Design of Wireless Positioning System Based on Technology of Communication Between Vehicle-to-Vehicle

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Abstract. According to the vehicle safety characteristics, a wireless positioning system based on vehicle active safety was designed by vehicle-to-vehicle communication technology. As the demands, ZigBee technology was chosen to accomplish wireless communication. Both software and hardware aspects of the system were designed. Moving node was located by position algorithm which is based on measure distance technology and“Distance-Loss”model.Using the marked model, the system was verified, the result shows that the system based on vehicle active safety is of good quality and meets the positioning requirements of vehicles.

Introduction

The vehicle-to-vehicle communication technology contributes to the active safety and traffic safety and improve the efficiency of the vehicle,which has become the important research direction of driver assistance technology[1-3].It can significantly improve the situation of road traffic inter vehicle information sharing,ensuring the driving safety.

The research on the vehicle to vehicle communication technology are in the initial stage,the research on vehicle positioning aspects has become a hot research topic,the existing research is based on GPS positioning.The active safety technology, because GPS in indoor and dense urban areas can’t work normally,and the positioning accuracy is low,therefore,GPS is not the most ideal choice.This paper uses the wireless communication module,the design of a wireless positioning system, and has carried on the experimental verification,from two aspects of distance error and accuracy analysis of the effectiveness of the system.

The wireless communication way choice

Because there is no special for communication vehicle communication design of the vehicle,so we must choose an appropriate communication mode from the existing wireless communication mode to realize the vehicle to vehicle communication function.Table 1 is a performance comparison of several commonly used wireless communication technology.

Table 1 The comparison of main technical parameters of wireless communication

Technical name	Technical standard	Transmission speed of / $Kbit \cdot s^{-1}$	Transmission distance of /m	Government supervision	Current application
GPRS	GSM	171.2	$1\text{-}2\times10^3$	Payment	Mobile Internet
WiFi	802.11g	5.4×104	100	Open	Wireless Internet
ZigBee	802.15.4	250.0	100	Open	Wireless sensor networks
Bluetooth	802.15.1	1.0×10^3	15	Open	Indoor terminal connection

Vehicle to vehicle communication technology can only adopt the technology of open communication,can see from the table 1 only Bluetooth, infrared, ZigBee, WiFi four technologies available.Bluetooth technology and infrared technology transmission distance is limited,it can not meet the requirement of transmission distance,WiFi in embedded integration without ZigBee well, the difficulty of developing high.

IEEE802.15.4 based on ZigBee technology is a new wireless data transmission network,the characteristics of low cost,free frequency is 2.4G.ZigBee technology with short time delay, high capacity and free frequency usage license is very suitable for vehicle to vehicle communication technology requirements.This paper intends to realize the system using ZigBee technology.

System design

This paper uses the JN5139 chip of JINNIC company as the main control of wireless location system chip.The chip integrated 32-bit RISC MCU kernel, 2.4 GHz IEEE802.15.4 transceiver[4].main control chip of high performance completed include: acquisition and implementation of ZigBee protocol,the positioning data of data processing, transmission, peripheral chip control.The whole system with JN5139 chip as the core,the hardware block diagram is shown in figure 1,includes: power supply voltage regulator module,communication module,the workshop data transmission module, display module.

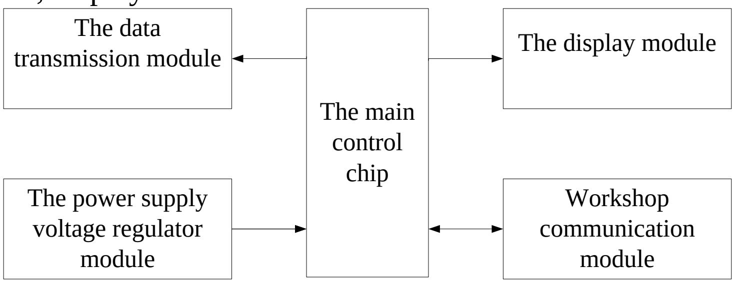

Fig. 1 Vehicular Ad-Hoc network hardware structure figure

The signal will produce attenuation in propagation paths and shadowing objects, signal intensity received will be affected to a certain extent, the actual distance measurements will be different because of different environment and different and shielding factor, this design uses the "distance loss" model of [5], its general form:

$$p = p_0 - 10n\lg[\frac{d}{d_0}] + i \quad (1)$$

Formula:P said received signal strength(dB);d_0 represents the reference distance(m);P_0 the distance of received signal strength of d_0(dB);D is the distance between two points (m);i is shadowing factor,it has nothing to do with the propagation distance,with mean m, normal random distribution variance σ^2;n is the path loss coefficient that environmental factors.Here n=2.i is generally determined by the calibration method.

Parameters characterizing the signal energy used in the received signal strength of RSSI and the signal connection quality of LQI (Link Quality Indication),according to the different wireless module, parameter characterizing the signal energy provided are different.The experiments show a linear relationship exists between RSSI and LQI, this paper adopts LQI to characterize the received strength signal.(1)can be as:

$$LQI = -(C_1 n \lg d + C_2) \quad (2)$$

The formula C1, C2 environment related parameters,need to calibration by experiment.

