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The Design of the Overload and Overspeed Detection System based on GPS, CDMA and GIS

Abstract. *The roads and the bridges have been seriously destroyed by the overload and the overspeed of large trucks, which often brings the fatal and huge security disasters. Although the overload has been controlled in the source and the transport tube has been strengthened, little success has been achieved. Therefore, it is required to develop a detection device which can real-timely detect the cargo capacity and the speed of vehicles. This system should intuitively and accurately monitor the cargo weight and the running speed so as to achieve the trucking information management, which will provide the regulatory basis for the transportation management department. The transport vehicle detection terminal designed in this paper has taken full advantage of the rich functionality of GIS system and adopted the vehicle dynamic detection technologies and the embedded technologies as well as the GPS satellite positioning technologies. At the same time, the CDMA wireless communication network has been also employed to communicate with the monitoring center so as to achieve the real-time monitoring for the transport vehicles. This technology is accurate and reliable, which has the good practical value.*

Streszczenie: *Przeciążenie i nadmierna szybkość wielkich ciężarówek może doprowadzić do uszkodzenia dróg i mostów oraz do poważnych katastrof. Istnieje więc konieczność wprowadzenia systemu detekcji pojemności ładunków i szybkości pojazdów, działający w czasie rzeczywistym. Informacje te muszą być przekazywanego do centrum monitoringu w departamencie zarządzania ruchem. W opracowaniu przedstawiono terminal detekcji zaprojektowany w oparciu o system informacji geograficznej GIS i system pozycjonowania GPS, zaadoptowane do detekcji dynamicznej. Do komunikacji z centrum monitoringu wykorzystuje się sieć bezprzewodową CDMA. Zastosowana technologia jest dokładna i realizowalna, ma duże praktyczne zastosowanie.* ***Projekt systemu detekcji przy przeciążeniu i przekraczaniu szybkości opartego o GPS, CDMA i GIS***

Keywords: GPS, GIS, CDMA, Overload and overspeed monitoring, Embedded system.
Słowa kluczowe: Systemy GPS, GIS, CDMA; Monitoring przeciążenia I przekroczenia szybkości

Introduction

At present, no matter the indirect detection method which has adopted the car components and the inductive displacement sensors to compose the dynamic detection device for the dynamic detection or the static weighting method which has employed the electronic tonnage instrument composed by the weighting sensors and the hydraulic jack to measure the loading capacity in the stationary state, both of them haven't been applied in the practice due to the complex detection devices and the inconvenient operations. It is necessary to develop a detection device which can directly and real-timely detect the cargo capacity under the dynamic (when the vehicle is running) and static conditions without being affected by the vehicle components. This device should intuitively and accurately show the laden weight and the mileage, etc. Then the safe traveling of vehicles will be ensured and the damage of roads and bridges will be greatly avoided. At the same time, this device can be used to support the information management of transport enterprises as well as provide the regulatory enforcement basis for the transport management [1-2].

The Geographic Information System (GIS) can directly and effectively use and express the geographic information data, which has met the demands of the integrated management of information and the data visualization services [3-5]. Therefore, it has been greatly applied in the fields of geological survey, traffic management and remote telemetry, etc.

As for the transport vehicle detection terminal designed in this paper, the embedded technology has been adopted when the GIS system is developed. After obtaining the latitude and the longitude of vehicles through the GPS satellite positioning, the CDMA wireless communication network will communicate with the monitoring center so as to real-timely send the various information of transport vehicles to the monitoring center [6-7]. Then the monitoring center can inquire and dispatch the whole traffic team. This system can not only give full play to the powerful application development capabilities of the common editing tools, but also take advantage of the rich functionality of the existing GIS system.

The overall design of system

The transport vehicle detection terminals based on GPS and CDMA are composed by the vehicle load detection system, the GPS detection terminal and the data transmission network, etc, in which the data transmission network is composed by the CDMA network and the Internet.

The vehicle terminal has employed the S3C2440A 32-bit ARM chip which is developed by Samsung company as the CPU. S3C2440A has adopted the advanced ARM920T core and 3-channel UART serial ports, 2-channel SPI ports, 8-channel 10-bit ADC and other rich resources have been integrated on the chip. The hardware structure is composed by S3C2440A, the debug interface on JTAG chip, the video interface, the audio interface, the reset circuit, the CDMA wireless communication module, the GPS module, the power supply circuit, the LCD touch screen and the keyboard, etc. The exterior of hardware is connected with the memory. The hardware structure can be shown in Fig.1.

