

The Intelligent Transportation System Using the Infrared Sensors Based on the ZigBee Protocol and Eclipse

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Abstract: There are more and more cars. The traffic jam cost people a lot of time on the road. This system got the number of the cars in waiting on every crossroad by the infrared sensors in the CC2530. Based on the Zigbee protocol, the routers embedded in the infrared sensors sent the information of cars in waiting to the coordinator wirelessly. Then the coordinator sent the information to the website which is developed on the Eclipse platform through the serial port. People can check the designated crossroad whether there is the traffic jam by smart telephone or the web browser. This system can release the newest information. It can be widely applied in the transportation system. *Copyright © 2013 IFSA.*

Keywords: Intelligent transportation system, Eclipse, ZigBee protocol, Infrared.

1. Introduction

The CC2530 provides solutions for a true system-on-chip (SoC). It combines the excellent performance of RF transceiver for ZigBee network. It is possible to build a strong network at a very low cost. It included the industry-standard enhanced 8051 CPU and programmable flash, 8-KB RAM and many other powerful features. CC2530 has many different operating modes to make it adapt to ultra-low power requirements. That short time for transitions between operating modes ensure low energy consumption.

This system mainly applied the CC2530 interrupt function. And it also used the Zigbee protocol to form the wireless network. It finished the intelligent

transportation software platform which provided the interfaces for the wireless sensor network.

Based on the ZigBee stack application support sub-layer (APS), paper [1] presents additional mechanisms which include the ZigBee data segmentation (ZDS) function, the modified acknowledgment transmission (MAT) function, and the ZigBee congestion control (ZCC) function. The method provides solutions for a situation where the data congestion problems are expected to happen due to a large amount of data transmission.

The paper [2] presents the design method of hardware and the software process for the Electronic ordering dish system. The CC2430 is used as its core processor. The paper [3] developed the ZigBee-based electronic aid for daily living for quadriplegics

system consisting of the assistive computer input device, application software, communication control board, and the appliance control nodes. The paper [4] is to improve the performance of the control network in smart home system, and to design the controller module which is used ARM server as our home controller processor. ZigBee Wireless module communicates with the wireless gateway normally, at the same time, connects with the mobile terminals to remotely monitor the 3G mobile phones. Combined with ZigBee wireless transmission technology, paper [5] realized remote real-time temperature monitoring for construction site. The system hardware consists of main controller, gateway, wireless sensor nodes and thermocouple temperature sensors. Through wireless sensor network nodes, the data is sent to main controller terminal via gateway. The paper [6] presents the use of a novel Real-Time Locating Systems (RTLS) based on ZigBee technology that provides users' positions in order to enhance context information in learning applications.

The paper [7] used Wireless MEMS Inclination Sensor Systems (WMISS). Its system used various bridge deflection measuring methods, ZigBee/IEEE 802.15.4 MAC protocol. The papers [8-10] developed a public transportation system using GPS, GSM, RFID, Zigbee or the TDOA positioning algorithm which acts as friendly to the user. The paper [11] designs and implements an Intelligent Control Box to convert different wireless signals of Cyber Physical Systems (CPSs).

Paper [12] presents a novel connectivity architecture using the radio frequency for consumer electronics based on the wireless zero-configuration and enhanced key agreement approach.

2. The Hardware Design of the System

The system used the CC2530 as the core chip. The routers were embedded with the infrared sensors. They communicated with the coordinator wirelessly with 3 db antenna. The coordinator was linking with the upper computer through the serial port. The system designed N meters marked in the four branches of the Fig. 1. It fixed sixteen small infrared sensors in eight lines. The number of vehicles in waiting for every direction was collected because the two infrared sensors count the number of vehicles which passed the two sensors respectively. The number of the vehicles is uploaded to the personal computer by the coordinator. In the website, it is received through the serial port and used to calculate the number of the cars stopping at the crossroads with the help of the algorithms. Then the traffic conditions are identified on the Google map of the website.

The value N in the Fig. 1 depending on the specific crossroads. And it can be altered. The system assumes that N is 200 meters from the first infrared sensor to the second infrared sensor. The position of the infrared sensor is on the stop line shown in the Fig. 1. The traffic conditions are divided very

congested, congestion, unimpeded, very smooth. Every traffic condition has its corresponding value range In the Fig. 1, the position of the two short lines in each direction is the place of the two infrared sensors. In the Fig. 2, it simulated for the actual intelligent traffic in the laboratory.

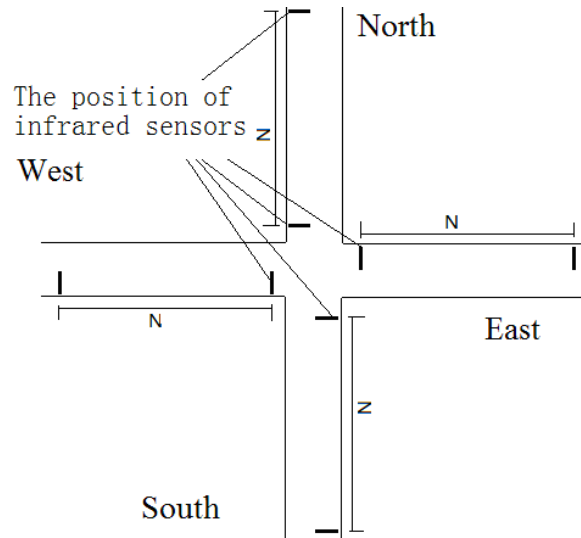


Fig. 1. The diagram of laying up the infrared sensors at the crossroad.

