The Navigation System of Vehicles Used in Dangerous Sections of Road Based on the Technology of Wi-Fi

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Abstract: The navigation system of vehicle adopts the Wi-Fi technology of wireless local area network, with wireless IP camera gathering information of the bend over the road, temperature and humidity sensor recording the real-time data acquisition, SCM computing the speed according to the parameters, through wireless router algorithm transmit the information, and thus the driver can get information beyond the perspective of the road and the cue of speed. The experiment test shows that this system can be used in the intersection curve, the road sections as inadequate stadia, ramp, with strong practicability.

Keywords: dangerous road; Wi-Fi; bend; range of visibility; navigation

1 The background of the research

Curve is what leads to reduce the speed of vehicle and influences the traffic safety. Small radius and big corners easily cause traffic accident, becoming the leading killer of drivers. Therefore, to establish a system which can effectively improve the stadia, guides pilots to drive safely under different conditions in the corner is imminent [1,2].

Currently the mainstream navigation system is the GPS navigation system, which is able to provide drivers with speed information. But there are obvious deficiencies of the GPS technology, for example, the GPS system cannot provide the driver with real-time traffic information. Moreover, GPS requires receiving machine to be directly toward the satellite. When in complicated topography, there may be the condition of the "blind" signal coverage, and thus leading to the change of the GPS signals in measurement including atmospheric transmission delays and the multipath effect error [3-5]. In addition, the change of the external environment, such as the rain and snow, the changes in temperature, require drivers to pass through corners in different speeds. Otherwise it may cause dangerous driving casuality. However, the GPS navigation system cannot adapt to changes of the external environment, and the rationality of the fixed speed suggested is also should be identified.

Based on the existing problems, and adopting the developing Internet technology, the paper proposes adopting the Wi-Fi network, connecting with computer mobile and thus constituting the LAN, transmit the road traffic flow and information. Wi-Fi network has its own advantages, such as the high transmission rate , little transmission delay and high stability, which can meet the special requirement of navigation in dangerous sections.

2 The principle of design

2.1 Design ideas

Firstly, the traffic survey (mainly adopting questionnaire survey method), combining with the qualitative research, constitutes the evaluation index of risk factors affecting the velocity of road vehicle. Moreover, dangerous roads install video equipment, recording the traffic information and set the real-time data acquisition to collect the information of road surface conditions (temperature and humidity). According to the road of ramp parameters, curve, and the temperature humidity, the SCM calculates the reasonable speed. The data will be transmitting into signals and then launched. On the vehicles the computer receives the signal and thus receiving radio information and the voice information, the drivers can learn the traffic condition beyond to the scope and get wise suggestion about driving speed.

2.2 The hardware design

The system mainly consists of the wireless router, wireless IP camera, Ethernet development board, temperature and humidity sensor and on-board computer.

2.2.1 ammeters WIFI profile

WIFI is a kind of advanced technology which can link personal computers, handheld devices (such as PDA and mobile) terminal connected wirelessly with the technology. Its main advantages include:

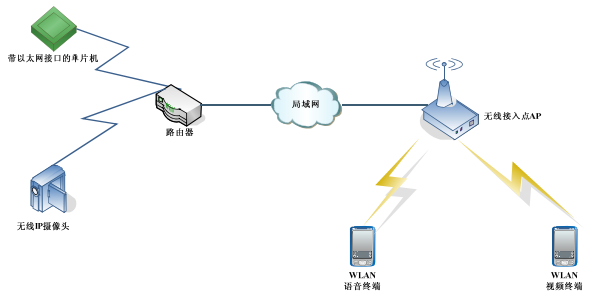

Figure 1. system diagram

(1) without wiring, suitable for mobile, being broad market prospect,

(2)wide radio scope. The maximum communication distance of WIFI wireless network is up to four miles,

(3) transmission rate is high, achieving the rate of 54Mbps, and thus according with the demand of social informatization.

2.2.2 wireless router

The router is set in dangerous sections, connecting a camera and MCU, responsible for sending the information of video and the information of speed. The system adopts d-link DIR - 665 300M high-performance enterprise wireless router, through multiple antennas, the capacity of wireless reaches 300Mbps, completely meeting the requirement of information transmission rate.

Figure 2. d-link DIR - 665 300M high-performance enterprise wireless router

Figure 3. SONY CCD 420 line hd wireless IP camera

2.2.3 wireless IP camera

IP camera is used to detect the traffic flow situation in hazardous road, then transmit information through the wireless route. SONY CCD camera 420 line consists of wireless IP, with the high rotating speed, response quickly. Moreover, the program can be compatible with low webcam etc, this system uses video monitor to get video information.

