

The Design and Implementation of Field Patrol Inspection System Based on GPS-Tablet PC

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Abstract. According to the actual demand of land regulation, this paper presents a field patrol inspection system combining GPS and tablet PC through the integration of hardware and software. This paper has overall designed the function and framework of the field patrol inspection system. On the fundamental of solving some key technical problems such as serial communication between PDA and tablet PC and intelligent processing of date, this paper has developed a integrated field patrol inspection system by combining GPS and tablet PC on the basic of GIS. This technology is already verified in practice and proved to be feasible, which will improve the efficiency of land management and can achieve indoor and field integration of field patrol inspection work.

Keywords: GPS · Tablet PC · Land management

1 Introduction

Land utilization is a dynamic project and land regulation is a routine work for land management. The main technique methods of supervising presently are GPS-PDA, aerial survey, satellite remote sensing and field paper checks.

The development of GPS/PDA achieves the transformation from manual labor to intelligent operation, which would improve the work efficiency of workers working in the basic units [1]. Owing to the small storage capacity, slow running of imagines, limitations to the operation of each layer, the GPS/PDA with PDA as the basic hardware platform is mainly used in field location acquisition, which should work with interior work [2].

The aerial survey is typically applicable to the use of investigation updating, which is difficult to be applied in the land change survey due to the high price, complex treatment technology and long cycle; satellite remote sensing is usually used in the dynamic monitor of land use, which can lead field investigation through grasping pattern spots [3]; the method of “direct field annotation” that widely used at present uses the paper figure as work base, measures with conventional methods, writes the changing information by hand with the modification questionnaire form, then processes the interior work data and statistics the area, which has a large workload [4].

Therefore, establishing an integrated system, which can maintain the daily patrol process in land law enforcement and accuracy requirement, has high work efficiency, can realize the basic geographic information navigation and positioning and the processing of graphs and dates, has an important real-world implication. Thus, the field patrol inspection system based on GPS/tablet computer was discussed, which including the system integration and designing, GPS data receiving and processing, figure spots changing and so on, in this paper. Basing on these studies, the field patrol inspection system based on GPS/tablet computer was designed and applied.

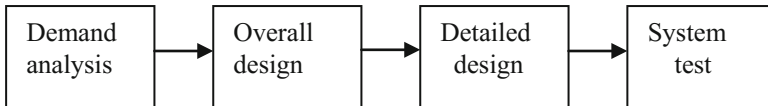
2 System Overall Design and Function Design

After processing the remote sensing data and thematic data under GIS environment, field patrol inspection system is undergone with the assist of the embedded GPS devices, which can exert the fullest potential of all date and sharply improve the efficiency and precision of the field investigation.

2.1 GPS/Tablet Computer System Design

Hardware Design

In the process of hardware design, first of all the work need to be done is demand analysis on the basic of early stage research, next is the overall design of hardware and then is detailed design about each module, finally is the test of hardware system. The flow chart of design is as follows:



Software Design

The software design of GPS/tablet computer system follows the ideas of software engineering. The design of the system software has experienced some stages, they are the feasibility study, demand analysis, general design, detailed design, coding, testing, iterative development and software test phase, etc. [6].



Specific tasks at each stage are as follows:

- (1) Demand analysis. During the early stage of the software design, field research is undergone to understand the land survey work process and make the business requirements of the basic land regulation clearly. Based on these information, the results of demand analysis is got, which could determine the business data stream,

the data dictionary of GPS/tablet computer system, and divide the software into base station data service subsystem, field data acquisition subsystem and data processing subsystem.

- (2) General design. Based on the object-oriented software design thought, modular analysis and data abstraction of each subsystem are proceed and improved, which leads the general design of GPS/tablet computer system model.
- (3) Detailed design. Firstly, dividing each module into specific program flow chart and algorithm, and then defining the communication interface between each module [7], finally forming the detailed design of each subsystem.
- (4) Software coding. Technicians code each subsystem of system on account of software development tools. In order to maintain the continuity of development, the compatibility of hardware platforms and operating systems should be paid more attention, and the code quality and the effectiveness of the proposed code comments should be controlled strictly, according to the characteristics of the various subsystems running environment.
- (5) Software testing. The testing and coding of GPS/tablet computer system software follows the ideas of iterative development. Every internal distribution of hardware system (internal release versions) is performed under the tester's test in detail, then the test report document is created, after modifying some problem by developers, regression testing is proceeding.

