Design of Accurate Vehicle Location System Using RFID

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Abstract

As for obvious shortcomings of using a simple GPS method to achieve the vehicle location, it is unable to require the information of real-time vehicle location and vehicle running state in some special circumstances such as tunnels and built-ups. Hence, the vehicle monitoring system to acquire real-time vehicle information is needed. In this paper, by integrating with the technology of RFID, GPS, GPRS, an accurate vehicle location system in a variety of complex environments is proposed, which is able to improve the precise vehicle location and get the mechanical information of vehicle status by the technology of wireless data communication.

Keywords: *RFID, GPS, GPRS, accurate vehicle location*

1. Introduction

At present, the modernization of transport has been an important criterion to take the measure of urban modernization level. Developments in communication and network technology have been improved highly. And the vehicle location, widely used in the road transport of dangerous goods (RTDG), logistics, armored car and other particular fields, becomes a core position in the modernization of transport. Thus, it is a hot research point.

Many researchers pay attention to the combination of GPS and other relevant technology for vehicle location. Many approaches have been proposed.

Based on GPS and GSM, Farooq U. [1] proposed and implemented a solution for enhancing public transportation management services in Punjab province of Pakistan. And Thong S.T.S. [2] proposed an intelligent fleet management system. Congshan Qu [3] introduced a GPS and CDMA application system based on embedded Linux operating system.

Based on GPS and GPRS, Tao Ning [4] designed the new vehicular monitor system. Yougui Liu [5] achieved vehicle location tracking on Internet by using GPRS vehicle location terminal and combining with Internet technology and GIS technology. Al-Taee M.A. [6] presented a distributed system for remote monitoring of vehicle diagnostics and geographical position.

Meanwhile, there are other methods by using just a single technology for vehicle location. Jie Du [7] described a vehicle-lane-determining system by low-cost Differential GPS (DGPS) receivers. Bana[8] proposed a pseudo-noise (PN) code to be carried by the magnetic markers. Gongliang Jiang [9] put forward the system architecture for public transport vehicle location and navigation system based on GPRS.

At the current, vehicle location devices with a single GPS technology-based product have played an important role on the market [10]. However, there are obvious shortcomings by using a simple GPS method in the aspect of positioning accuracy and coverage.

For instance, it is unable to require the information of real-time vehicle location and vehicle running state in some areas such as tunnels [11] and built-ups. Narrow streets between high-rise buildings blocking GPS signal paths provide limited visibility to satellites and cause multipath effects, so reliable in-car navigation only becomes possible with high position accuracy and up-to-date map database [12]. The accuracy of GPS location is not precise and the position drift for vehicle location is large. As a result, the management of vehicle is inconvenience and can not meet the requirement of a high standard for managers.

Due to developments of RFID technology, it has been widely used in many fields. In sense that several key technologies of RFID, GPS and GPRS are independent and lack of relational connection, their advantages could not be mingled with each other.

In response to such problems, by integrating with the technology of RFID, GPS, GPRS, an accurate vehicle location system in a variety of complex environments is proposed in this paper, which is able to improve the precise vehicle location and get the mechanical information of vehicle status by the technology of wireless data communication.

The rest of this paper is organized as follows. In Section 2, a brief overview of RFID technology is given as background information. In Section 3, the scheme of accurate vehicle location system is given. Section 4 introduces the designation of accurate vehicle location system, including hardware and software. Finally, conclusions and future works are described in section 5.

2. RFID background

RFID is not a new technology. RFID technology is one of the pivotal enablers of the 'Internet of Things' [13]. Today RFID is a generic term for technologies that use radio waves to automatically identify people or objects [14] and have revolutionized automatic identification and data capture technologies [15]. The system comprises two separate components, namely a transponder or tag usually located on the item to be identified or tracked and an interrogator or reader [16].

A tag (or a transponder) can include other information which opens up opportunities to other new application areas except the ID.RFID tags fall into two main categories: Active and Passive. Passive tags do not contain a battery or power source. Active tags have internal batteries and can thus work for longer distances as they do not depend on near field or the interrogator to transmit or receive [17].

