ITS VEHICLE SUBSYSTEM BASED ON GPRS

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ABSTRACT

The IMS(In-vehicle Monitoring Subsystem) of VMS(Vehicle Monitoring System) is the multifunctional and complex integrate embedded system, which sends the data of various in-vehicle devices to MC(Monitoring Center) and accepts commands and schedules from there. Using GPRS platform in this system make it possible for real-time and effective data transmission. This paper proposes some new insights on IMS applied to public traffic, including its software and hardware composition, and its realization method.

KEYWORDS

ITS, GPRS, GGSN, SGSN, GPS, PPP, Embedded System, IMU, IMS, VMS

INTRODUCTION

Under the background of cities traffic changing rapidly and degree of complexity improved increasingly, the research and development of ITS have become urgent and necessary. Since 1950s European, American and Japanese have begun the research in ITS and achieved a great progress from the end of 1980s to the beginning of 1990s. As for as VMS of ITS, it develops with the improvement of wireless transmission technology, experiencing several stages from conventional radio, analog trunking system to SMS (Short Message Service). The appearance of GPRS undoubtedly gives stimulation to development of, which intensifies the function, improves the reliability, and enhances utility of the IMS. We can safely say that GPRS pushes the research of VMS into a completely new stage.

THE CHARACTERISTICS AND REALIZATION OF GPRS SYSTEM

GPRS is the acronym of General Packet Radio Service, one member of content realized by GSM

Phrase 2.1.It is a new kind of data transmission service. The appearance of GPRS has two important meanings: ①Introducing packet switching ability into the GSM network; ②Rate of transmission exceeding 100kbit/s. It is well known that GPRS adds two crucial nodes to the primary GSM network----GGSN (Gateway GPRS Support Node) and SGSN (Serving GPRS Support Node) and modifies some software and hardware correspondingly, which could protect the investment in fixed assets of GSM farthest and make the communication system to stride a large step to the direction of UMTS.

On the point of the entire Internet, GPRS network could be considered as a IP subnet of the Internet, and the GGSN is its gateway which performs the function of a router approximately, by which the GPRS network could connect to external TCP/IP and X.25 network. And the property of GPRS is invisible to external data network simultaneity.

The transmission platform of GPRS is suitable for intermittent and aperiodic data transmission, the interval time between twice transmissions much greater than average transmission delay. It is not only fit for frequent transmission of modicum data but also for frequent transmission of mass data. GPRS has many incomparable advantages that other transmission methods possess:

- Higher frequency resource using ratio, the same frequency resource as GSM
- Always on-line, on line forever once connecting
- Real time and high efficient, the highest transmission rate up to 171.2kbit/s
- Low cost, charging in accordance with data flux

GPRS could provide many kinds of service, including carrying service, user terminal service, bear service and so on. Thereinto carrying service consists of PTP (Point To Point) service and PTM (Point To Multipoint) service which both sustain the IP standard. So we can use GPRS as Internet, browsing WAP site and Email online and exchanging data with Internet. Our IMS is a new embedded system based on the characteristics of GPRS.

METHONDS OF ARCHIVING SYSTEM HARDWARE

VMS based on GPRS contains IMS, data transmission channel and MC. Figure1 shows the position of these parts in the system:

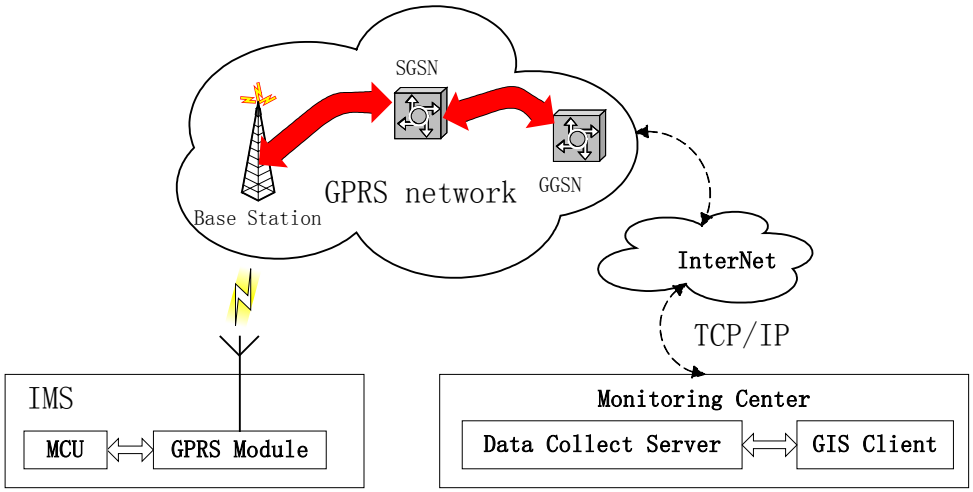

Fig. 1 VMS (Vehicle Monitoring System) architecture

In this system, IMS(in-vehicle monitoring system) is located in the underlayer, including IMU(In-vehicle Monitoring Unit) and some peripheral. Data transmission channel contains mobile base-station, GPRS gateway and Internet network. MC is located in the toplayer, including one or more computer with external network IP address, GIS(Geographic Information System) and interactive monitoring platform.

Compared with MC, IMS is the pivotal part in the entire system. How to realize IMS successfully becomes the sally port in the system because its environment is so complicated and it requires high reliability. IMS consists of many devices, such as MCU processing unit, GPRS data communication module, GPS receiver, LCD, VIR (Vehicle Information Recorder), ICTA (IC Card Ticket Agent, audio communication unit, ASN（Automatic Station Notifier）and so on. Every part undertakes relatively respective function and exchanges the data with IMU, so how to disposal the in-vehicle devices in line is one of the important work for IMU. The structure fig of IMS is shown in figure. 2

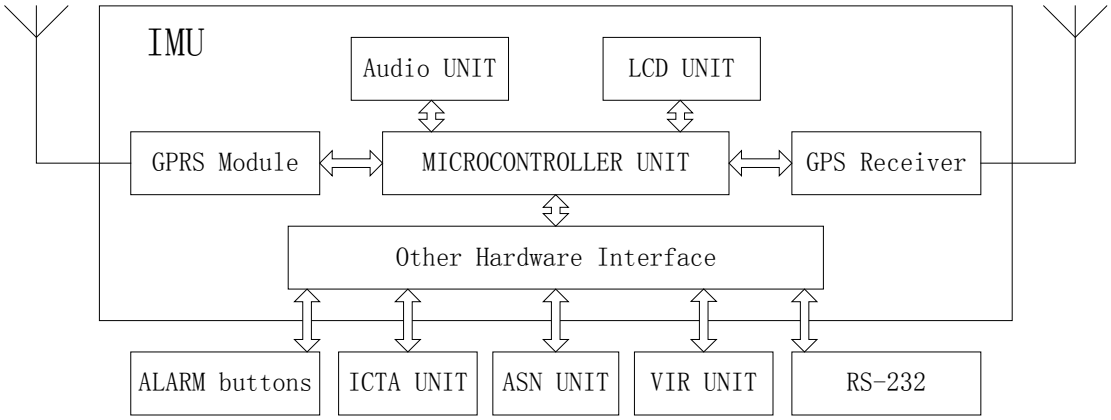

Fig. 2 IMS (In-vehicle Monitoring Subsystem) hardware architecture

In the MCU processing unit, we select the high performance to price ratio microcontroller—W77e58. Its especial advantages are shown as following:

- Two enhanced full duplex serial ports
- 32kByte on-chip Flash EPROM

We consider one of the serial ports as data output which could send the useful data to ANS and be monitored by computer. The other serial port should be taken for the multiplex port which could initiate the system parameters, receive GPS signal, ICTA data, VIR data etc. By using the 32kByte on-chip flash EPROM, we can save the step of adding external EPROM. By this means, the cost of hardware is also cut down.

We select the G18 wireless modem manufactured by MOTOROLA co. as our GPRS communication module, which is considered as hardcore when accomplishing the GPRS data communication. The operation for GPRS module is a significant step in IMU program. GPRS module integrates TCP/IP stack and the serial port for user according to RS-232 standard that is very convenient to operation.

VIR should gather various data via all kinds of sensors, such as the number of passengers who go on or got off in every station, the using condition of the fuel, the temperature and the humidity in the bus and so on.