2.2 Functional Framework

The basic function of the field data collection in land use status update survey realized by the integrated GPS/tablet land supervision data acquisition system is shown in Fig. 1.

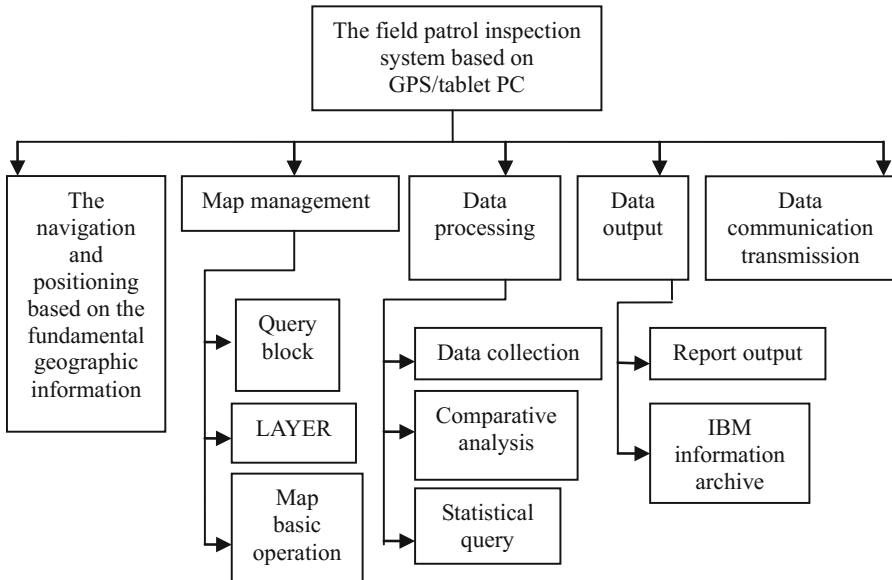


Fig. 1. The function frame of GPS/tablet computer field patrol inspection system

- (1) System initialization and setting function: setting the survey area code (provincial, city, county, township and village), associated data file name, setting the file storage mode, geology code system, GPS data receiving parameters and the transformation parameters between different coordinate system;
- (2) Base map operation function: realizing the function of importing, opening, displaying, querying, hiding and shut down the base map, and the hierarchical display and management of the base map data;
- (3) File operation function: realizing the function of creating, opening, saving and deleting the file, and archiving the search results after patrolling;
- (4) View operation function: realizing the function of amplifying, narrowing and roaming the view;
- (5) Navigation function: guiding field inspectors arriving the destination rapidly, through setting the identification of the destination and using GPS navigation and positioning;
- (6) Recording data function: realizing the receiving of GPS point data in real time, recording the inflection point, line, figure spot, linear features, sporadic feature and the topological relationship between other patterns of the terrain and GPS point data, and recording the attributes including its connected relationship with graphics, which can achieve the modification of graphics connection relationship and attribute data;
- (7) Coordinate calculating, coordinate transformation, data exporting functions: realizing the calculating of GPS receiving data, the transformation from latitude and longitude coordinates to land coordinates, and the transmission of original data, recorded data and calculating data;
- (8) Data format conversion function: realizing the transmission between recorded data format and land use standard data format;
- (9) Analysis function: contrastively analyzing the collected field data that is superimposed on the fundamental data, and confirming the region land use information immediately;
- (10) Transmission function: realizing the data communication between the law enforcement supervisory monitoring system and the on-board remote law enforcement supervision system, the collected data was sent to metro monitoring center and law enforcement patrol vehicles through the offline copy, Bluetooth, and 3G technologies, etc.

