The Design of Traffic Warning Platform Based on IoT Technology

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Abstract. With the rapid development of China's economy, the number of vehicles has a sharp increase. It led to the traffic problem becoming more and more serious, with the problems of traffic congestion, easy to cause accidents, solving the accident no in time and so on. For the current traffic congestion problem, the paper designs a traffic warning and monitoring platform based on IoT technology. It takes advantage of computer technology, communication technology, sensor technology and so on, connecting together vehicles with the side of road infrastructures over wireless network, and finally we can know the status of the entire cars' on the monitoring platform which is at road junction. It can shorten the time of finding and dealing with accidents, improve the overall efficiency, reduce operating costs and facilitate people's life.

Introduction

Both developed and developing countries, with the improvement of people's living standards and quality of life, cars have become an essential means of transport in daily lives. Due to the sharp increase in the number of vehicles, the traffic problem becomes more and more serious, with the problems of traffic congestion, easy to cause accidents, solving the accident no in time and so on. So to build a more perfect traffic warning and monitoring platform using relevant technology is very imminent. With the appearance and development of IoT technology, [1] it makes the paper's design possible. Aiming at the problem, the paper designs a traffic warning and monitoring platform. It mainly uses CC2530 wireless communication module, button for sending alert information module and PC's processing and displaying module to achieve the purpose of real-time monitoring and early warning.

System Design Overview

The basic starting point of the design is to discover and deal with traffic accidents in time, as much as possible to reduce the loss of life and property of people, in order to improve the overall management efficiency. When a traffic accident or emergency occurs somewhere, press an on-board terminal warning button, after pressing information can be transmitted to the coordinator at the intersection controlling platform. Coordinator will illuminate a red warning light after received the data to achieve the purpose of warning. At the same time it will collect the RSSI value of received data. Then the PC software through processing which is at the controlling platform will display roughly distance at the interface. This is the distance between the accident took place and controlling platform, achieving the tasks of early warning and simple ranging, which is still meaningful for dealing with and rescuing the accident in time.

In the design of hardware for the platform I use ZigBee technology, because it has many advantages, such as low cost, low power consumption. Also it can realize automatically wireless communication network and accommodate more network nodes, achieve easily, etc. [2] As the network manager, coordinator using powered is a full-function device. Vehicle terminal nodes using a battery-powered reduced-function device have responsible to sensor, collect and send the data and information.

The Design of System-node

The paper's design uses ZigBee development boards with a CC2530 wireless communication module. It mainly includes the transmission of wireless data, the collecting of RSSI values and the PC's processing. The platform designs on the basis of Z-Stack's basic routines GenericApp program.

The Design of Terminal Node

In my design, the main function of the sensor node is pressing the key to send information. The information I used to send is 0-24 digits. That is to say, each time you press the button, it will send a number to the coordinator. And each sending digital is successively increased, i.e. from 0 to 24.And it will be followed by cycle. And I use a for() loop to get accurate distance. So that you press the button each time, it will send the digit data ten times automatically. This is because of the need to take multiple groups of RSSI values to average for an accurate distance.

The Design of Coordinator Node

In my design, when the coordinator receives data which send by the terminal, it need to illuminate warning light by simply processing the data for warning, and take the data's RSSI out. Then RSSI values will be sent to PC for processing by the serial port.

The point to note here is the function GenericApp-MessageMSGCB(afIncoming MSGPacket_t *pkt), which is the key part of the design for coordinator. It can take the received data's RSSI out using pkt->rssi to extract after the serial port is in a good definition. And here because the terminal transmit ten data each time, so it's extracted ten RSSI values. Use HalUARTWrite() function to transmit the RSSI values by serial port. After coordinator receives the relevant information, warning light will be lit for warning; here I use the function HalLedSet (HAL-LED-1, HAL-LED-MODE-TOGGLE) to make the coordinator light alternately blinking by pressing the button. Using this function we can clearly, intuitively know each pressing effect and corresponding distance for the displaying of distance behind. Then it completes the system-nodes' design.