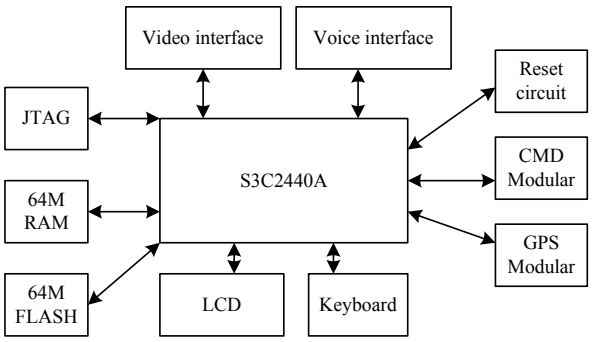

Fig.1. The hardware structure of the terminal

The vehicle load detection device is completed by the freight vehicle load automatic detection and display device, which is composed by the circuit connection of the weighting sensors, the signal transmitters, the mileage sensors and the load detection displays. The weighting sensors have employed the metal resistance strain sensors which have been symmetrically installed between the rear

plate and the rear axle steel prop under the beams of vehicle rear wheels. The mileage sensors have adopted the photoelectric speed sensors which have been installed in the vehicle transmission. The load detection display has employed the intelligent automated instrumentation and the measured signals have been sent to the RS232 interface of S3C2440A.

The vehicle terminal can accurately position the vehicles though the GPS satellite network. Afterwards, it will access to the Internet through the CDMA wireless network and then the terminal will be linked to the monitoring center servers. The speed, the time and other GPS data information of vehicles will be real-timely transmitted to the monitoring center and the detection center can real-timely monitor the running state of vehicles. The GPS module is the key to achieve the precise positioning, which has been considered as the core in the design of terminals. In this paper, the terminal has selected the SIFE GS-15B module developed by Gstar Company. The GPS antenna has been internally installed in GS-15B with the full functionality.

The CDMA module interface terminal has adopted the Huawei EM200 CDMA1X modules and integrated UART, UIM card, antenna and other rich resource interfaces, which has supported the standard AT command set. The EM200 module is connected with S3C2440A through the serial port 1, which has achieved the data receiving and delivering between them.

System design

The terminal software is designed according to the WinCE 5.0 embedded operating system. The operating system has a lot of advantages such as the good user interface, the higher timeliness, the less resource, the rich development tools, the strong technical support and other advantages, which has fully met the design requirements of the terminal software.

The design process of terminal software

Firstly, the system should be electrified. Secondly, the WinCE kernel should be loaded. Thirdly, CPU, LCD, GPS, CDMA and other peripheral modules are required to be initialized. Fourthly, the serial drivers and the network protocols should be loaded. Finally, the user applications are required to be implemented. The user applications of terminal have contained the CDMA wireless network access program, the network data transfer program and the GPS serial port receiving procedures, etc. The design flow chart of terminal software can be shown in Fig.2.

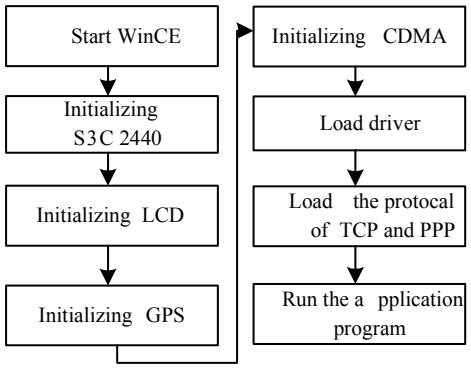

Fig.2. The design flow chart of terminal software

The CDMA module can be controlled by terminal through the AT command so as to achieve the wireless network access and the network data transmission. When the system is operated, the CDMA module should be initialized. Then it will be kept in the dial-up waiting state. The terminal will connect with the logon network through the PPP dialup. The user name and the password are card. After landing the Internet, it is required to call the GPS serial port program and the network data transfer procedures. At the same time, it is also necessary to send the GPS positioning information of terminal to the monitoring center through the timing mode.

