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The Research of Safety Monitoring System Applied in School Bus Based on the Internet of Things

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Abstract

Internet of things (IOT) is the third wave of the world development of information industry after computer and internet. In this condition, the intelligent transportation system (ITS) comes into being. The core technology of the ITS is the modern communication technology with advanced computers, automatic control technology, sensor technology in order to achieve the real-time traffic control and management. The project is aimed to develop an internet of automobile based on the on-board GPS. It expands the on-board terminal function like multi-point acquisition of infrared signal transmitted by the human body, and then sends the message to each other by the Zigbee communication protocol. Finally, the message will be sent to the monitoring terminal and mobile phone on the platform of the Telos Mote (Revision B) in order to control the GPRS module to send message to computer terminals and mobile phones to achieve a comprehensive grasp of vehicle status information in real-time. This will help us make appropriate response to the unexpected emergencies so as to solve many problems in the security management of school bus. This system will guarantee the safety of students effectively.

Keywords: ITS; GPRS; Telos Mote (Revision B); Zigbee communication protocol.

1. Introduction

In most organizations, information travels along familiar routs. Proprietary information is lodged in databases, analyzed in reports. Information also originates from public sources, harvested from the Internet, or purchased from information suppliers. But the predictable pathways of information are changing: the physical world it self is becoming a type of information system. In what is called the Internet of Things (IOT), sensors and actuators embedded in physical objects are linked through wired and wireless network. In this system , the technology of IOT is used on automobiles for special services like school

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bus to sense the environment and communicate which enable the automobiles to become tools for understanding complexity and can responding to it swiftly.

The system consists of monitoring terminal and detecting nodes which form wireless sensor network (WSN) with Telos, an ultra-low power wireless module. Telos has an internal antenna achieving the communication between the monitoring terminal and detecting nodes and can be connected with the infrared detection module to achieve the

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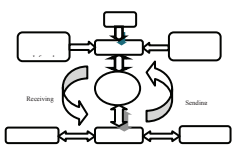
detection of people. The technical design describes the status information covering the whole vehicle and reports it to the supervision unit. Besides all the functions it possesses of which the detection of people occupying the most important place many other applications can be appended such as the anti-theft feature.

The main characteristics of the system include dynamic network topology, heterogeneity of nodes, unattended operation and it is easy to conduct. The paper describes the work principle and design of the system, detailed parameters of each module and the installation and distribution of nodes. And this paper is concluded in section 6.

Figure 1. System block diagram



2. Related work

In 1999, "Internet of Things" is coming into being. IOT is a network of Internet-enabled objects, together with web services that interact with these objects. Once the concept was put forth, it gets the attention all over the world. At the end of 2009, China has officially classified the IOT as one of the five state emerging strategic industries.

The next few years, the communication of vehicle data will be changed gradually from the hardware of the embedded electronic systems to the software of the wireless sensor network. Nissan Motor Company (Japan) is working on Network of the car in the web2.0 + telematics in order to achieve IT architecture of automobile. This technology provides richer functionality for the customer in the next generation of information services. GE (the USA) applied the concept of EN-V electric network to automobile which combines electrification and internet of automobiles.This technology develops the Global Positioning System (GPS) navigation technology, Car-2-Car communication technology, wireless communications technology and remote sensing technology. ZTE (China) collaborated with Shanghai Telecom provides an on-board monitoring system for the World Expo. VIP automobiles in the Expo are fixed with the vehicle axis acceleration sensors, alcohol sensors, smoke sensors and so on. The message collected by the sensors can be sent to the monitoring office by the general packet radio service (GPRS) in real-time.

On-board GPS, as a new information transmission and monitoring platform, provides great condition for development of ITS. However, the practical application of on-board GPS is still limited in the basic functions of navigation. This is not only a waste of the excellent resources, but also severely a restriction to the development and application of the internet of automotives.

3. Hardware design for system

3.1 Telos Rev B (Low Power Wireless Sensor Module)

Telos is an ultra low power wireless module for use in sensor networks, monitoring applications, and rapid application prototyping. Telos leverages industry standards like USB and IEEE 802.15.4 to interoperate seamlessly with other devices. Revision B includes increased performance, functionality, and expansion.With TinyOS support out-of-the-box, Telos leverages emerging wireless protocols and the open source software movement. Telos is part of a line of modules featuring on-board sensors to increase robustness while decreasing cost and package size.