The Theoretical Analysis of RSSI Ranging

When there occurs a traffic accident or emergency situation, knowing the distance in time between the accident occurred and monitoring platform is also very important. The design is to complete this feature. This design uses the RSSI ranging method based on the classical theory and empirical models to achieve the conversion of distance. [3]

It can be derived the formula of the RSSI and distance as follows by the classical formula:

$$RSSI=A-10*n*\lg r. \tag{1}$$

Wherein, the left side of the equation is the RSSI value of received data. A is the received signal strength at a distance from the transmitting node 1m, and n is environmental factors. Different environments, different n values. A and n values' precise selection is the key to the accuracy of distance after converting.

In order to obtain the specific values of A and n which consist with the test environment, I do the experiment and record relevant data such as RSSI and the distance.

The experiment carried out on the school playground, the terminal and coordinator nodes are ZigBee development boards with CC2530 chip. Coordinator node put at the height of 1.5m, the terminal nodes placed on the ground; coordinator node didn't move and the terminal node moved, every 2-3m measured once; The nodes' transmission power set 1dbm which is the default transmission power of the protocol stack. Terminal nodes have been continuously sending data out, coordinator have responsible for extracting RSSI; Here should be noted that, each distance's RSSI which measured is the statistical average of all four directions to coordinator altogether 80 measured values, i.e., front and back, left and right, each direction 20 RSSI measured values. The purpose is to measure more accurate, minimize measurement errors, decrease the influence of different directions and the error caused by weather and so on.

In order to make sure the relationship between RSSI and the distance, I use a graphical analysis of the measured data; The environmental factor n can be obtained by curve fitting methods. Fig. 1 shows the experimental data after fitting.

Wherein in the fitting curve A is -46dbm, and the difference compared with the actual measured data is small. The environment factor n is 3. So the curve fitting mathematical formula is: $RSSI(dBm) = -46 - 10*3*\lg r$; This curve can be better matched the experimental data. By observing the fitting curve, you can see RSSI varying with the distance obviously within 20m, so more than 20m the measurement accuracy may not be guaranteed.

The Design of System Visual Interface

Due to the limited hardware resource of ZigBee nodes, data processing capacity is limited. And also to visualize, the relevant data processing need to be completed by PC. The design uses VB programming language to develop and the platform is Microsoft Visual Studio 2010.

The design is to estimate the distance by the signal strength of received data. So the visual interface on PC composes of serial port setting, RSSI value of received data and the converted distance. Fig. 2 shows the design of specific interface.

It has two parts in the design of PC programming; one part is the serial data transmission between coordinator and the PC. The other part is the converting of distance by RSSI.