We needn't extract the data about the sum of money got from the ICTA until that the bus go back to the terminal, but could send them to the MC via GPRS platform.

ASN should calculate the distance between the bus and the station by using the Positioning data which is received via the GPS receiver and disposed by MCU processing unit, and report the name of the station etc. automatically.

The chip 24c01A based on I^2C bus standard stores the initial system parameter which is read and written by byte. Its capacity is 1kByte, storing PDP context, data sending interval, MC phone number, local port, MC IP address and port, SIM card username and password, bus number, route number, and team number etc.

On the whole point of view, The system utilizes the multifunctional MCU which has the advantages of low cost, low power consumption, high stability and reliability to realize the logging on GPRS, transmitting data by TCP/IP and controlling various peripheral to work in line. So we can say that it is a very practical advanced system with high performance to price ratio.

METHODS OF ARCHIVING SYSTEM SOFTWARE

On this IMS, the software part of GPRS data transmission is contained in the IMU. The GPRS module is absolutely necessary component so that it is the only device should be self-checked on starting up. The flow chart of this program is shown in Figure.3.

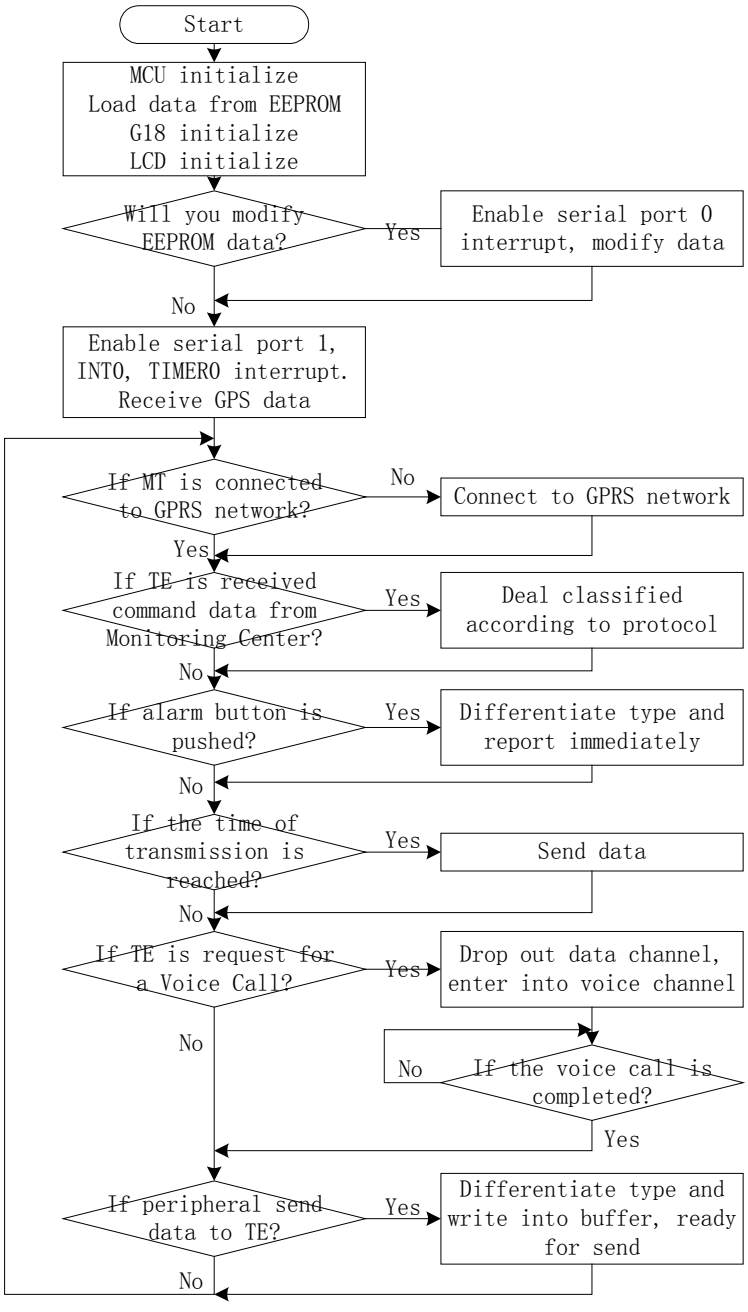

Fig. 3 The embedded software flow chart

Note: TE（Terminal Equipment）refers to MCU, MT（Mobile Terminate）refers to G18 wireless

modem.