The AT command which has established the PPP (point-to-point protocol) connection as well as the return values can be shown as follows:

AT%ACCNT=card.card
OK
AT%PPPOPEN
%CORC:#888,1
%PPPOPEN:0
%PPPSTATUS:0
OKAT%PPPSTATUS //PPP
%PPPSTATUS:0

CDMA wireless network communication program

When the terminal is connected with Internet through the CDMA network, the wireless network communication program will upload the GPS data parsed by terminal to the monitoring center through the Internet. The procedures of the wireless network communication program of the monitoring center can be shown as: 1) the socket () function is used to establish the socket; 2) the bind () function is adopted to use the socket and the local IP address; 3) the listen () function is employed to connect the request; 4) the accept () function is used to send and receive the data; 5) the fork () function is adopted to derive the new child process and the terminal communication.

Terminal GPS serial procedures

The terminal GPS serial procedures are mainly used to receive and parse the GPS data. The GPS module output has followed the NMEA-0183 standards. The procedures can be shown as follows:

1) the OpenPort () function is adopted to open the serial ports so as to obtain the operation handle of serial port 2; 2) the GetCommState () is employed to read the DCB variables of serial port parameter structure; 3) the SetCommState () is used to set the serial port 2; 4) the received GPS data and the parsed GPS information are displayed on LCD by the SetWindowText ().

The embedded technology GIS sofetware based on mapinfo

Mapinfo is a powerful general-purpose geographic information and spatial data management system, which has a lot of functions such as the rich GIS data editing conversion function, the analysis and processing function, the browsing and displaying function and the querying and retrieving function, etc. It is one of the GIS basic platforms that have been widely used. In this paper, the GIS application software has been developed through employing the popular Mapinfo geographic information system, the Visual Basic 5.0 programming language and the embedded technology. There are three methods to embed the Mapinfo system into the application program: the OLE automation method, the extensive response method and the dynamic data exchange method.

The OLE automation refers to the dynamic information exchange process conducted by two different applications through the client/ server approach. The application which is considered as the server has provided a group of object models with specific methods and properties. However, the room procedures have used the standard communication

interface for access and control. The highest level of the OLE automation object model provided by Mapinfo refers to the ApplicatiON object. The object collection of MapBasic application MBApplications and the object collection of its public variables MBglobals have closely followed. The Mapinfo objects should be embedded into the applications and it is required to declare an ActiveX object variable so as to establish the Mapinfo running instance:

Public MapInfo As Object:

Set MapInfo=CreateObject（'MapInfo.Application'）

Based on the above codes, the MapInfo system has been started and automatically run in the background. Through accessing the properties and the methods of Application objects, most of the functions of MapInfo system can be obtained. If the map display function of MapInfo is required, other map windows can be embedded into the specified forms or graphical controls. The following codes can allow the map windows of MapInfo to be displayed in the Picture controls of application forms.

MapInfo.Do"Set Application Window"& Form2. Picture 1.hwnd

MapInfo.Do"Set Next Docment Parent"& Form2. Picture1.hwnd &"STyle 1"

When the map windows are embedded, the applications can enlarge, reduce and move them. Other windows provided by MapInfo system can be also embedded through the same method, such as the illustration window, the layout window, the information window and the data browser window, etc.

Most of the functions of MapInfo system can be used by the applications through the OLE automation technology. However, as the client/ server operation method has been adopted, the applications under OLE automation mode can not fully meet the application demands. Therefore, it is required to employ the CallBack (response) method and the dynamic data exchange technology.

Conclusions

According to the current situation that the overload and the overspeed of large trucks are very serious and they have not been effectively controlled, a transport vehicle detection terminal has been proposed in this paper through employing the modern electronic technologies. It has fully used the rich and intuitive functions of GIS system and adopted the embedded mature development technologies, the GPS satellite positioning technologies and the CDMA wireless communication technologies as well as the vehicle load dynamic measurement technologies. Then the communication with monitoring centers has been realized and the real-time detection for transport vehicles has been achieved. The practice has proved that the detection for cargo capacity and speed is convenient and accurate. The interface is friend and the expansion function of system is strong. The effect of this system is good and it has the good market prospects.

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