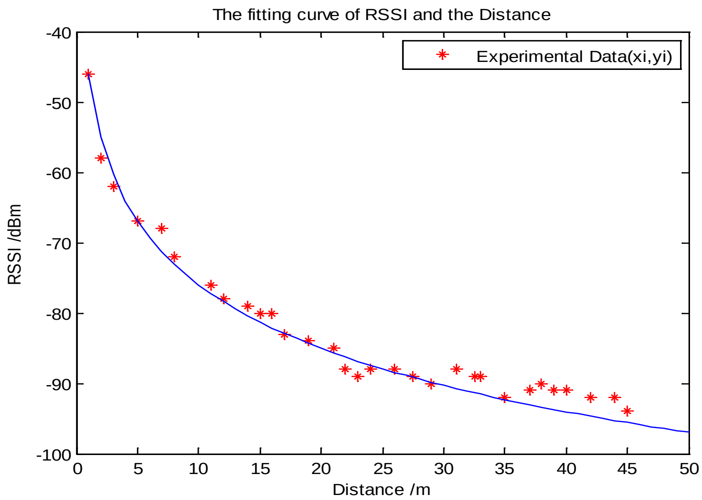

Fig. 1 The Fitting Curve

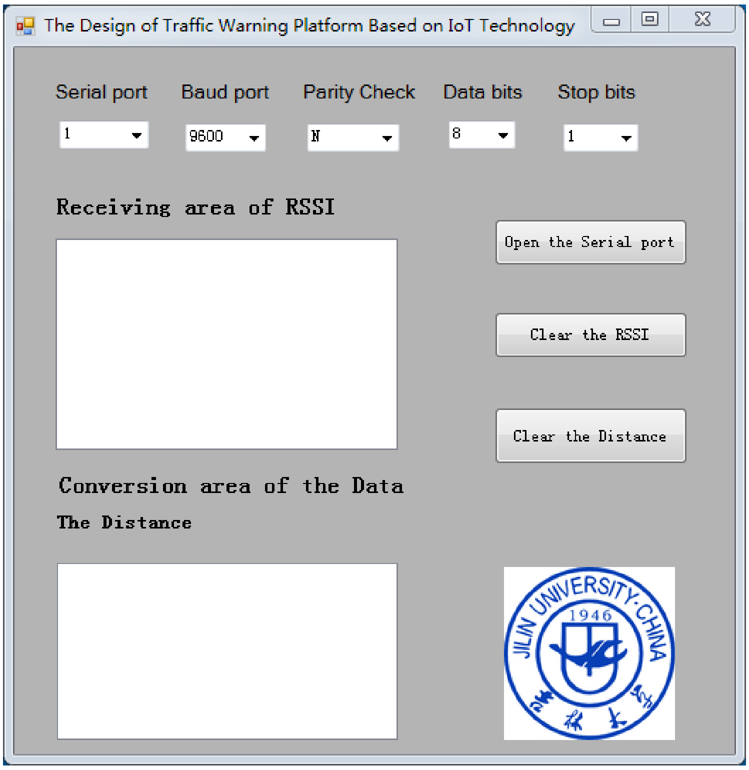

Fig. 2 The Design of PC's Interface

Serial Data Transmission

Here I do a simple data processing. Because the RSSI is easy influence by the environmental, and as previous mentioned, the received data are ten RSSI, so here I do remove the maximum and minimum values of the ten RSSI. Then I take the average of the 8 RSSI remaining to calculate. The purpose is to minimize errors and improve the conversion accuracy.

The Conversion of Distance by RSSI

It should be noted that the distance calculated according to the formula are in meters. Here to make more accurate for display, the final distance is multiplied by 1000. So the unit transfers from meter to millimeter. So when display, the distance unit is millimeter.

Experimental Results and Related Analysis

Firstly the coordinator and terminal nodes should be powered on. Then when we press the key on the terminal each time, LED1 on coordinator will light alternately and it will display approximate distance on the PC interface. So we reach the purpose of early warning and distance ranging. The specific results are showed in Table 1.

Table 1 Experimental Test Results

Actual Distance[m]	Display Distance[mm]	Actual Distance[m]	Display Distance[mm]
3	3771	9	10575
3	3483	12	9024
5	6069	12	13417
6	6570	20	17021
9	8336	20	21595

After a large number of testing we find that in less than 3m error can be maintained at less than 1m; In less than 6m error can be almost around 1-2.5m; And within 10m the error is about 3m.So we can find the error is gradually increasing with the increase of distance. The experiment test the furthest by about 20m and error is about 4-6m. Overall, it can satisfy the requirement of the design. Because the board's transmission power is 1dbm which is the default of protocol stack, so transmission distance is limited, furthest about 25m. So the design can satisfy the requirement overall.

If we want to transfer farther, firstly we can turn up the board's transmission power. For example we can set 4.5dbm which is the maximum transmission power for CC2530. At this time the transmission distance can be up to about 75-100m. Secondly, we can increase the routing nodes to make up multi-hop network to increase the transmission distance. If they apply on the platform, the effect can meet the demand.

Summary

The paper design a traffic warning and monitoring platform for the current prevalence problems of traffic congestion, accident-prone. The paper focuses on the principle and implementation process and we do experiments. Experimental results show that when there occurs a traffic accident or emergency, the platform can reach the effect of warning well, also we can know the distance between the accident and controlling platform. It can shorten the time of finding and dealing with the accidents, improve the overall efficiency, reduce operating costs and facilitate people's life.

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