An RFID reader together with an antenna can read (or interrogates) and write tags. A reader detects the tags that is attached to or embedded in the selected items. It varies in location, size and other information. The reader communicates with the tag through the reader antenna, which broadcasts radio waves and receives the tags response signals within its reading area. After the signals from tags are detected, the reader decodes them and passes the information to middleware [18].In the process of making the tag identification, a reader first sends a request signal to tags in its field, and then the tags, which received the request signal, respond by sending their ID to the reader immediately [19].

RFID systems mostly utilize Low Frequency (LF) at 125–134 KHz, High Frequency (HF) at 13.56MHz, and Ultra High Frequency at 433 MHz and 860 to 930 MHz and more recently Microwave Frequencies at 2.45 GHz [15] [20]. The communication range of communicating with the tags in an RFID system is mainly determined by the output power of the reader.

The field from an antenna extends into the space and its strength diminishes with respect to the distance to tags. The antenna design determines the shape of the field so that the range is also influenced by the beam pattern between the tag and antenna.

3. The Framework of Accurate Vehicle Location System

The system architecture consists of four layers to regulate the vehicle location system, which are a physical layer, a device layer, a data transmission layer and an application layer. The framework is shown in Figure 1.

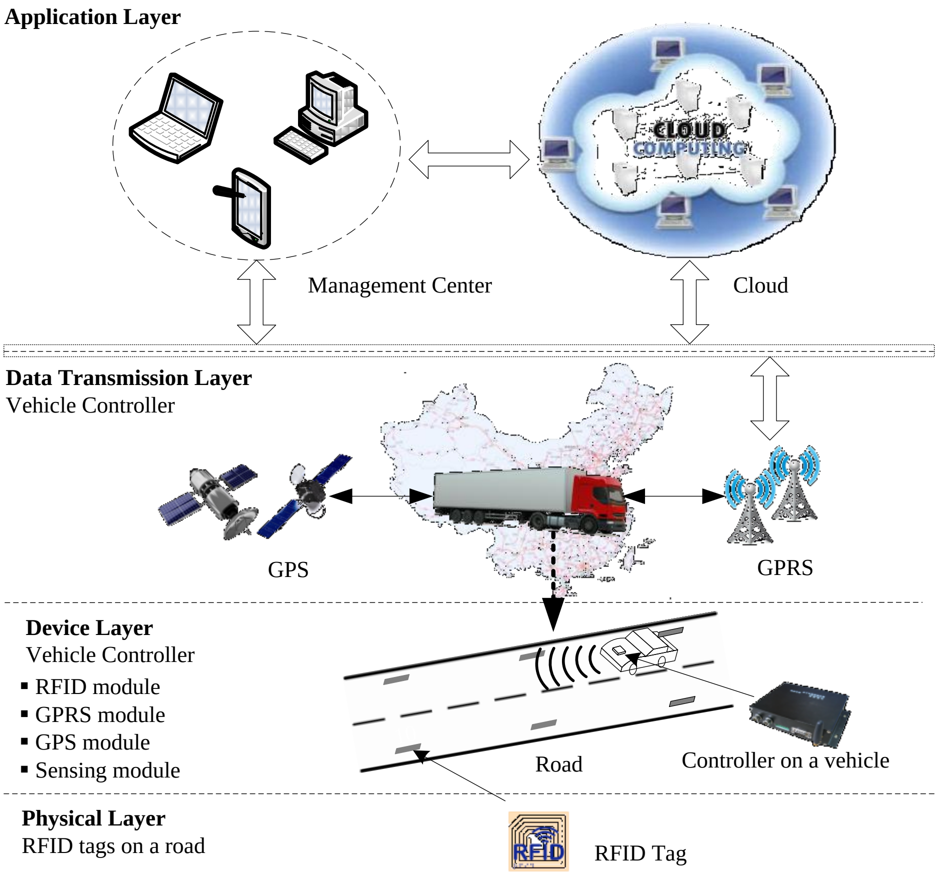

Figure 1. Architecture of vehicle location system

(1) Physical layer

The physical layer mainly consists of passive tags. The vehicle equipped with a controller sends electromagnetic waves to tags and retrieves the position information from tags. RFID tags are installed along lanes on a road in a manner which could maximize the coverage and the accuracy of position.