"Distance-loss" after deformation need calibration parameters in the model including C1 and C2,we use experimental method to calibrate the model,under the corresponding conditions of calibration model of positioning experiment. Distance-loss model calibration using a mobile node and a reference node, adjust the position of the mobile node (x, y) value, at the same time get LQI value in the corresponding position, data of calibration of (x, y, LQI), to complete the model calibration, the calibration results are shown in figure 2, the abscissa for distance, y coordinate for the measured LQI value. Through the analysis of the data processing, it is concluded that the model after calibration , as shown in type (3).

$$LQI = -45\ln(d) + 190 \quad (3)$$

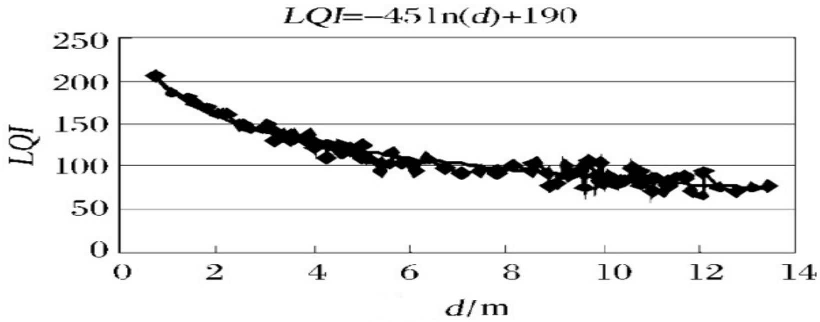

Fig.2 "Distance-loss" calibration results

Experimental verification

Experimental sites of 10 m x 10 m, as shown in figure 3,the reference node 1 to 4 reference node for the anchor nodes, according to the length, width 1 m sampling interval.

Experiments, every mobile,mobile node data will gather a group of 4 reference node(x_{ij},y_{ij}, LQI_{ij}),among them,i said the reference number of nodes,the values for i= 1, 2, 3, 4, j said the number of samples,value for j = 1,... , n.By using the data collected(xij, yij) calculate the ith the first j a reference node sample data, the mobile node and the actual distance between the reference node.Using the acquisition get LQI_{ij} and calibration of the positioning model calculation time first j fixed nodes of the ith sample data of the actual distance measurements.Using formula (3) of the mobile node can be calculated from 4 of the reference node distance,and then by the trilateral measurement method can determine the mobile node's position in the field.

According to the collected sample data calculated mobile node distance measuring distance,the actual distance of the anchor node, positioning accuracy, as shown in figure 3.

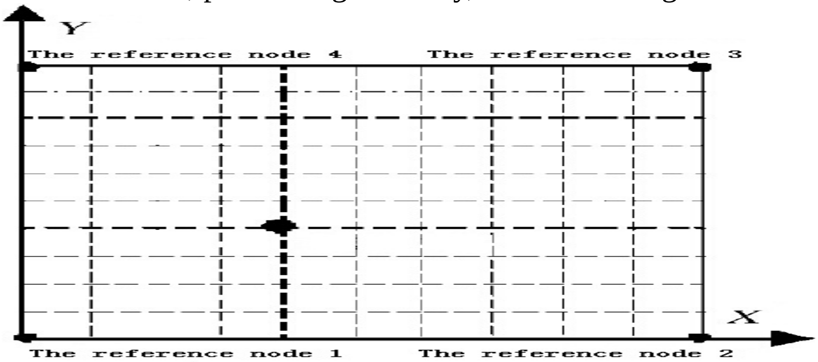

Fig.3 The diagram of the experimental site

Can be seen in figure 3,the positioning system is given by the distance measured value from theoretical value always near,can carry on the effective positioning to the mobile node.In the distance is the childhood of measuring accuracy is higher than that of distance is bigger when measuring precision, on the one hand is because when the distance the signal attenuation is more serious, the received signal will appear lost, on the other hand is wireless communication module 2.4 GHz radio frequency signal, its itself is easily affected by environment and noise, the noise also can’t be completely removed.

Table 2 analyzed the location accuracy of positioning accuracy within 2m,3m,(the statistical sampling points 105), can be seen from table 2, for the collection of data points, 90.38% of the positioning accuracy of the data points within the 2m, more than 97.11% of the points meet positioning accuracy within 3m.Based on the system can carry on the effective positioning of vehicles within the network,and meet the requirements of vehicle active safety.

Table 2 Positioning accuracy result statistics

Model accuracy		Anchor node 1	Anchor node 2	Anchor node 3	Anchor node 4
≤2m	The number of sampling points to meet the conditions	96.00	94.00	100.00	100.00
	The total sample point percentage (%)	92.30	90.38	96.15	96.15
≤3m	The number of sampling points to meet the conditions	103.00	103.00	102.00	103.00
	The total sample point percentage (%)	99.04	99.04	98.08	99.04
Max error/m		3.10	3.72	3.35	3.35

Conclusion

Using ZigBee communication to achieve a wireless positioning system,which uses a modified "distance - loss" model, and by LQI value of the network to locate a mobile node based on the experimental results show that vehicle to vehicle wireless communication technology stable positioning system the hardware and the software, using LQI positioning,which can greatly improve the positioning accuracy, able to using network effectively positioning the vehicle to meet the needs of vehicle location, with the high positioning accuracy, adaptability advantages. this design can improve vehicle active safety, help reduce traffic accidents,with good prospects in frequent traffic accidents today.

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