According to the basic function design, field patrol inspection system based on GPS/tablet PC can be divided into five modules: the navigation and positioning based on the fundamental geographic information, map management, data processing, data output and data communication transmission. Map management mainly includes map basic operation, layer operation and query block. Data processing includes data collection, comparative analysis and statistical query. Data output includes report output and information archiving.

2.3 The Acquisition and Processing of GPS Signals

The technology of reading GPS locating information through the serial communication between tablet personal computers and GPS cards is widely used in many fields. Due to small in size, large capacity, fast running speed and easier to site operation of tablet computer, so the GPS communication and information processing by using tablet computers shows some advantages [5].

The connection between tablet computer and GPS data is achieved by a serial port or parallel port of tablet computer and GPS-OEM mainboard, tablet computer can read the data of GPS-OEM mainboard, control the OEM mainboard and calculate the GPS cable data. Because of the slow reading speed (9600 bit rate), the COM cache interface is needed, so the design of data interface between tablet computer and GPS data is a relatively independent part of system software.

The JGG20 OEM mainboard that produced by LAVAP company was selected in this paper, which configurate with GRIL language (LAVAP company's copyright) that independent with the hardware. The thread of Window CE was designed independently to send GRIL language instruction through the COM interface of OEM, and to control OEM, which can achieve the data communication, controlling, extracting the cable information and saving the period GPS data in real time.

Under the development environment of Windows, the system that with the help of Supermap Objects and visual studio2005 development tool of Microsoft was explored, this system could run on a tablet computer or a computer with Windows operating system.

```
serialPort = (SerialPort) portId.open("GISLAND", 60);
serialPort.setSerialPortParams(4800, SerialPort.DATABITS_8,
SerialPort.STOPBITS_1, SerialPort.PARITY_NONE );

in = new BufferedReader( new
InputStreamReader(serialPort.getInputStream()));
```

The computer regards the GPS modules as a COM interface, the code is connected to COM interface, and some code to read GPS information with correct bit rate as following:

```
serialPort = (SerialPort) portId.open("GISLAND", 60); //
Opening port, reading one GPS message every 60 seconds

serialPort.setSerialPortParams(4800,
SerialPort.DATABITS_8, SerialPort.STOPBITS_1,
SerialPort.PARITY_NONE ); //Setting port parameters,

in = new BufferedReader( new
InputStreamReader(serialPort.getInputStream()));
//Reading message
```

- (1) When starting or stopping the GPS communication, serial port should be opened through opening a file, and related parameters should be configured;

- (2) After opening and setting the communication port, a system timer event can be created, and messages can be received and processed by events trigger mode;
- (3) GPS receiver can receive, calculate and send GPS navigation and positioning information continuously to the computer through ports when it in the state of work. The fields of information must be extracted from cache byte streams through systems and be transformed into locate information data that has practical significance and could support the figure spot changes;
- (4) GPS coordinate transformation: the calculated GPS point data is based on the WGS-84 geocentric coordinate system and the field patrol inspection results is based on the located Gauss plane coordinate system, so the GPS positioning results of geodetic coordinate (L, B) must be transformed to local Gauss plane coordinate (x, y).

There are two steps: the first step is to transform the WGS-84 geodetic coordinate (L, B) to WGS-84 Gauss plane coordinate; the second step is to combine the Gauss plane coordinate with local Gauss plane coordinate through plane coordinate transformation. The flow sheet of GPS communication signal module and analysis module is shown in Fig. 2.