(2) Device layer

The device is a vehicle controller, mainly composed by a RFID module, a GPRS module, a GPS module and a sensing module. It is the core of entire vehicle location system, which is used to collect and transfers information. The functions of device are the collection of information of ID, GPS position and vehicle status, storage and transmission of those information to the management center and cloud by GPRS network.

(3) Data transmission layer

The main function of this layer can be used to transmit the data collected from the device layer by GPRS network.

(4) Application layer

Based on above layers' data and knowledge, the application layer, included the management center and cloud, can fulfill the mission to monitor and manage remote vehicles.

The cloud has a powerful function of processing, analyzing and storing the information, which involve position, vehicle status and real-time circumstance. As well as the results of computing information from cloud terminal could give the administrator many effective suggestions. We will investigate and pay attention to this part in the future.

4. The design of accurate vehicle location system

4.1 Hardware design

4.1.1 RFID tag arrangement

Here, we force on the tag arrangement on the road. A tag of waterproof sees Figure 2. According to different practical requirements, there are many methods of tag arrangement. Enzhan Zhang [21] presented the scheme called Active RFID Positioning (ARP). The paper focused on tag and reader installation, positioning precision, and evaluated the relationship among reading range, vehicle speed, tag installation and inter-tag distance. Due to his theory, we arrange RFID tags along the road in Figure 3 and match with the contacting time and vehicle speed, and balance the per cost and precision. Finally, we set the distance D of approximately six meters.

Figure 2. Tag

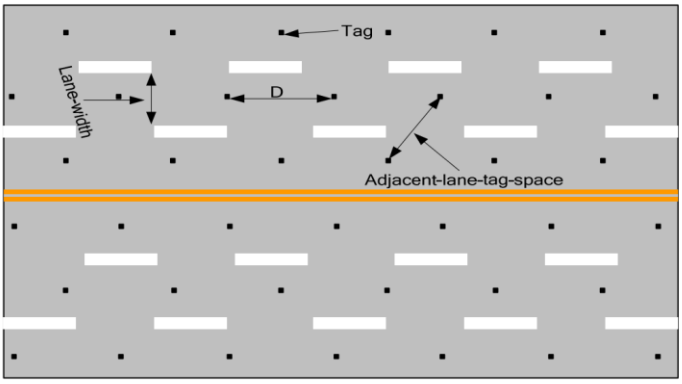

Figure 3. Tag arrangement

4.1.2 Vehicle controller components

The hardware of Vehicle Location is composed by power module, clock module, LED module, RFID module, GPS module, GSM module, sensing module and core controlling module. The structure of vehicle controller is in Figure 4 and the vehicle controller shows in Figure 5.

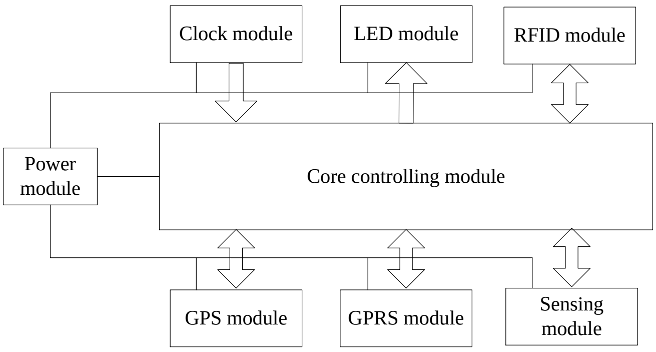

Figure 4. Structure of vehicle controller

Figure 5. Vehicle controller

The fundamental function of above components is as follows:

(1) A power module is used to mange, afford the power.

