DEVELOPMENT OF ACCELERATOR MANAGEMENT SYSTEMS WITH GIS

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Abstract

We have been developing accelerator management systems for SPring-8 on a Web based Geographic Information System (GIS). Such systems are simply ”Google maps for accelerators”. We employ an open-source GIS system, MapServer, for the systems. MapServer is constructed on a server-client model. MapServer, which is behind a web server, reads data from various data sources, i.e., CAD data files, image files, relational databases and XML file, and constructs a web page of a map upon clients demand. Client application written in the web standard displays a map on their web browser. We have developed two web-based systems on MapServer. The accelerator inventory management system displays equipment locations on the map by reading data from a relational database. The other SCSS (SPring-8 Compact SASE source) alarm system displays an alarm location on the map in real time. The system reads real-time and static alarm data from the MADOCA database. We will show the mechanism and development of the above mentioned systems in this paper.

INTRODUCTION

A Geographic information System, GIS, is a system for managing geographically related data on computers. It creates, stores and manages data with spatial information and displays them on geographic maps. It has been widely used for scientific investigations, resource management, asset management, environmental impact assessment, urban planning, cartography, criminology, history, sales, marketing, and logistics.

In ICALEPCS 2005, Larrieu et al. [1] presented the potential use of commercial GIS for accelerator site management. Their work extended the GIS application area from geographical regions to buildings.

On the other hand, Google Maps and Google Earth [2] quickly became very popular in Web and desktop environments. Although, they have poor functions compared with professional GIS, maps on computers received much attention from ordinary PC users. In particular, google maps received much interest owing to their smooth operation, zooming and panning, despite their simple use of standard web browsers equipped with Javascript. The technique used in google maps called Ajax (asynchronous javascrprt+XML) and it has recently became main stream in web client programming.

Inspired by previous works we developed *Google map for SPring-8*, because SPring-8 is a large facility and we have sets of data that should be grouped by their location. We built two systems on GIS. One is an inventory management system for SPring-8 and the other is a real-time alarm display system for SCSS. For the next-generation X-ray free electron laser, which is under construction in the SPring-8 campus, we started using GIS to manage equipment location from the start of its construction.

In this paper, we first explain MapServer on which we constructed our GIS. We then describe the two systems that we developed. Finally, we discuss the plan of the equipment management system for the X-ray free electron laser.

GIS

Requirements

The system using GIS requires following conditions.

- Web based client and server system.
- Open source.
- Capability to handle available CAD data.
- Ease of managing application development and data maintenance.

MapServer

We choose MapServer [3] because it satisfies the above requirements. Many commercial products satisfy the above requirements except the open source. MapServer is the de facto standard in the open source GIS community. MapServer was originally developed at the University of Minnesota for managing forest resources. It handles a wide range of image formats, vectors and raster data and attributes in text format, XML-formatted files and relational database management systems. Two books have been published on MapServer [4], [5] in the United States, one of them has been translated in Japanese [6]. We do not explain details of the MapServer functions here. Much of information is available from the Internet and those two books.

Mechanism of Mapserver

MapServer reads various formats of data files. The attributes of data files, such as coordinates, display areas and layers are managed by one text file called MapFile. MapServer integrates data files upon the client's request with a MapFile configuration and generates a temporary image file to display on the client's application. MapServer has a set of APIs, named MapScript, to request MapServer. The user can build applications using MapScript. The application should not be necessary web application, but it should be stand-alone application. MapScript has wrappers

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that are used by many languages like PHP, perl, Python, Java .NET.

MapServer can run on multi platforms. We developed systems on Windows 2000 machines with MapServer Version.4.10.3. We examined whether it can run on Linux server without any modifications. The p.mapper client is written in Javascript taking account of the incompatibility between Internet Explorer (IE) and FireFox browsers. We tested our systems on IE, Mozilla Firefox and Opera browsers.

Client system

We developed both systems on the basis of a p.mapper [7] for a system for web browsing clients written in DHTML and server written in PHP/MapScript. We chose p.mapper from a wide variety of selections because of its many functions.

APPLICATION SYSTEMS

We have been developing two systems for the SPring-8 equipment manager and SCSS test accelerator [8] alarm display system.

SPring-8 equipment manager

We developed the SPring-8 equipment manager to manage equipment which are distributed in the SPring-8 site. Currently, the system manages the VME system and PLCs. The system also manages the following items.

- Equipment like VME chassis and PLC modules linked to location
- Slot management of VME
- Maintenance history and plan of equipment

A PostgreSQL relational database server manages above attributes. The system manages a group of pieces of equipment and displays the group in different layers on a map. The user can select layers by pressing buttons displayed on web browsers.

In addition to the default p.mapper function, we add two functions. One is the database viewer and the other is the data entry. The user can view the database entry of objects selected on the map. The user also add objects or data from the web browser, point and click on the map on the browser and enter notes on the equipment to popped-up window or add new equipment. The user-generated data are useful in tracking object history.

P.mapper provides many other default functions such as distant measurement, hyperlinking from icons on the map, zooming using a DHTML function and reference mapping.

A screenshot of the equipment management system is shown in Fig. 1.

SCSS alarm display system

We use GIS for the real-time and dynamic display of the data. SCSS successfully observed the first lasing in June 2006. We applied a standard SPring-8 alarm system [9] to monitor SCSS equipment. It monitors data that are acquired periodically from SCSS and writes alarm data to the SPring-8 control database when unusual data are discovered. We developed a graphical alarm display system for displaying the name and location of an alarm signal on the interactive map. A database client process periodically reads alarm data from the database and writes a alarm file for MapServer. The alarm file contains the name, location and alarm level of an alarm signal in GML (Geography Markup Language) file format [11]. The client program running on the browser periodically reloads map images from the http server without reloading entire web pages using Ajax techniques. The alarm system monitors 686 signals of SCSS. Because we have no time to enter the location of each signal to database, we divided the map into 26 areas and assumed the signals belong to those areas. The alarm signals are displayed in the area of the map. A screenshot of the SCSS alarm system is shown in Fig. 2.

