A Realization of Power Cable Patrol System Based on GIS and 3G

Zhangwei Li and Shoucai Su

***Abstract*—The inspection of Power line is an important work to guarantee the electricity network's operation. At present, using the paper files - heavy workload, low efficiency - is the main method in power line inspection. This paper presents a real-time power patrol management system based on GIS and 3G. This system build a Patrol Management website based on Web GIS, administrator could complete the management task on the web. Otherwise, the system use PDA as the patrol terminal, which installed software developed based on Embedded GIS, Mobile Database and GPS. GPS and GIS spatial query technology can replace the Bar Code, Information Button and RFID technology, to supervise and query in inspection work. This is more than reduce the hardware requirements of the patrol terminal, also greatly improves the automation and intelligent level of inspection work. In addition, the WCDMA standard PDA could upload real-time video in support of high-speed mobile communications network, manager can see live. This is more conducive to management, to assist and to supervise the inspection work.**

***Index Terms*—3G, GIS, GPS power cable inspection.**

I. Introduction

Power inspection is the important measure to keep abreast of the status of grid operation, to ensure reliable transmission of electrical. The early patrol operations, patrol officers need to carry the paper file to the inspection site. Zhang Bin and his colleagues take barcode and information button technology in the inspection [1]. The system has better mobility, interchangeability; the fund of system implementation also has been reduced. New system use RFID tag to replace the bar code [2]. RFID tag is more secure, can store more information, and it hard to be damage cause environment. Mobile Database technology and GPS also has been used in inspection system [3]. It can reduce more money for the system, because there is nothing needs to install on the equipment.

We call the system mentioned on previous paragraph off-line inspection system. In this kind of system the administrator cannot know the situation of inspection scene before the task is completed. Zhou Chen proposed SMS data synchronization method based on the GSM cellular mobile communication network [4]. But the number of SMS characters is restricted, and the high cost of transmission is a problem. The GPRS is a more effective alternative solution [5]. It has a higher transmission rate, lower communication costs, etc. In recent years, the development of embedded GIS technology also attracted the attention of researchers [6]. On the basis of the above study, we use the WCDMA mobile communication network to further improve the efficiency of data exchange in the inspection process, combined with the Embedded GIS and embedded database auxiliary patrol officers. And even the introduction of the video call feature management center to keep abreast of the inspection site and guidance patrol officers to respond to unexpected situations. On the other hand, the use of Web GIS technology and Web-based management approach to make management more convenient, intuitive management the inspection task [7].

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II. System Architecture

This system hardware mainly consists of three parts: intelligent handheld terminal, inspection server, inspection management client as shown in Fig. 1. Intelligent Handheld terminal is a PDA carried by inspector, assist inspector to complete inspection. Intelligent inspection terminal will get through 3G network proceed data exchange with inspection server, accomplish inspection task lead, data collection, generate inspection record etc. The database of inspection server saved all data the system operation needed; provide services to inspection terminal and inspection management client through WebService and Website forms. On the management client, administrator will use web-based method to manage the inspection; the administrator only need to login the inspection management website to complete all management tasks. On the management client, administrator and engineer could check real-time inspection status, check historical inspection record, generate and distribute inspection tasks, watch the inspection video and so on.

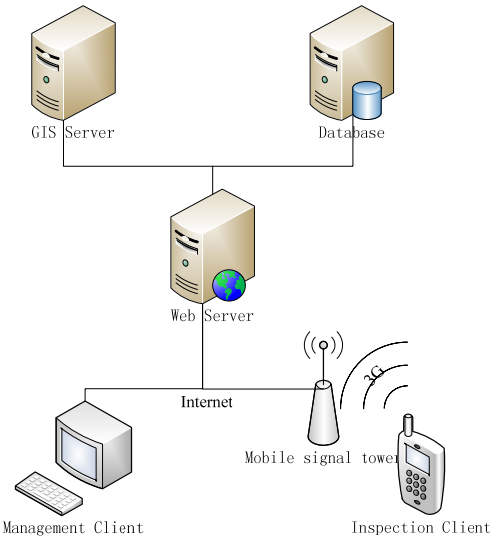

Fig. 1. The architecture of system

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A. Inspection Server

Submit your manuscript electronically for review. Inspection server consists of three parts: Database, GIS server and Web server, which is the core part of the inspection system.