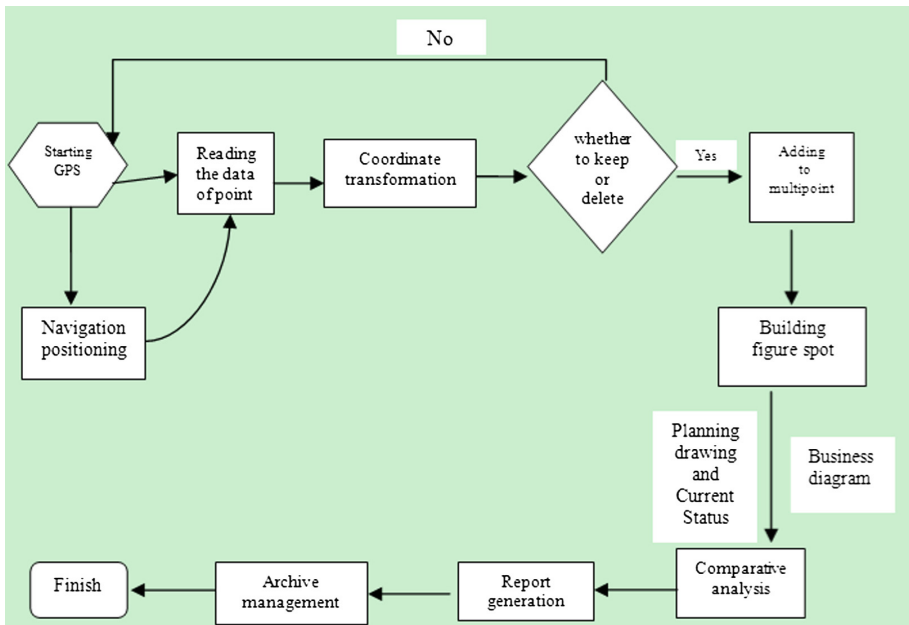


Fig. 2. The comparative analysis flow chart between GPS signal collecting and reading and figure spot

The flow of GPS communication signal module and analysis module: start the receiver GPS, reading the point data from figure inflection point, transform the WGS-84 geodetic coordinate (L, B) of point to plane coordinate, save plane coordinate

date, adding to multipoint, building figure spot, obtain area of various types land through comparative analysis between planning drawing and current status map, output area form of various types land, archive save.

2.4 Figure Collection and Analysis

Figure collection and analysis is the key module of a system.

Figure collection mainly includes the graphical data acquisition, data collection and comparative analysis of figure spot, present status and plan. And graphical data acquisition includes the graphic drawing automatically and manually. Graphical data acquisition can achieve the graphic drawing automatically or manually according to the point information obtained by the GPS signal reception and module analysis and acquisition parameters set by the user. As for the attribute data, actual survey information can be inputted to the system by field patrol inspection.

- (1) Point messages can be collected through receiving GPS signals and transformed to inflection point coordinates of pattern spot. The module receives these data and stores them into temporarily point sets. The specific method as follows: The inspector hand-held GPS/tablet computer and stand at inflection point of patrolled land for 5 s to collect GPS location information, then base station real time differential system can determine the exact location of the inflection point with a error about 1 m. The pattern spot can be created after the data collection, and all kinds of attribute information about add features will be recorded.
- (2) Collecting attribute data includes: the class name, nature of the ownership, location, practical applications and other attribute information. The pattern spot can be created after the data collection, and all kinds of attribute information about add features will be recorded.
- (3) Comparative analysis: the collected pattern spot from the field and the imported analysis data will be collected for overlay analysis, which can get the information about the occupation area of all kind of lands and judge whether the using land is illegal or legal for field personnel.

3 Conclusions

The GPS/tablet computer technology is a new technology of land regulation that combines with GPS, GIS and tablet computer, which is mainly used in land regulation field patrol inspections. Land field patrol inspection system with GPS/tablet computer technology realizes the integration of hardware and software and integrated application of GPS and GIS, which represents a development direction of land management applications with GPS [8]. After applied this system in some national project teams, it got a great success and greatly met the land regulation field patrol inspection field investigation work.

Comparing with GPS/PDA that used recently, land field patrol inspection system with GPS/tablet computer technology realizes the navigational positioning that based on basic geographic information and guides the field inspectors reach the destination immediately. This system has a fast running speed and can get specific information about land utilization by comparatively analyzing the collected figure spot, the present status and plan and make a judgment at once.

After the application in the demonstration zone, this system can largely improve the accuracy, efficiency and automation of land regulation field verification, which can achieve the “real-time supervision law enforcement and decision”, improve the working efficiency, enhance the land regulation and realize the popularization and application in land supervision business. This is the essential technological base of land regulation, and has great significance for improving the science and technology support system of land and resources.

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