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Smart Archive Management: Application of IoT, BD and GIS to Infrastructure ArchivesManagement

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Abstract

In the management of infrastructure archives, there are three problems that need to be solved: the lack of smart infrastructure archives management paradigm with systematic and standardization, the fact that 2-dimensional paper-based infrastructure archives cannot accurately describe three-dimensional infrastructure archive information, and the problem of "information gap" caused by the lack of integration of infrastructure spatial information and archives. This paper proposed a new paradigm of smart infrastructure archive management. The Smart Infrastructure Archive Management Paradigm takes realizes the perception of infrastructure archive resources by combining the Internet of things technology, cloud computing and big data technology, as well as geographic information system. This paper proposes the Physical Archives Management Platform, the Archives Smart Repository Management Platform, the Infrastructure Archives Visual Management Platform. The research outputs have been applied to the Archives Management of Zhengzhou University and achieved good feedback.

Keywords

smart infrastructure, geographic information system, archive management.

1. Introduction

The infrastructure archive involves a wide range of records, produces rich materials types. Infrastructure archives are characterized by large amount of information, high correlation and complex contents. The management of infrastructure archives should pay more attention on how to do a good job of management and provide good utilization and development of digitized infrastructure archives is an urgent direction to discuss[1]. How to effectively and reliably solve the problems discussed above is the focus of this paper. This paper makes the following contributions:

Theoretical innovation. The Smart Infrastructure Archive Management Paradigm (SIAMP) gains the comprehensive perception and application of infrastructure archive resources by combining the Internet of things technology, cloud computing and big data technology, geographic information system, artificial intelligence and other new-generation information technologies. Smart archives are characterized by a high degree of technological openness. We carry out research on the management architecture of smart infrastructure archives, and explore new technologies and models of smart infrastructure archives management.

Practical application innovation. The project results have been successfully applied to the infrastructure archive management of Zhengzhou University, including three platforms: Physical Archives Management Platform (PAMP), the Archives Smart Repository Management Platform (ASRMP), the Infrastructure Archives Visual Management Platform (IAVMP). The technology application is completed from the three aspects of physical security, repository security and efficient utilization. The smart infrastructure archive management paradigm is constructed with the smart infrastructure archive management as kernel. The problem of "information asymmetry" is solved by constructing a 3D information platform and a visual platform for smart infrastructure archives respectively.

2. Current Management Situation of Infrastructure archives

In the practical management , the content of record in infrastructure file contains three-dimensional information, and this is the opposite of two-dimensional physical archive which can not fully and accurately descrip the information in archives. Besides, the professional module has a strong correlation with the physical building information, which makes the professional module usually confront the condition of "information gap" among the three aspects of "archive user, archivist and building location", which has a great negative impact on the work of archives management.

The main pain points of current infrastructurearchive management are as follows:

· The lack of smart infrastructure archives management paradigm with systematic and standardization.

· The fact that 2-dimensional paper-based infrastructure archives cannot accurately describe three-dimensional infrastructure archive information. The planar infrastructure archives cannot comprehensively and accurately describe the information of three-dimensional infrastructure records. As of now, there is no effective intermediate platform between 2D paper files and 3D infrastructure.

· The problem of "information gap" caused by the lack of integration of infrastructure spatial information and archives. In the management and utilization of infrastructure archives, the situation of "building is not on file" and "people do not know the building" often occurs. When the archival materials are produced, there are non-standard names. Cognitive errors of document checkers in building names is not rarely seen.

3. Method

To build a smart archive information service platform, it is necessary to realize the comprehensive perception and application of infrastructure archive resources through the application of new generation information technologies such as cloud computing, big data, Internet of things, artificial intelligence and geographic information technology with mobile Internet technology as the tool.

3.1. Internet of Things,Cloud Computing and Big Data

The main idea of applying LOT technology to infrastructure archive management is to standardize the whole archive management process by establishing unified standards under the tenet that everything can be connected to the Internet[2]. Cloud Computing technology integrates multiple computing entities with relatively low performance into a system with strong computing power through the network. Big Data enables the archives management system to have the characteristics of wisdom, which provide more appropriate services in combination with the needs of users.