(2) A clock module provides the basic clock signal for core controlling module.

(3) A LED indicator displays the system state through different flicker.

(4) A RFID module reads the information of RFID tags.

(5) A sensing module is used to sense the state of environment and vehicle equipment. When vehicles encounter the severe turbulence, strong electromagnetic interference and sudden power-down, the controller will automatically save the current information and shut down for protection. If the environment status resume normally, the controller will continue to work.

(6) A GPRS module is the core module of real-time monitoring vehicle system for automatically connecting the GPRS network after booting, automatically reconnecting to the network and uploading data. As a result, it can achieve the function of connecting the network and sending information.

(7) A GPS module is used to locate the vehicle through the GPS global positioning system. It can acquire the information of vehicle location, current time and vehicle movement speed, etc..

(8) A core controlling module is used to achieve functions of tag data proofreading, reader coordination, data transmission, data storage and task management.

Figure 6 show the work flowchart of vehicle controller. When the vehicle is traveling in tunnels, underground parking and other circumstance that traditional GPS can not be accurately positioned, the controller mounting on the vehicle starts the RFID module to read RFID tags on the road. And the information of tags and vehicle status store in the controller memory cell. After reconnecting to the network, the controller will continue to transmit data and upload it to the cloud terminal and management center.

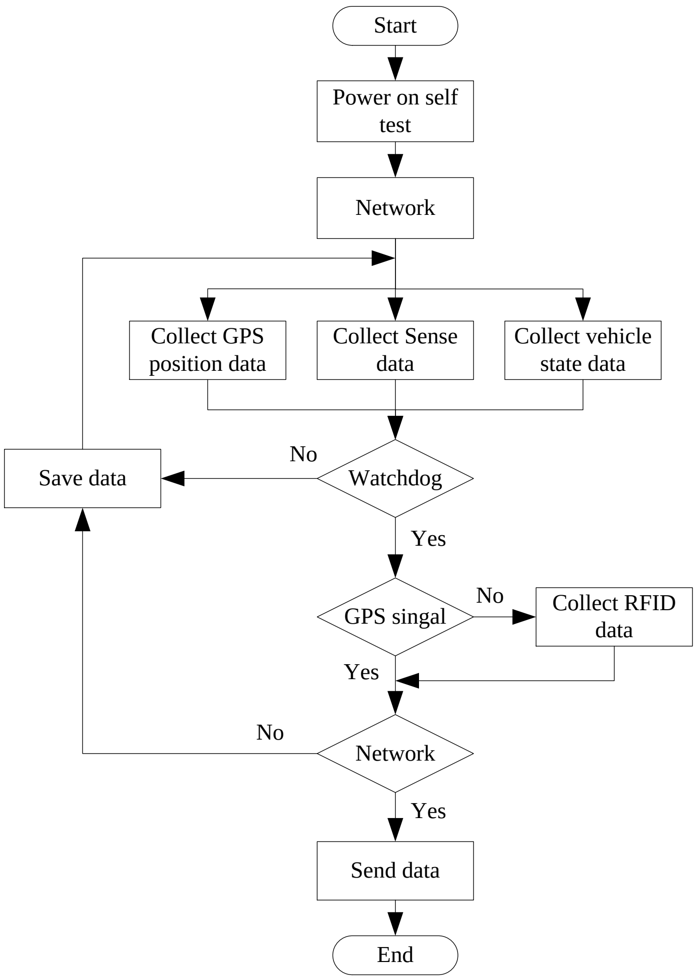

Figure 6. Work flowchart of vehicle controller

4.2 Software design

The software is programmed by Microsoft Visual Studio 2008 and the large database system is designed by Microsoft SQL Server 2005 Developer to create and manage ID and position of vehicle used in the system.

This system is tested in Nanjing University of posts and telecommunication and Figure 7 is the practical system interface of RFID vehicle location. There are three functions displayed below:

(1) Select Vehicle: Display the vehicle name and ID that a controller reads on the travel route.