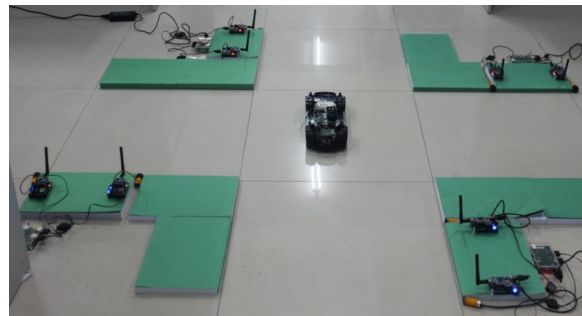


Fig. 2. The figure of the simulation for the intelligent traffic.

2.1. CC2530 Module and Infrared Sensors

Nine CC2530 modules consisted of the entire hardware architecture. One is the coordinator. And the other eight modules are routers. The sensing range of the infrared sensors is from 3 cm to 80 cm. The infrared sensors are fixed on the CC2530 through three wires. They need DC 5 V supply voltage. There is a small yellow potentiometer knob in the infrared sensors. The distance measured by the infrared can be adjusted by rotating the knob. As long as the measured object is in sight of the infrared sensors, a low level will be output.

To make the infrared sensors and the CC2530 work normally, P0IEN, PICTL and P0IFG have to be programmed. P0IEN is the Interrupt mask register. PICTL is the Interrupt control register. P0IFG is the

interrupt flag bit. The IEN1 includes the bit of the enabling the interrupt.

In the system, the application set the registers to control the external interrupt in CC2530 as follows.

```
POIEN |= 0x10;
// P0_4 is set to be the interrupt mode;
PICTL &= ~0x10;"
// the falling edge trigger the interrupt
IEN1 |= 0x20;
// P0 port interrupt was allowed
```

So the P0_4 port of the microcontroller is set to trigger interrupts at the falling edge. The system will process the data from the infrared sensor through P0_4. Whenever the infrared sensed the running car, it resulted in a falling edge to trigger the interrupt. In the interrupt service program, the value of the variable was added by 1. After the gradual accumulation, the total number of vehicles sensed by the infrared will be counted.

3. The Software Design

This suite of device uses the IAR integrated development environment in the Windows platform to collect the information of the infrared module. The website has been finished in the eclipse development platform which is a famous integrated cross platform. It uses the Structs technique and hibernate to load the Google map. It makes the received information from wireless sensor network store in Mysql database. And it displays them dynamically and browsed by intelligent phones and computers in the internet.

3.1. The Design for the Data Acquisition Module

The data acquisition module has finished the designs both for the application protocol of the routing nodes and for the protocol of the coordinator node. The protocol is consistent with the message struct which is received by the website.

Their application layers of the routing nodes complete the following tasks. First, they start infrared acquisition module. Second, they set the specific information and the data collected from the infrared sensor together into encapsulated packets. Third, they send the data packets from the APP layer to the HAL layer according to the Zigbee protocol to the coordinator. The number of each routing node corresponds to the defined module number according to the following Table 1.

The application layer of the coordinator node is mainly to complete the following tasks. First, it accepts and processes data from the routing nodes. Second, it analyzes and filters the data packets. And it encapsulates the data into packets and sent to the upper computer through the serial port.

Table 1. The coding of the routers.

The number of the routing node MEBEE_GROUP_CLUSTERID	The sequence number of modules
MEBEE_GROUP_CLUSTERIDA	1
MEBEE_GROUP_CLUSTERIDB	2
MEBEE_GROUP_CLUSTERIDC	3
MEBEE_GROUP_CLUSTERIDD	4
MEBEE_GROUP_CLUSTERIDE	5
MEBEE_GROUP_CLUSTERIDF	6
MEBEE_GROUP_CLUSTERIDG	7
MEBEE_GROUP_CLUSTERIDH	8

3.2. The Design and Implementation of Web

The website used the AJAX technique and java program language on the Eclipse platform. The several modules consist of the whole architecture. They refresh the screen respectively or are refreshed manually. The website received the fixed stuct data according to the protocol from the coordinator. It resolved the data struct and released to the interface realtimely. It can receive data from more than one USB port at different crossroads simultaneously. And it included the servelst technique and the concurrency control scheme. Also it is able to receive a large number of data from many infrared sensors by one or more coordinators. It can display the Google map according to the requirements of users. And on the map, users can browse the traffic conditions of their target crossroads online. The condition is determined by the number of the vehicles at the crossroad then.