2.2.4 Ethernet development board

Ethernet development board is used for dealing with the real-time temperature and humidity, and thus computing the current speed. 51NET, which consists of a 10Mbps Ethernet interface and four RS232 serial interfaces, can learn ARP, ICMP, TCP and UDP protocol, this system adopts the board 51NET to deal with the real-time data gathered by the temperature humidity sensor, and then calculating the reasonable speed.

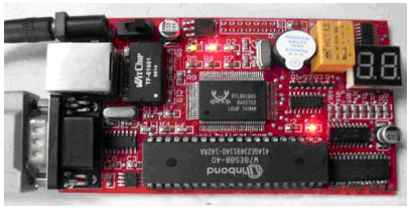

Figure 4. 51NET Ethernet development board

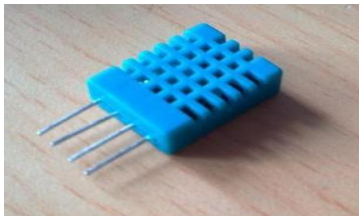

Figure 5. DHT11 temperature and humidity sensor

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2.2.5 temperature humidity sensors

Temperature humidity sensor is set in dangerous sections, gathering information about the temperature and humidity of the road. By using digital temperature and humidity sensors DHT11, it can combine the temperature sensor and humidity sensors, realizing the measurement of environmental temperature and humidity, with the character of broad measuring range and high precision.

2.2.6 On-board computer

On-board computer, which receives the information of the navigation system is the terminal equipment of the network. Currently, 95% of the cars in developed countries such as Japan have installed the on-board computer, achieving automatic navigation. In China, currently it has also started to popularize vehicle-mounted computer installed in the car. For the convenience of experiment, lenovo ThinkPad model 6200 portable computer instead of on-board computer for data processing and video display.

2.3 Software system design

In the study of basic theories and its algorithm based on Visual c + + as development tools, we develop the navigation system software terminal.

(1)The module of video displaying and control. The picture in the left part of the module shows the information of the road. The intermediate part is used for the control of camera, realizing the function of the camera focused, scaling, rotating, videos, and facilitating the adjustment functions such as the best Angle camera.

(2) SCM control module. The button of "SCM control" can manage the single-chip microcomputer, in the box of IPSetep, after clicking the "connecting the SCM", the text box will show the microcontroller configuration parameters, after inputting the configuration parameters, and then clicking the "set" button to update the parameters of single-chip microcontroller.

(3)The module of camera configuration. The "search" button can be used for searching the interface of the camera, the control interface shows the computer network parameters by running this program. Clicking the "search" button, the camera will find the type, name and IP address of the camera, in the right side of the interface of the camera is the network parameters.

(4) The module of parameter Settings. After the setting of the curve radius and the parameters of carriageway width, clicking the button to control the SCM so that the single-chip microcontroller will calculate the limited speed.

(5) The module of parameter informing. Real-time information of temperature and humidity in this module will be showed with dynamic curve, the SCM calculates driving speed which also display at the same time, the system will forming the drivers of reasonable speed. In addition, audio frequency and volume Settings can be adjusted.

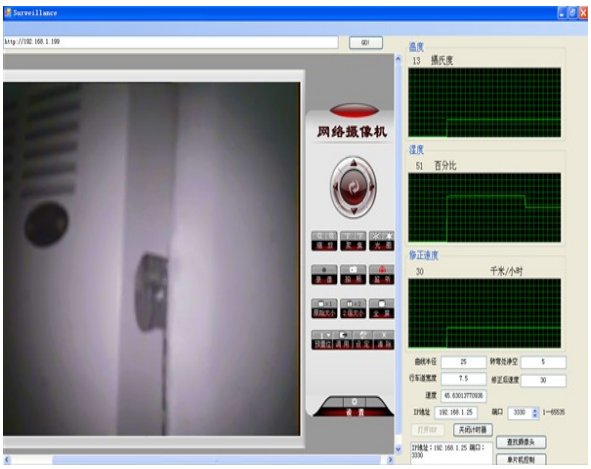

Figure 6. Software interface

3 Modeling of curves speed

3.1 Analysis of Influencing Factors on curves speed

Many influencing factors are involved in speed in curves, such as sighting distance, friction coefficient of pavement, weather conditions, density of traffic flow and Counter flow. We selected pavement friction coefficient and sighting distance which can be collected exactly by sensor to constitute the mathematical modele, the factor which can not be collected quantificationally are corrected through correction factors.