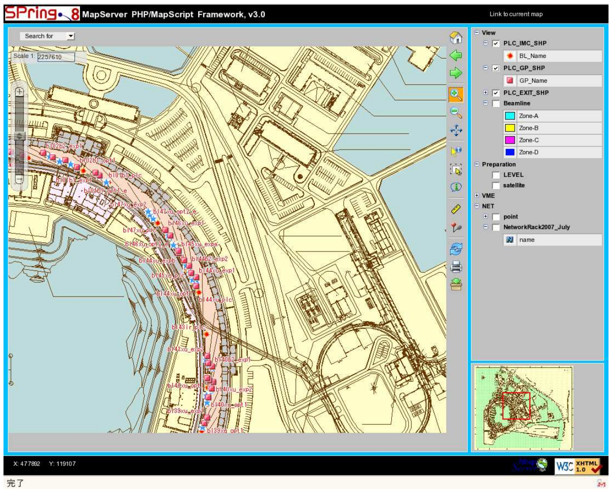

Figure 1: Screenshot of SPring-8 equipment management system.

Data Sources

For the original map data, we converted CAD data files to MapServer-readable shape file format, because MapServer cannot handle CAD data directly. We used fGIS [10], a free application, to convert dxf file formats of AutoCAD to shape file format. We deleted unwanted data from original CAD data manually before conversion.

Development

After we decided to develop a system using MapServer, it took about one man month to develop the equipment manager. Most of the time was spent to understand MapFile. In addition, at the beginning, we have very little knowledge of PHP and Javascript. One month included learning those languages. On the other hand, the development of the SCSS alarm system was straightforward. We

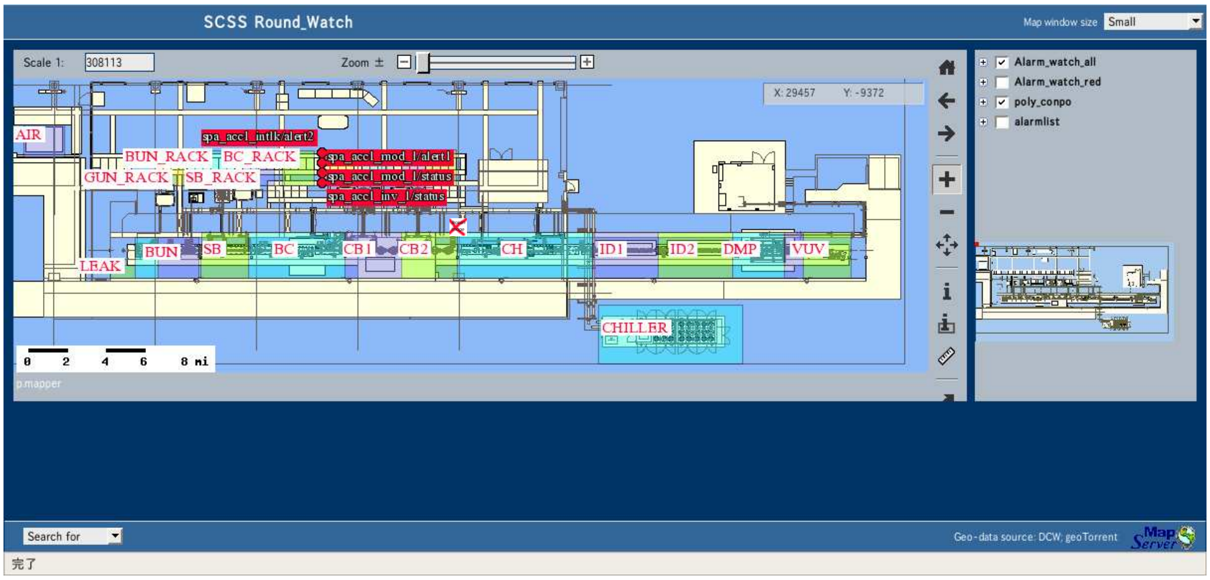

Figure 2: Screenshot of SCSS alarm system

Figure 3: Example of QR-code

developed the system in only one week. After we learned how to configure MapFile, the development became quite easy. However, entering data points takes much manpower. After entering VME and PLC data, we started data entry for the other equipment.

X-ray FEL inventry system

We are now constructing another inventory management system for X-ray FEL. It manages equipment tagged with a two dimensional bar code (QR-code) [12]. The location of equipment is managed by a QR-coded label on the floor. During equipment installation, the location of the equipment is entered by a handy terminal with a QR-coded label, which are distributed in 1m mesh on the floor. The history of the equipment is tracked by a QR-code label and a database in which the location and the time are recorded. The database system is connected to the SPring-8 MADOCA database, which are used for accelerator operation. The combination of logging data in MADOCA database and inventory management database may reveal an unknown property of individual pieces of equipment.

CONCLUSION

We developed two accelerator management systems on an open-source GIS, MapServer. MapServer provides an easy means of developing and integrating data distributed randomly into a map system. The systems provide unique user experiences with smooth interactive operation. Users acknowledges the power of combining visible maps and databases in daily operations. The point and click database entry system is accumulating data that will be useful in tracking equipment history. The GIS with a 2-D bar-code label system for X-ray FEL is under development. The system will provide help with the construction and operation of FEL with a unique combination of inventory and operation database.

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