3.2 GPS system module attached to vehicle

After the system is started, the receiver will capture the signals from the GPS satellite and then measure the pseudo-distance between the antenna and satellite and distance change rate so that it will be able to demodulate the satellite orbital parameters and some other data. According to the data, the vehicle's geographic location like latitude and longitude, as well as the speed and time information will be calculated.

3.3 Infrared sensor Module XSC-ME003

Table 1. Electrical Parameters of the Infrared sensor

Items	Electrical Parameters
working voltage	DC 4.5-20V
Static current	<50uA
Level output	high3.3 V /low0V
Trigger mode	L:unrepeatable Trigger /H:repeatable Trigger
Delay time	5-200S(adjustable) Range :a few tenths to tens of minutes
Block Time	2.5S(Default) Range :a few tenths to tens of seconds
Board Dimensions	32mm*24mm
Induction Angle	100 degrees Cone angle
Sensing distance	7m

3.4 SIM300 GPRS module

The SIM300 is a complete Tri-band GSWGPRS solution in a compact plug-in module.Featuring an industry-standard interface, the SIM300 delivers GSM/GPRS 900/1800/1900MHz performance for voice, SMS, data, and Fax in a small form factor and with low power consumption.

The reading features of SIM300 make it ideal for virtually unlimited application, such as WLL applications ,M2M application, handheld devices and much more.

4. System software design

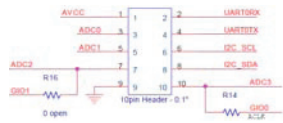


Figure 3. the Expension Interfaces of the Telos (Rev B)

4.1 GPS

We connect the three pins RXD，TXD, GND on the GPS module with the three pins No. 4,2,9 on the wireless transceiver Telos. The GPS can send message to the MSP430 regularly.

4.2 Infrared signal acquisition

Connect the three pins VCC, GND, ADC on human body sensor module with the three pins No. 1,9,3 on the Telos. Controlled by the programmed MSP430 chip , the Infrared sensor will monitor whether there is any infrared signal repeatedly until it examine out some. Then the XSC-ME003 will send out high signal through the pin ADC. If Telos monitors this high signal twice continuously, it will send the information to the main node immediately.

4.3 GPRS

We connect the three pins RXD，TXD, GND on the SIM300 module with the three pins numbers 4,2,9 on the wireless transceiver Telos Mote Revision B. When the infrared signal is detected, start the SIM300 module by the pins above at first while transmitting information. When the module receives instructions it will send text messages to a designated mobile phone through the GPRS network. At the same time, a certain PC will use Socket to set up a TCP or UDP Server with the GPRS module as a client connection to achieve the exchange of information.

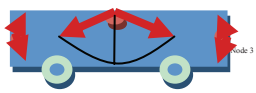
4.4 Zigbee network communication protocol

The Zigbee standard specifies a networking layer, Application Support Sublayer, and an Application Framework layer. The Zigbee standard also defines the concept of a device profile, in which a device can advertise what type of device it is and what services it provides. Zigbee profiles are at the heart of what Zigbee is trying to accomplish, which is to provide interoperability between wireless devices from different manufacturers so that a consumer of home automation wireless devices can have a wide array of products to chose from, instead of having to purchase all of their wireless switches/lights from a single vendor because they will not communicate with another vendor’s lights/switches.

5. Installation in car

There are three infinite sensor nodes in a car. The installation is shown in Figure6.As the thermal infrared sensor for human body is with an opening angle ranging from 0 ° to 100 °, a monitoring length of 7 meters, so that this arrangement can ensure every corner in the car is able to be detected.

Figure 6. the Installation in the Car



6. Conclusion

In the future, development of WSN is sure to be related to IOT. And then many new significant technologies will be applied in various fields. For example in wireless sensor networks, the technology of information fusion, also called data fusion, has been attached importance to and developed rapidly. So for our design of the device there are still many directions to be explored.

And this practical device has the following advantages and positive effects:

1) Simple and practical structure, convenient to use, low power consumption.
Wireless sensor module precisely completed the collection, analysis, processing of the data. And the mote will be applied to the research and development of wireless and sensor network protocol.

2) Reliable, efficiency, in the test of peer-to-peer communication which send messages of the detection of people with infrared sensor has been proved effective

3) Wide application prospects, this device has an outstanding expansibility which enable itself to achieve many new practical functions. And in addition, networked application of the automobiles can help control the specific motorcade such as the fire team.

On the whole, performance of the multi-function on-board device has been improved.

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