3.2 Friction coefficient of pavement

The friction coefficient of the road surface changes according to the temperature and season, it will attenuate under travel load. According to Gan Baozhu, taking 20℃ as cut-off point, generally , it decreases accordingly below 20℃.

3.3 Calculation on curves sighting distance

3.3.1 Basic Assumptions

(1)Vehicles in circular curve corners, the drivers within sight of road for circular curve;

(2) The obstacles influencing stadia curve are simplified to one point;

(3) Assume the vehicles are driving at a steady speed on circular curve.

3.3.2 Calculation on sighting distance

The curve sighting distance calculation formulation was put forward in Scientific literature[7]

$$S=\frac{\pi(R+1.5-B/2)}{90}\arccos\left(1-\frac{h}{R-B/2+1.5}\right) \quad (1)$$

3.4 Calculation on speed

Modern motor adopts ABS braking technique, road friction in the braking distance equals to the work done before the translation of auto brake with energy. According to Wang Runqi , the braking distance of curve is

$$L=\frac{v_0^2}{2g\varphi}+\frac{t_1 v_0}{2} \quad (2)$$

Due to the restrictions of driver stadia, through the navigation system drivers can see the sight beyond the sighting distance, it assumes that the driver start to brake before countering oncoming vehicle, then according to the meeting breaking distance calculating the speed.

$$\frac{1}{2}S=\frac{v_0^2}{2g\varphi}+\frac{t_1 v_0}{2} \quad (2)$$

It can be concluded that speed is calculated by the following equation:

$$v=\frac{\mu g}{2}\left(\sqrt{t_1^2+\frac{2\pi(R-\frac{B}{2}+1.5)}{45\mu g}\arccos\left(1-\frac{h}{R-\frac{B}{2}+1.5}\right)}-t_1\right) \quad (4)$$

Above all the formula: g — gravitational acceleration, take $9.8m/s^2$; μ — friction coefficient of pavement; B —lane width ,m; h —turning head room, m ; v —calculated maximum permissible road speed(m/s); t_1—breaking force time, take 0.4s; R_s—track position radius of curve inside, m; γ—central angle of corresponding sight line,(°); S—sighting distance , m; B—traffic lane width , m ; R—Radius , m.

4 System testing in real operating conditions

4.1 Test route

Xuzhou 206 federal highways Yao Zhuang cross-road.

This road is located in the intersection of Xuzhou Kunlun avenue and 206 federal highways, since it was designed as a secondary access road, the turning factors were not considered, and the turning radius is very small, hardly reaches 20 meters. Moreover, a two-meter wall in the middle of two branch road leads to shortage of serious sighting distance.

4.2 Test conclusion

Experimental results show that the best speed pointed out by the system is slightly lower than the actual speed on the straight road, and speed tips varied with the temperature and humidity, it has the features of high sensitivity, low delay, system security and stability. With the temperature is 13℃ , humidity is 68% , curve radius is 25m, the turning headroom is 5m, the lane width is 7.5 m, the system tips speed for 30km/h ; when humidity comes to 80%, tips speed for 21km/h.

5 Innovative features

This system has the following innovative features:

(1)It adopts wireless LAN technology, building rapidly LAN, to realize real-time interconnection between

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road network and on-board computer network, it is the first time for Wi-Fi network technology having application in dangerous section vehicle navigation.

(2) This system uses network combined with blue-tooth technology to realize effective navigation in dangerous section, directly achieving P2P (end-to-end) real-time information transmission without a control center, monitoring of counter road traffic flow, and transmitting real-time video information to drivers;

(3)Real-time traffic information collection. The system utilizes temperature and humidity sensor to collect road surface data, combines with the basic path parameter of danger section, sets the best speed hint of dangerous sections according to different weather conditions to drivers, it precedes the previous navigation because the drivers are guided by static pictures;

(4) The system provides a video transmission function which solves the existing problem of the stability of information transmission and visualization. Cell phone or PDA on the vehicle can receive real-time dynamic video information which enables drivers to adjust driving speed according to the traffic flow beyond sighting distance.

6 Application prospect

This system is an unprecedented real-time prompt system which can reflect the dynamic traffic information of the road, offering the integrated treatment results of dynamic changes of factors such as the traffic flow, road conditions and weather conditions. The system can give the driver with voice prompt or video information of road condition in sighting insufficient places. It can usually be applied to sharp curves, blind curves, road intersection, long straight up the steep slope, continuous slope and downhill, rain and snow section, etc. This system is feasible in technique and reasonable in economy, which allows mass production and possesses strong practicability.

The next stage is to add up to the image recognition function achieving voice prompt of real-time traffic flow situation, thus automatically guiding vehicle and improving driving safety on dangerous sections.

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