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Scientific Research

Research on Key Technology of General Embedded GIS

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Abstract: With the development of mobile devices and digitalization of information, the GIS system will be more popular than before. For the variable of mobile devices and different system structure, the design of universal embedded GIS system will be more difficult. In this paper, we talked the features of embedded GIS and the key techniques, design a highly portable general embedded GIS platform, and by using some applications to tested the advantages of the new system.

Keywords: embedded GIS, spatial data, portable

1. Introduction

Computer has moving fast into the mobile times. With the support of hardware, operation systems, GPS application and network technology, the access real-time location information, visit information and seamless combine the mobile object with the large geographic spatial database by wireless network have become the reality.

Embedded GIS is the combination of embedded technology and GIS, which is the extension, complementation and development of the former GIS.

This paper aims at meeting the demands of the fast-growing graphical mobile information service, combining the current embedded system and GIS theory, and highly portable development embedded GIS.

2. Feature and Key Technology of Embedded GIS

Embedded GIS integrates most GIS functions and combines fully of hardware and software. It's also an ideal solution for navigation, position, map query and spatial data integration which can be used in various areas.

2.1. Embedded GIS Feature

The main feature of embedded GIS is its diversity in facility, data management and function design. Heterogeneous embedded chip diversity results various product branches. Different system structure and embedded operating system are the main difference between facility and data management. In addition, because of different concerns of users, results the big difference between data management and visual demand. For the mobility of embedded GIS and hardware are closely combined, thus embedded GIS can better achieve various functions that can't be realized by PC, such as, GPS or base station positioning, wireless data telecom, etc. All of the above, expands GIS application areas, and generates more demands for embedded GIS.

2.2. Key technology of general embedded GIS

2.2.1. Spatial Data Organization

GIS mainly deal with geological spatial data [1]. With limited memory and storage space, high performance data model is essential for the mobile terminals. Besides, data management and applications of embedded GIS system should be closely integrated, so as to ensure its utility. Hardware platform in a PC or workstation used for Data management of GIS is not feasible for embedded devices, such problems as Memory size, Data read-write speed limit and spatial analysis performance and display performance. Only the pure usage of vector or raster storage can not meet the needs of the embedded platform [2], [3]. It's necessary to analysis smart mobile terminals such as, PDA or PMP and design a hierarchical sub-blocks vector data model. This data structure is applicable to all kinds of intelligent terminals for the hardware platform embedded GIS system is the key technology to achieve rapid storage and display of vector data.

2.2.2. Spatial Index Technology

The key of spatial data organization is data index and query. The performance of spatial index will directly affect the whole system performance. General spatial index are BSP trees, KDB trees, R trees, CELL trees,

quadtree, etc. In addition, simple grid spatial index has been widely applied. To most mobile applications, spatial index design will start from the analysis of embedded file system which was highly limited by display screen, memory and operational performance. Fast and short index structure and data access are key elements for index design.

2.2.3. POI（Point of Interest）Data Organization

The data which integrated with various industries has been an important context in Embedded GIS products. While the performance of database technology in common PC is limited for embedded system. Combining actual applications and designing separated data storage management is the general method for embedded GIS products.

2.2.4. Network Data Organization

The high efficient topological spatial data organization, management and analysis are basic functions of GIS. The various application network topological data should be included within this system. Path analysis is widely used in GIS application operation. Network data organization and management program will better serve embedded GIS system in limited computer performance. Path analysis is one of basic function of embed navigation product, so the platform design should organize network data carefully and optimize network analysis strategy and solution.

2.2.5. General Design

To meet the demands of embedded GIS system general versatility, the thoroughly analysis of mobile terminals is needed. At present, most embedded GIS related systems are designed for specified area, the data organization, data storage, memory management and GUI interactive design are limited by the designed functions. For high portability, the system needs to be designed from the bottom layer, especial the independence design of data access, GUI system and hardware abstract layer.

3. General Embedded GIS Design

From the above, we can see, embedded GIS is quite dependent in data management and application design, which integrates better with the basic layers. It tells us that system design and analysis should be conducted from bottom layer.

3.1. Spatial Data Organization Module and Index Design

The paper adopts the following design methods according to the embedded GIS system analysis.

Firstly, data access optimization design, which will fully carry out integrity optimization management for accessing data to reduce the times of data access. It is applicable to use data-layer and data-block method to manage the spatial data, and establish quadtree index structure according to data sparse density to achieve read and operation. Graphic data are composed by multi-scale maps for different scale embedded GIS data different accuracy display. Thus, all the graphic data are layered quadtree grid structure, all networks ID will be generated according to different scale and be indexed. All the corresponding data can be fast stored and accessed.

Secondly, to ensure data space utilization, optimize data storage, without storing by floating point data, and data are stored according to size and non-floating point.

Finally, to achieve GIS related functions, spatial data use data packet storage method[6].

It mainly has the following types, display data packet, POI data packet, network packet, the attribute data packet, etc. Every packet contains the following components, packet header information and inner packet data information. The former refers to the physical data index information and the latter refers to data stored in physical media. The following are specific explanation of various packets.

Display data block: Spatial data organization and management is to improve data fast transfer and zooming, and also store spatial data annotation information (figure 1).

POI data block: Spatial data organization and management design should in accord with high performance index, to meet various queries and index demands.

Network data block: network data organization and management in graphs main refers carrying out network analysis of these data.