(2) RFID Tag: Display RFID tags corresponding to the position information.

(3) Vehicle Location: Display the current position of vehicle and the location of RFID tags in Figure 5. The blue triangle represents the current vehicle position and GPS could not achieve the accurate vehicle location in this position. The green arrow indicates the position of RFID tag on the road.

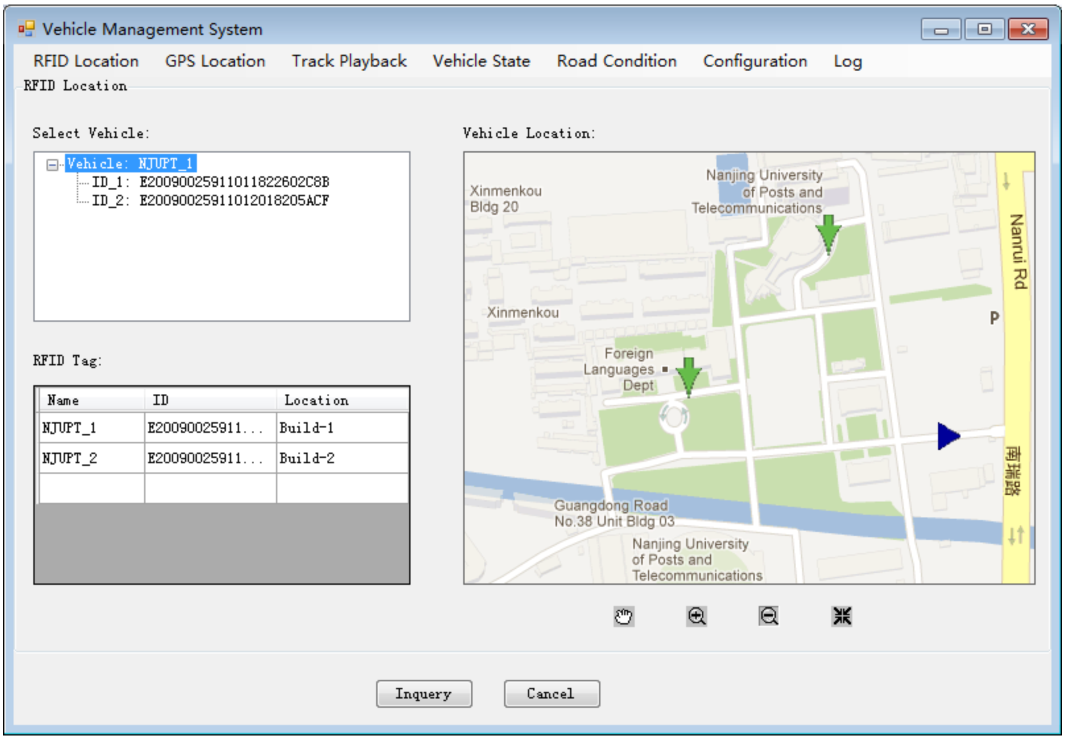

Figure 7. Interface of RFID location

5. Conclusion

The vehicle location system integrating with RFID, GPRS and GPS could locate the accurate vehicle position under complex environments. Meanwhile, it has reached high satisfaction for administrators to manage and monitor the vehicle. Viewed in this sight, the system can be regarded as an efficient tool since the vehicle location does not remain blind, even some areas such as tunnels and built-ups. In the future, what our research team is going to investigate is combination with cloud terminal of powerful information processing and analysis capabilities. This need for our system is more complicated, so we will pay more attention to the high stability and reliability in our future.

6. Acknowledgment

The research is support by National Natural Science Foundation of P. R. China (Grant No. 61170065 and 61003039), Peak of Six Major Talent in Jiangsu Province (Grant No.2010DZXX026), Project sponsored by Jiangsu provincial research scheme of natural science for higher education institutions (Grant No.12KJB520009), Science & Technology Innovation Fund for higher education institutions of Jiangsu Province (Grant No.CXZZ11-0405).

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