0                                                     | Yes                                    |
| 4  | Shantou   | 16     | 16                        | 0                                | 0                                                     | Yes                                    |
| 5  | Foshan    | 137    | 137                       | 77                               | 0                                                     | Yes                                    |
| 6  | Shaoguan  | 70     | 70                        | 14                               | 0                                                     | Yes                                    |
| 7  | Zhanjiang | 169    | 169                       | 158                              | 27                                                    | Yes                                    |
| 8  | Zhaoqing  | 149    | 70                        | 0                                | 0                                                     | Yes                                    |
| 9  | Jiangmen  | 20     | 20                        | 0                                | 0                                                     | Yes                                    |
| 10 | Maoming   | 198    | 0                         | 0                                | 0                                                     | Yes                                    |
| 11 | Huizhou   | 202    | 202                       | 202                              | 0                                                     | Yes                                    |
| 12 | Meizhou   | 292    | 292                       | 0                                | 0                                                     | Yes                                    |
| 13 | Shanwei   | 178    | 83                        | 2                                | 5                                                     | Yes                                    |
| 14 | Heyuan    | 0      | 0                         | 0                                | 0                                                     | Yes                                    |
| 15 | Yangjiang | 205    | 205                       | 150                              | 4                                                     | Yes                                    |
| 16 | Qingyuan  | 10     | 10                        | 0                                | 0                                                     | Yes                                    |
| 17 | Dongguan  | 278    | 278                       | 187                              | 0                                                     | Yes                                    |
| 18 | Zhongshan | 389    | 389                       | 0                                | 0                                                     | Yes                                    |
| 19 | Chaozhou  | 191    | 70                        | 0                                | 0                                                     | Yes                                    |
| 20 | Jieyang   | 0      | 0                         | 0                                | 0                                                     | Yes                                    |
| 21 | Yunfu     | 1036   | 894                       | 170                              | 24                                                    | Yes                                    |
| 22 | Shunde    | 195    | 38                        | 0                                | 0                                                     | Yes                                    |
| **Total** | **6427** | **4619** | **1477**               | **72**                           |                                                        | **11**                                  |

Demolition of ancient buildings, destruction of ancient building ruins, and destruction of the environmental features of cultural relics protection areas have occurred from time to time due to economic construction. The contradictions between cultural relics protection and economic construction have intensified, and the responsibility and burden of cultural relics management departments have become increasingly serious [2]. The protection of historical buildings varies from city to city, and the progress in the documentation of historical buildings and the construction of information platforms are significantly different. There is also a large gap in the number of published historical buildings. There is still a lack of historical building attribute information, incomplete historical files, and space problems such as unclear location, the content of field investigation records are too long to enter information and management in a timely manner, resulting in complicated internal collation, summary and statistical work, and may cause data loss.
The technologies and methods used by many experts in the digital protection of cultural heritage are equally feasible in the protection of ancient buildings. The content involves the subject applications of computer graphics, image processing, and virtual reality, digital modeling, virtual restoration, and auxiliary management. Digital display and other technical frameworks, key technologies and typical system applications. These are all good explorations for the digital protection of ancient buildings [3].

3. Methodology

3.1. System architecture

The system design fully considers the close combination of practical use and functions, and divides the overall structure of the system into five levels according to application requirements and scalability principles, as shown in Figure 1. The entire mobile GIS system is divided into infrastructure layer, data acquisition layer, database layer, and system application layer. Separate from user presentation layer, data layer, application layer and user presentation layer, which is convenient for system function expansion.

![System architecture diagram](image)

The infrastructure section includes the hardware, network, and operating system required for software operation. It is the guarantee for the normal operation and use of the smart building management system in historical buildings. The operating system uses the Android client.

The data acquisition refers to the use of the system's personnel to input relevant information such as the two-dimensional and three-dimensional spatial information, attribute information, and multimedia of the historical building distribution into the system through various channels, as well as the collection
and collation of thematic data from historical cultural information mining, historical buildings description and publication, which provides multi-source heterogeneous data for the data section.

The data is composed of a basic geographic database, a historical building thematic database, and other databases. The original data collection is classified, sorted, and integrated.

The software application is a variety of professional functional services provided to users based on the data layer, including map browsing, navigation and positioning, historical building display, and thematic chart statistics functions.

The user presentation is the interaction interface between the system user and the system, and it specifically represents a platform for users to provide various application work. According to different users, this layer can provide functions including querying, browsing, maintenance, management, statistical analysis and decision making.

3.2. Functional module

The system is deployed on mobile devices, and corresponding functional applications are designed for ordinary users, staff and decision analysts. Map browsing modules, navigation, positioning modules, historical building display modules, and statistical analysis modules are developed to establish the pattern of historical building protection in Guangzhou, which offers integrated solutions for historical building information collection, archiving, storage and use, and carries out comprehensive digital intelligent protection and management of historical buildings.