3.2. Geographic Information System

The Infrastructure Archives Visual Management Platform built by GIS Spatial Index Technology establishes a new archive retrieval approach between the database query of infrastructure archives and the spatial location of GIS, that is, to establish the unique identification of infrastructure archives through the index relation of "archival code" and "geographical location". Through this unique identifier, the building in the visual map and the archival information in the archival management system can be associated[3]. The construction of infrastructure archives management platform based on GIS technology can combine abstract archive information with intuitive map, realize one-to-one correspondence between buildings and archives, facilitate the management of infrastructure archives and provide quick and accurate utilization. IAVMP associates GIS maps with infrastructure archival information through a link table of "geolocation - archival code" .

4. Smart infrastructure archive management

4.1. Paradigm of smart infrastructure archive management

The core technology of SIAMP consists of five parts: infrastructure layer, information-resource layer, application-supporting layer, application layer and decision-making layer. The five layers can be divided according to the cloud computing platform architecture, including IAAS (infrastructure as a service), PAAS (platform as a service), and SAAS (software as a service). IAAS plays as a data center, infrastructure hardware and software resources supporting by Internet. PAAS provides an infrastructure. It corresponds to the application support layer in the technical system. SAAS includes various emerging application software, corresponding to the application layer and decision-making layer in the technical system. See in Fig. 1.

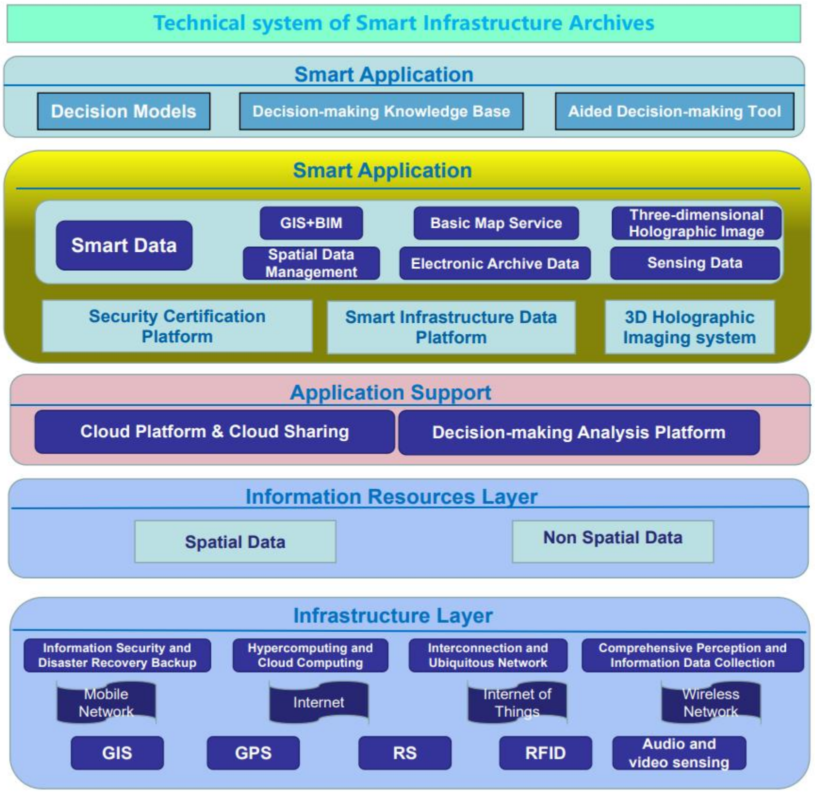

Fig. 1. The smart archive management paradigm

4.1.1 The infrastructure layer

The infrastructure layer includes comprehensive intelligent awareness, real-time data collection, interconnection and intercommunication transmission, massive storage computing, data mining analysis, and security disaster recovery backup, to achieve information or data collection, acquisition, perception, transmission, storage management and other functions.

4.1.2 The information resource layer

This layer is built on the infrastructure layer, and improves the efficiency of infrastructure layer. IRL builds both spatial and non-spatial databases. The spatial database is composed of topographic data, basic image data, basic three-dimensional spatial.

4.1.3 Application-supporting layer

This is the "bridge" and "link" between information-resource layer and application layer, shielding the distribution and heterogeneous characteristics of data resources from the lower layer, and providing transparent and consistent programming interface and environment to the upper layer. The key technology of this layer is to solve the fusion research of spatial information and business information of infrastructure.