In general, after the necessary initiation, this program will enable serial port 0 and serial port 1, timer 0 interrupt and external interrupt 1, and then complete a serial of judging jobs: if MT is connected to GPRS network; if TE receives commands; if TE requests a voice call; if time of transmission is reached; if peripherals send data to TE; if emergencies have taken place and so on. Each situation should be dealt with responding segment of program, and return to main loop to judge new working conditions.

IP package is transmitted on the GPRS network, so it should enter data channel from voice channel, namely active PDP Context, which is the key technology of software of IMS. Specifically explain as follow: MCU initiates G18 Module with AT commands, including:

AT&C2------DCD is set to ON when PDP is active; AT+CSQ------Signal quality; AT+CGDCONT------define PDP context. Then use ATD*99# to active the PDP context, after this operation, We enter into PPP negotiation phase, and will use LCP (Link Control Protocol), PAP (Password Authentication Protocol), and IPCP (IP Control Protocol). Now we describe the progress approximately:

step 1. TE (MCU) send LCP Request to MT (G18)
step 2. TE receive an LCP Request
step 3. TE send an LCP ACK (for step 2)
step 4. TE receive an LCP ACK (for step 1)
step 5. TE send a PAP Request
step 6. TE receive and ACK to its PAP (from step 5)
step 7. TE send an IPCP request for an IP of 0.0.0.0
step 8. TE receive an IPCP request
step 9. TE reject an IPCP option (from step 8)
step 10. TE's IP--0.0.0.0 was rejected (from step 7) but get an IP suggested
step 11. Send new request requesting the suggested IP
step 12. Receive a new IPCP request with the option TE rejected (in step 9) removed
step 13 TE ACK his new request (from step 12)
step 14 TE receive an ACK for its request

By this means, we can setup the wireless channel from terminal equipments to GPRS aerial interface so that peripherals of IMU can take advantage of this channel to send data to the MC, while accept commands and schedules from there. On considering the data transmitting characteristics of IMS such as lower quantity of flow, higher burst rate, discontinuous data and so on, so we adopt the simpler UDP protocol. It has been proved that the effects are very striking after testing.

METHODS OF IMPROVING SYSTEM RELIABILITY

In order to ensure IMS to work steadily and reliably, we take appropriate measures to improve it in software and hardware aspects, which can be shown as follows:

1. First of all, we improved index of power supply quality. This system uses DC power supply with wide-range input and two isolated output. We adopted some measures such as multiple filter, over-voltage and over-current protection and reverse protection in input end as well as two-stage voltage-regulated technology and repeated filter in output end so as to get safe and reliable power.
2. The whole system selects components with first level industrial standard. Digital ground, analogue ground and shielded ground are isolated each other so as to isolate high frequency signal farthest.
3. On programming software, we use watchdog to prevent system breakdown and adopt sending counter to ensure normal sending speed of signal, examine the working status of all modules at regular intervals so as to guard against error operation from MC etc.

By using a series of effective means, we have improved reliability of system dramatically while met the demand of all-weather running without increasing system's power consumption.

SUMMARMY OF EXPERIMENTAL DATA

After three-month experiment run on the buses, we coordinated lots of experimental data, result can be shown as follow Table.1

	Rate of data losing	Rate of data delaying	Rate of error code
Insufficiency of protecting means	6%~12%	1.5%	<0.001%
Sufficiency of protecting means	3%~8%	0.01%	≈0

Table. 1 Experimentation data

It can be seen from table.1 that each index of system had been notably improved after making several improvements on system reliabilities. However, because of existence of blind area, delay and loss of data also occurred occasionally. We believe that this situation will appear less and less while system performance will be perfected day by day with the increasing construction of GPRS network.

CONCLUSIONS

IMS based on GPRS has many outstanding characteristics such as real time, higher speed and lower error code rate. Its realization will greatly improve the present situation of our more and more disordered traffic. With the rapid development of relative technologies and increasing demands from society, we are deep confident that the ITS based on GPRS would be in new movement to promote applied development in few years.

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