Inspection Database provides data support for the inspection system, which contains the user data of the whole system, power line and equipment data, inspection task record and inspection trajectory data. Most power management departments have already built up their own equipment Database, therefore inspection management system and other system can share the equipment Database. Inspection task record is established by administrator based on inspection plan. It includes every inspection line and equipment data sheet, and administrator distributes the task to inspector. Inspection record used to store the goal line and equipment running status, defect information and site photos etc. Inspection trajectory data record includes the inspection terminal's location. These data not only can provide a reference for the administrator, but also provide support for inspection historical query.

GIS server released the whole area's map into a map services, provide visualization support for the inspection management, and make the system more vivid. On the Web server, uses WebService to support the data exchange between inspection terminal and Database on server, at the same time monitoring the video signal from inspection terminal and retransmit it to designated port which management client could read. In addition, inspection management site on the web server refers to the services released by GIS server, publish itself to the network, the administrator can use website to manage inspection system and supervise the inspection.

Above all, inspection server in the whole system not only responsible for receiving , storing, managing, publishing; But also publishing website and provide video signal retransmission services.

B. Inspection Management Client

Adopting popular web-based management method, administrator only needs to login the inspection management site on the Web server and then precede remote management. Use browser to log into the system website, once achieve system management, inspection management tasks etc on the Website. This method requires lower demand for the client's hardware and software, reduces the system's hardware fund, also make the system's mobility and portability stronger.

Management client gives users different permissions based on their various requirements, such as system administrator, inspection administrator and inspection supervisor. System administrator does not need the professional knowledge of power inspection, which responsible for website maintenance and update, database maintenance and management, and user management and so on. Inspection administrator has permission to access Database and inspector profile, which apply their profession knowledge of power inspection and its manage whole inspection plan so that generate inspection tasks and distribute to inspector. Inspection supervisor could check current state of the inspection, browser history inspection track and record, inspectors' attendance through the website in the form of a map view. In addition, inspection supervisor could keep contact with inspector who is performing a task in order to understand the status of the inspection scene and assist inspector to complete inspection tasks. When inspector need to call the administrator, running a video call software on the management PC from a specified port of the server to read network video stream and play (media player), at the same time collect local audio signal through a microphone and then transmit to the server. Inspection administrator and inspection supervisor execute management tasks through the map view form, visual operation can greatly improve the working efficiency.

C. Intelligent Handheld Terminal

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This system uses a PDA with Windows Mobile 6.1 operating system inspection terminal. The PDA has 2 megapixels camera, 0.3 megapixels external camera with dual LED flashlights (can output standard H. 264 video frames), support ISO15693 standard of RFID card reader, built-in GPS module and supporting Bluetooth2.0 + EDR standard, and supports both GSM and WCDMA communication formats.

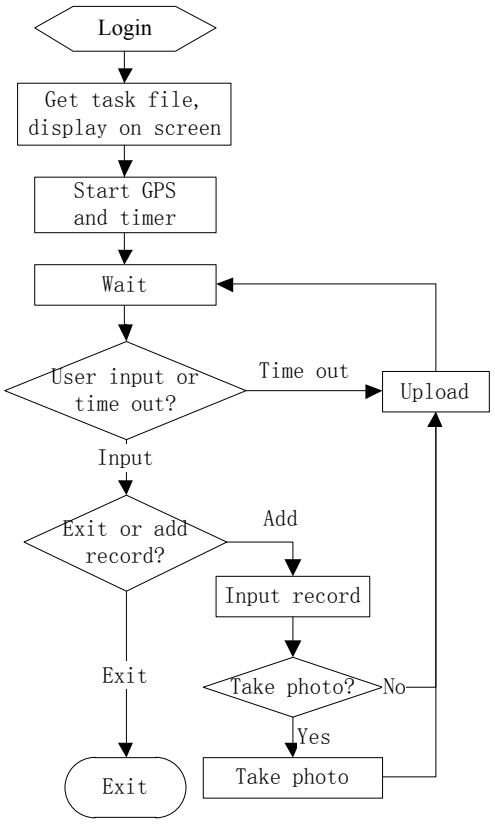

Fig. 2. The program flow of mobile client

Inspection terminal installed mobile inspection client software, which developed use Visual Studio 2008 and C# language based on third-party Mobile GIS SDK (ArcGIS Mobile). Software obtains the inspection lines and inspection device information from the server, combine with the

location information provided from built-in GPS, which could achieve the inspection point close remind and leaking warning. It is better to assist and supervise inspector, avoid missed inspection, improve the quality of inspection task. Software upload the location information collected from built-in GPS to server-side at regular time during the inspection process. On the other hand, inspector could input equipment running state, equipment defects record through touch screen, can also collect the photo, and upload to server.