Attribute data block: Various spatial data and attribute information storage and management, including various industry data management.

3.2. POI and Network Data Organization Model

POI data shorts for “Point of interest”, which is abstract from spatial entity concepts. It has been widely used, and

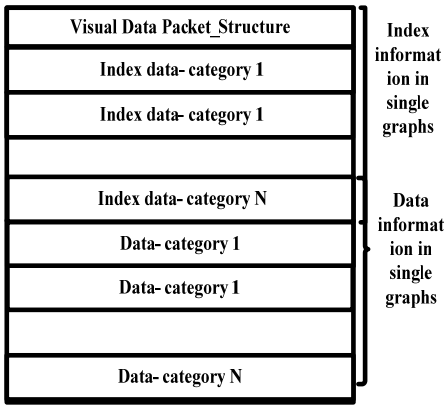

Figure 1. Display data packets structure

lots of field has detailed classification and coding specification. It is main method for fast information query in common GIS. To achieve high performance POI query and index, data should be carefully organized and designed. This system main carries out multi-layer index and queries according to the administrative divisions.

Network data is mainly used for network analysis which is very important in GIS system. Network data mainly stores data and mutual topological relations, which is the basis of network analysis. In this system, data are stored after compression which greatly reduces storage space.

In addition, it mainly stores network topology and node information.

3.3. System general design

One of main features of GIS is that it is applicable for various embedded platform, that is, it has high portability. It has two main parts, the visual module and data storage module which will greatly affect the product performance.

3.3.1. Data General Storage Design

Because of different terminal device and various API interface operation system, to ensure system independence and portability, it's necessary to design this part separately. The adopted approach is to use text document to manage data and only design basic data read and protection function. But this method increases difficulty of system design such as, massive data storage, data fast read of different region, etc.

This system design bases on physical document storage management method. For single physical document (figure 2), this system uses sub-page management method to save memory and sets page size to compose one physical document by multi-pages. The storage sector main consists of documents basic information and data. According to the operation system supporting storage method, the physical documents have two storage sector, physical document management and data. Physical document management start from the beginning to data sector and data sector start from its beginning to the end.

3.3.2. General GUI Design

Embedded GUI design usually adopts hierarchical structure and starts from OS kernel. As shows in figure 3, it has three layers, the bottom is GAL(Graphics Abstract Layer)-IAL(Input Abstract Layer), which is above the system hardware OS kernel and closely related to hardware drivers. The middle of the kernel layer is the most important part of GUI, which is usually C/S model. The top API layer is the users programming interface provided by GUI. The GUI system isolated GAL and LAL layer, which can isolate the underlying graphs device and upper interface which greatly improves GUI portability. Actual display in embedded device is Frame Buffer operation [7].

GUI is built on operation system, so the design should

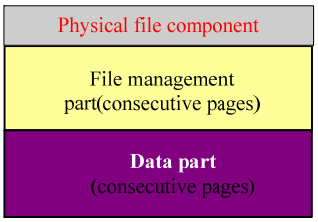

Figure 2. general data storage structure

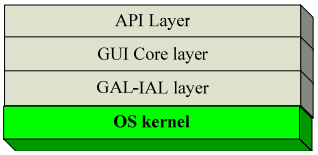

Figure 3. GUI layer

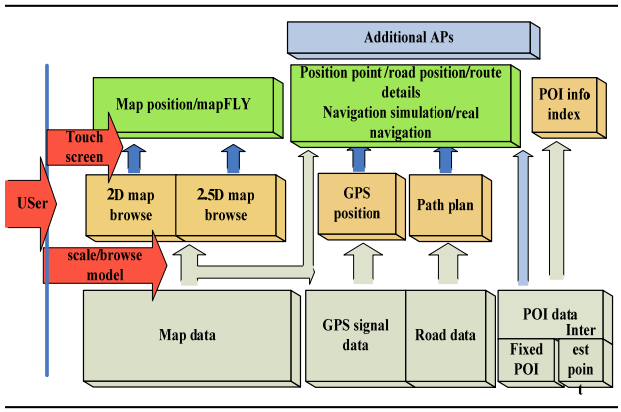

Figure 4. Embedded navigation system design graphs

take full advantage of operation system function, such as, process creation and cancellation, various communication mechanism, etc. These are interface provided by OS(Operating System). GUI system has the following functions, 1) Window's management, creation, destruction, switches, mobile, focus switch. 2) Message package, access and input events from the device file and convert it to the message structure. 3) The timer management, send the message to the server timely. 4) Memory management, use buffering mechanisms to improve the display effect. 5) Event management, window object communication, user and GUI object interaction, OS kernel and the GUI information exchange and synchronization.

4. System Application Development Cases

The embedded navigation system is designed by using the embedded GIS system on uc/OS2 system in this paper. This system also be ported to eCos, Linux and Windows Mobile and be tested on hardware platform such as, ARM, MIPS, etc. It has been testified that there is no difference between the systems.

Since the application layers are the same, only data access and message and timer modules need to be adapted. Figure 4 is the product function structure.

5. Conclusion

Embedded GIS will be widely used in personal and spatial information management, since 80% human activity relates to spatial information. Embedded GIS development is inseparable from the relevant hardware and software technology development. The device performance improvement, wireless communication and Internet technology will foster embedded GIS system application in mobile terminal development in all GIS sectors.

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