The map browsing module is for all system users. In the map browsing module, the electronic map is used as the base map, and vector spatial data such as historical buildings and cultural relic lines are superimposed. The main historical building attribute information is marked on the map, and map zooming and annotation are supported. GIS functions such as point, attribute query, location query, measurement distance, area, etc. Data collectors can use historical methods such as photos, text, voice, and handbook to collect historical building information, record the current geographic location, and simultaneously display it on the collection terminal. On the map, it provides support for collection personnel to check the collection effect.

The navigation and positioning module reads the current location through the positioning module of the mobile device, and automatically loads the surrounding electronic map and historical building information, which is convenient for users to query the surrounding historical building information, and supports users to navigate from the current location to the query destination. For the data collector, the system provides the track of the movement of the terminal holder by GPS.

It provides functions such as mutual query of graphic attributes, keyword query, selection query, historical building positioning, buffer analysis, etc. It supports the superimposed display with the basic topographic map, government electronic map, image map, and historical building thematic data. The information and data display module is based on the basic geographic database, and displays the appearance, spatial location, distribution, living status, and surrounding natural environment of the historic building in a 720° full-scale real scene composed of two-dimensional government electronic maps, two-dimensional image maps and DEM.

The statistical analysis module mainly provides a batch output of historical building information summary tables, using histograms, line charts and other charts for analysis and statistics, and at the same time provides map finishing tools to beautify and standardize data output. Such as thematic statistics: Query the result data or existing historical building data in accordance with different statistical methods. According to the user’s selection, the historical age of historical buildings can be classified and counted. At the same time, historical buildings can be counted by area, such as the total data of all historical buildings in the regional statistical system.

4. Result and discussion

The historical building information platform is a unified platform that integrates multiple technologies such as GIS, network, software development, CAD, and has the characteristics of multi-person parallel engineering. It focuses on the entire process of information communication, data processing and
management, and other planning, especially legal collaboration and convergence of plans. The mobile GIS historical building protection system is applied to the research of intelligent protection management of historical buildings in Guangzhou. The goal of the project is to obtain historical information such as historical building location, plane, elevation, age, protection range, etc., and store it in the same information platform in a standardized format to achieve data sharing and coordination in different regions. By setting certain permissions, the dynamic maintenance of data is achieved, ensuring the real-time and accuracy of historical building data information. In addition, the historical building information platform is linked with other statutory planning information platforms such as control regulations and soil regulations to achieve the coordination of historical building protection and statutory planning, facilitate daily planning implementation and management, and achieve proper protection of historical buildings. On the other hand, the digital management system of historical buildings provides a scientific basis for the formulation of the general plan for the protection of historical buildings in Guangzhou. Through comprehensive investigations and leak detections, the number distribution, preservation status, management rights and use of historical buildings in Guangzhou are fully understood, thus establishing a scientific and effective cultural heritage protection system, and accomplishing the comprehensive, coordinated and sustainable development of Guangzhou’s economy and society.

5. Conclusion
Mobile GIS is a GIS built on the basis of a mobile computing environment and a mobile terminal with limited processing capabilities. It provides mobile, distributed, and random mobile geographic information services. It is an integrated system of three major technologies: GIS, GPS, and mobile communications. The international GIS community refers to the integration of GIS + GPS + wireless Internet as mobile GIS [4].

Relying on the advantages of mobile GIS technology, it integrates data collection, data entry editing, data query and display, and data management functions. The photos, videos, and attribute information obtained on-site are recorded in the information system in real time, which provides suitable users with different functions, combines with the protection content of the provincial government’s protection of historical buildings in various cities, conducts archival management of historical buildings, taps the value characteristics of historical buildings, and formulates protection measures and protection plans based on actual conditions, provides a work pattern for the protection and management of historical buildings.

There are many advantages of using mobile GIS systems to protect and manage historic buildings:
1) In terms of data update, using electronic maps as basemaps, historical building information can also be adjusted and changed as needed, ensuring the timeliness of data updates, and improving the reusability of data for wise use in more areas [5];
2) Using mobile GIS system, it can enter various field-collected attributes and multimedia information in real time through electronic equipment as a mobile collection tool, or directly send to the server for processing through the network to achieve the purpose of rapid data storage;
3) The mobile GIS system has the characteristics of being used anytime and anywhere, providing functions such as browsing, querying, statistics and analysis to change the status of traditional management methods still lacking corresponding information systems in the daily management of historical buildings, to meet daily management needs, as well as to improve the informatization level of historical building management.

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