4. The Results of the System Testing

The smart traffic system is applied at the crossroads. So the distance between the coordinator and the router is tested. Because of various uncertain factors in the wireless transmission, some routing nodes transmit data can not reach the coordinator. Also this research does the statistical analysis for the packet loss rate as follows. There is a variable in the router's program which indicates the times of the sent packets. Of course, the variable is part of the package. The coordinator finally sends the received data to the upper computer through the serial port. The serial port assistant can display the received packets and save them in a local text document for the analysis.

The test is finished on the outdoor venues. The routing nodes numbered by 1, 2 are 50 meters from the coordinator. The nodes numbered by 7, 8 are placed 70 meters away from the coordinator. The nodes numbered by 3 and 4 are 20 meters away from the coordinator. And the nodes numbered by 5, 6 nodes are 10 meters away from the coordinator. In the testing, eight routing nodes send the information got by the infrared sensors on the routing nodes respectively at the same time. And the only

one coordinator receives the information from eight routers and sends all information to the website in the upper computer. The obtained test results of the system are in the local text document. The statistical result is shown in the following Table 2.

Table 2. The test result.

The node number	The distance	Transmission times	Receipt times	The packet loss rate
1	50 m	52	31	40 %
2	50 m	54	28	48 %
3	20 m	65	23	64 %
4	20 m	66	21	68 %
5	10 m	51	24	52 %
6	10 m	55	24	56 %
7	70 m	52	9	82 %
8	70 m	57	14	75 %

In the Table 2, the nodes numbered by 1 and 2 which are 50 m away from the coordinator have the lowest packet loss rate. The nodes numbered by 7 and 8 have the highest packet loss rate. But such high packet loss rate does not affect the system. First, the nodes numbered by 7 and 8 sent packets at regular intervals. In other words, their time interval is longer than the time interval of the other nodes numbered by 1, 2, 3, 4, 5 and 6.

Their last packet represents the newest information. Second, the website is refreshed every 5 s. So it does not need that every packet is able to be received. It only needs the newest packet of every routing node. It analyses the data and does the statistics for the received data. It accords to the latitude and the longitude to display whether the traffic of the crossroad is heavy on the online Google map. The website interface is shown in the following Fig. 3.

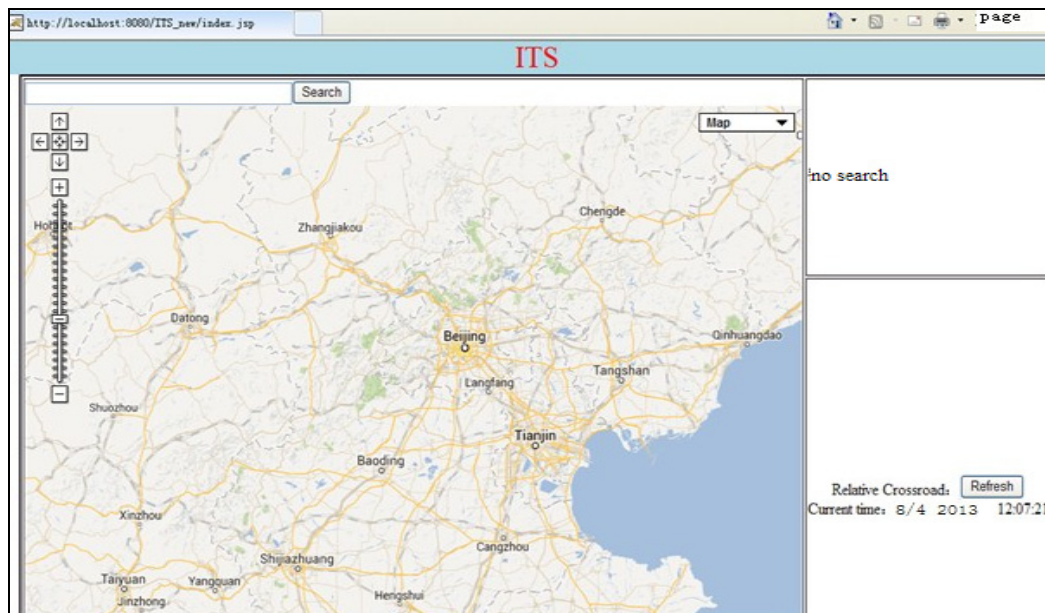


Fig. 3. The website of the intelligent traffic.

The blank space on the left corner of the Google map can input the name of the space. Then the user can click the 'search' button. Then the target place will be marked in the red color on the map. The address of the place will display on the top right of the Fig. 3. The specific information of the target place sensed by the infrared sensors at the crossroad will be uploaded to the website and will be shown in the bottom right of the Fig. 3. If there is no search condition, the right will be as shown in the Fig. 3 now.

5. Conclusion

This research has the difference from the paper [8]. It does not require that microcontrollers, GSM

Modem, GPS, Zigbee, RFID, LCD and infrared sensors are put in cars. It only put the wireless Zigbee nodes at the crossroads. Then the traffic information can be got through the internet. If the quantity of the Zigbee nodes is larger, the routers can be father nodes for the end nodes. And all the nodes based on the Zigbee protocol form the tree network. The public transport service can be effectively implemented by deploying the concept of this paper. And the service quality can be improved.

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