4.1.4 Application layer.

It is also known as the application entity, provides services to the system. The archivists establish their own business management system by using various information resources provided by the application-supporting layer according to its own business needs.

4.1.5 The decision-making layer.

This is a management system that uses various basic and professional databases of infrastructure information platform, various decision-making models to form model and knowledge base to solve problems in a certain domain way through human-computer interaction.

4.2. Three-dimensional smart platform of infrastructure archive

The traditional two-dimensional management mode of underground pipelines has been unable to meet the needs of infrastructure development and services. The research and development of underground pipe network information system is to edit the basic geographic information data and underground pipeline data according to certain structure and layer, and store them in database in digital form. It realizes the smart management of underground pipe network data.

GIS is introduced into the information management of infrastructure archives, which can describe its distribution characteristics scientifically, completely and accurately, and provide reliable decision-making basis for the utilization of infrastructure archives, so as to realize the intelligent, three-dimensional and efficient management and utilization of infrastructure archives.

GIS component. The development of geographic information technology has experienced the process of functional module, package software, core software, and then developed to component GIS and WebGIS. 2)Spatial database technology supports the storage of massive data, structural query and analysis of spatial data, and provides convenience for spatial data management. 3)Geographic Data Element Set. Data is the core of all geographic information.

4.3. Infrastructure Archives Visual Management Platform

In the process of utilization, infrastructure archives are faced with the problem of inconsistent information, which is manifested in that the building name recorded in the file information of infrastructure files is not completely consistent with the building name submitted by archivists. This is because the name of infrastructure may change due to a combination of factors such as time, management, and city planning. When the change occurs, the archivist usually submits the usage request based on the current name of the building, but in the archive management system, the information related to the building is recorded according to the name of the building at the time of filing. This leads to the situation that the usage demand submitted cannot be met, and it is impossible to judge whether there is no archival information related to the building in the archive, or the inaccurate usage result is caused by keyword search error due to information inconsistency.

To solve the problem of inaccurate archive usage requirements, infrastructure archives visual management platform was built. Based on the principle of uniqueness of geographic coordinates of infrastructure construction, the platform associates the requirements of archive usage with the keywords of the infrastructure archives management system, and uses geographic coordinates as the keywords to achieve accurate searching. The construction goal of the visualization platform for infrastructure archives is to solve the information inconsistency problem among infrastructure archives, building geographical location and usage information, organically connect the physical space of infrastructure buildings with the information of infrastructure archives, and realize the accurate correspondence between physical coordinates and archive information.

5. Practical application in Zhengzhou University

5.1. Achievements in the construction of smart infrastructure platforms

The Infrastructure Information platform of Zhengzhou University mainly includes underground pipe network information management system, infrastructure archive management system, account management system, infrastructure business information system, etc. It conrains of PAMP and ASRMP. It is a comprehensive information system management platform. Through the construction of underground pipe network information system, the above ground and underground space information in the campus can be perfectly combined. The information management is realized, and the span from two dimensions to three dimensions is realized. The system function result diagram and display effect are shown in Fig. 2.

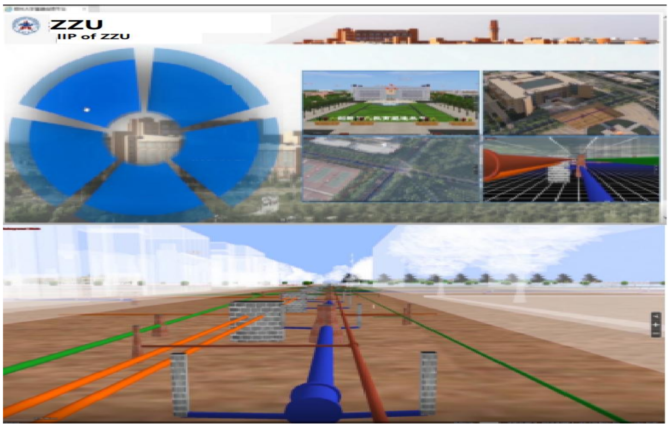

Fig. 2.Infrastructure Information platform of Zhengzhou University

& Combination map of above-ground and underground information

The burst pipe analysis function highlights the faulty pipe and can locate the valve controlling the pipe. Profile analysis function, according to the actual position of the pipeline, buried depth and section size output a specified range of longitudinal section of various values, and provide a print output of the value. In order to make the scene closer to the real environment, the system provides time simulation, rain and fog weather simulation and other scene simulation functions. The system provides property query, including click query, box query and other functions. The user selects the pipeline to be queried, or the pipeline type to be queried, to display the properties of the selected entity. And the query results directly generated chart, help users to find the required entity attributes easily and quickly. These four functions are shown in Fig. 3:

Fig. 2. Diagram of Tube burst analysis & Profile analysis &Scene simulation &Attribute information query

After reporting the need of querying the 3D model, the system can display the detailed information of the building and the building's archive information, including archival code, archive title, archive unit and other detailed information. The system also realizes the fast browsing of the archive for user, which can help the user to conveniently and quickly inquire the specific content of each archive, and the paper archive electronic, which improves the management efficiency of the archive . As shown in Fig. 4. The system provides archive usage function, which is associated with the archive entity. After selecting the name of the building to be queried, users need to click Query button to display all the archives associated with the building.

Fig. 3. Utilization and browsing of Archives

5.2. Achievements in the construction of Infrastructure Archives Visual Management Platform (IAVMP)

IAVMP can realize the organic connection between the physical space of the campus and the archival data of the campus, integrate the physical campus and the virtual campus, fully perceive the physical environment of the campus, and support the visual display of the name of the university buildings and the details of the archives. It realizes the docking with the existing archives management system and the visual presentation of infrastructure archival data on the map. To realize the searching and querying of infrastructure archives on the map, the system need to improve the intuitiveness and ease of operation of university infrastructure archives data, and provide scientific and effective management means for university infrastructure archives data.

The 3D campus virtual simulation map should provide the following functions: 3D simulation virtual display, 3D campus map display, map label, map label information viewing display; Free zoom, any area can be free map zoom, zoom operation; Arbitrary drag, drag the map to view incomplete display part of the map; Building positioning and query, building positioning coordinate system to achieve three-dimensional map building positioning query. As shown in Fig. 5:

Fig. 4. The 3D campus virtual simulation map

In the archive storage module, the "building mark" information associated with the archive can be viewed through the "detail" function of the archive entry and the archive ultilizing order. This module can also be through the "storage" and "please select the location" function, click the corresponding building, select "confirm" to achieve the archive and building association. As shown in Fig. 6.

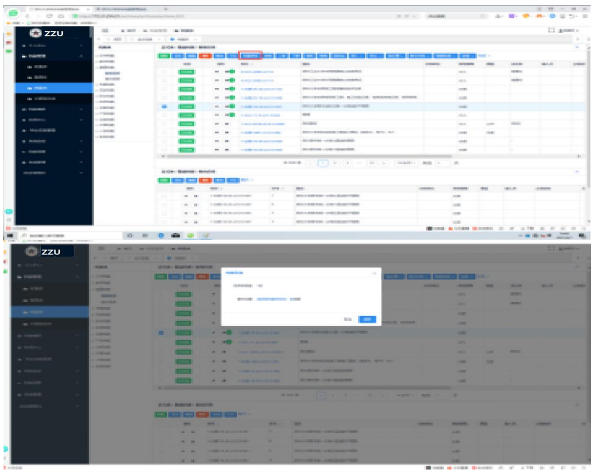

Fig. 5. The function of selecting location and clicking on the building

In the retrieval module of infrastructure archives, through the function key of "Retrieval of Archives", the building information can be transferred to the query page of the archive retrieval system with the key to query the results.

6. Future work and conclusion

This research carries out the work of smart infrastructure archive management paradigm. We analyzes the current problems of infrastructure archive management, and puts forward the theoretical framework and practical solutions. Combined with the new generation of information technology, we propose the smart infrastructure archive management paradigm, and three platforms. It is designed to solve the three problems of lack of systematic, standardized and smart infrastructure archives management paradigm, the inability of paper-based planar infrastructure archives to fully and accurately describe three-dimensional infrastructure archive information, and the problem of "information gap".

In the next step, GIS technology should be further applied to archive management, such as 3D archive display and utilization.

7. Acknowledgements

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