Software could use the external camera according to the inspection need for the scene of the real-time video and voice, and sent to the server by using the Socket technology. The server will retransmit video signal to management client, it would help engineers to guide the inspector to cope with emergency.

If inspection terminal map data is enough to satisfy particular topological structure, it can provide additional services to inspection. For example, should use the basic road map information to provide path query and navigation services for inspector.

Mobile inspection client program flow chart is shown in Fig. 2.

III. Key Technologies

A. Data Exchange between Inspection Terminal and Server

System need to exchange inspection tasks, location information and inspection record data between the server and inspection terminal. This kind of data has small data size and transmission for a long interval. It can be used through the following two ways.

First way based on the file data exchange. Using the WSE (Web Service Enhancements) supported WS - Attachments service on the server side, and on the inspection client terminal programs use OpenNETCF. Web Services2 (a third class library), accomplish file transfer between server and terminal inspection. This way consume more time because data between the database and file conversion, file packaging and analyzing, but read-write in the backup database ensures the data security.

The second is to use SQL Server CE RDA (remote data access) technology for data exchange, it allows installing a SQL Server CE Windows Mobile devices directly get a list copy from the database on the Server, and send the revised list back to the Server and modifies the source list. This technique is directly exposed the database to the network, so you need to use more complicated and higher security authentication mechanism to ensure the data security. The more complicated and difficult problem is when multiple terminals at the same time sending data to the Server, update the same source list may cause the data loss.

In this system, should use the first way which is the file format for transmission of data to implement the data interaction. Packaging as a XML file for data transmission. XML file with a simple structure, convenient for Web transmission characteristics. The system for several main file exchange format makes the following constraints.

Task file

```
<?xml version="1.0" encoding="utf-8"?>
<task code="" >
  <line name="" length="" type="" start="" end="" >
    <point name="" location="" >
      <equipment name="" code="" />
    </point>
  </line>
</task>
```

Location file

```
<?xml version="1.0" encoding="utf-8"?>
<location code="" taskcode="" >
  <utc-time value="" />
  <longitude value="" />
  <latitude value="" />
  <altitude value="" />
  <speed value="" />
  <azimuth value="" />
</location>
```

Record file

```
<?xml version="1.0" encoding="utf-8"?>
<record code="" taskcode="" generatedon="" >
  <equipment name="" code="" >
    <content value="" />
    <attachment value="" />
  </equipment>
</record>
```

Inspection tasks, lines and the device node could expand more child nodes, device node could expand child node to store more device properties. Inspection record of the attachment for on-site photo, the file name of the attachment node stored. One record may not have attachment, can also expand multiple attachments node to notify the server's receiving program has multiple attachments will be uploaded.

B. Real-Time Video Transmit

Client program video upload module will transmit the on-site audio data which collected by inspection terminal to the management client side, and accomplish the voice calls between administrators and inspectors. Large amount of data transmission and high real-time requirements, which is the main reason for the system to choose the PDA that supports 3G network.

The extension camera of inspection terminal can collect image signal, using inside camera's hardware encoder to compress signal to conform to the h. 264 standard video frame. Inspection terminal program read frame data, collected with microphone audio signal into TS stream in order to realize high speed data transmission, system using WinSocket technology to set up the connection between server and inspection terminal. The inspection terminal program send TS stream to server's specified port, monitoring program on the server-side will write it into another network ports, at the same time put the data in-file and save.

Administrators use streaming media player software on the management client to play video, meanwhile collect audio signal sent to the server, once more the server transmit it to the corresponding inspection terminal. Such one-way video two-way voice communication function would be realized.

The above described the process of client requests video communication and socket connection. Requirements sending out could be management client or inspection client.

IV. Conclusion

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

This inspection system uses 3G mobile communication technology; not only translate electric power inspection work from off-line into online; meanwhile stable and high-speed data transmission channel makes local upload the audio signal to be realized. Intelligent inspection terminal use GIS and GPS technology, which does not only improve the efficiency of inspection task execution, but also make the management becomes more convenient and efficient. The system not only has extensive application prospect in the electric power industry, it also could be used in water supply, oil and gas transmission.

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