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Design And Implementation Of Intelligent Fog Guidance System

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ABSTRACT: The fog-prone areas of expressway are mainly affected by special geographical environment, most of which occur in mountainous and hilly areas, lake depressions, remote suburbs and other places. The intelligent fog zone guidance system can automatically change the working mode according to the visibility of the environment. In addition, it can also communicate with the Information Board on the spot and announce the road condition ahead of time, so that vehicles can be reminded and guided at the front end of the road where the fog occurs and at the road where the fog occurs, which makes up for the deficiency of the traditional method.

1 Project Background

Dangerous sections with a high incidence of highway accidents have a significant impact on the overall road operation safety, and more accidents occur in "black spots", namely, road sections prone to fog [1], dark ice, crosswinds, and road sections with low design standards such as sharp bends and long downhills. Inclement weather and accidents often cause highway closures. The closure of expressways not only causes trouble for people to travel, but also prompts travelers to change routes or other modes of transportation. It also reduces expressway utilization and causes direct economic losses [2].

(1) Road sections with low visibility

Heavy rain, heavy fog, haze and other low-visibility environment prone sections have a great impact on the safety of expressway vehicles, and are prone to accidents such as rear-end collisions, rollovers, and wall collisions. Especially in autumn and winter, the chain rear-end collisions of highways in our country mostly occur in the sections of group fog sections.

(2) Road sections with reduced friction

When the weather is rainy, cold, or snowy, the friction between the wheels and the road surface is weakened, which leads to difficulties in vehicle control and accidents such as skidding and rollover. Especially in some sections with high humidity and wind, due to the effect of wind cooling, freezing will appear when the temperature is lower than 0℃. This kind of local icing (dark ice) section is difficult for drivers to find, and accidents are more frequent.

(3) Other dangerous sections

On highways with sharp bends, long downhills and cross-wind prone sections, drivers often relax their vigilance and adopt unsafe driving methods such as high-speed passing and neutral sliding, which are prone to accidents such as wall collision, rollover, and brake failure. From various research and analysis at home and abroad, no matter what kind of complicated road conditions and changeable weather conditions are encountered, the main cause of traffic accidents is still insufficient safety awareness of drivers and lack of information on dangerous road sections ahead. It can be informed in advance, and at the same time, the speed is too fast during the driving process, and the special situation cannot be dealt with in time[3]. Drivers being responsible for accidents accounted for more than 70% of the total number of accidents. If the driver can be intelligently navigated on the road in advance, the driver can pay attention to the dangerous situation ahead, and induce the correct driving behavior, vehicle safety accidents can be avoided[4-5].

2 Classification strategy of intelligent fog zone guidance system

In accordance with the relevant regulations of the "Implementation Regulations of the Road Traffic Safety Law of the People's Republic of China" and the relevant regulations of the industry standard for the "Fogy Road Safety Guidance Device" issued by the Ministry of Transport of the People's Republic of China in February 2016, the response of the driving guidance system is divided into 4 Levels[6], as shown in Figure 1.

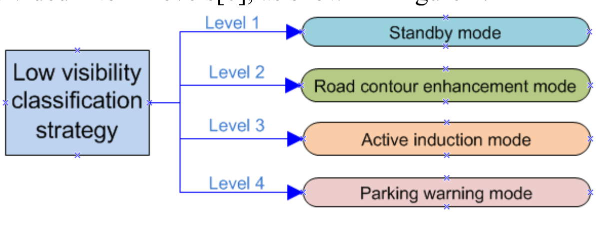

Fig.1. Classification strategy

Level 1: standby state. When the visibility is greater

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than 500m, turn off the induction light, turn off the light strip, and the equipment stores electric energy, as shown in Figure 2.

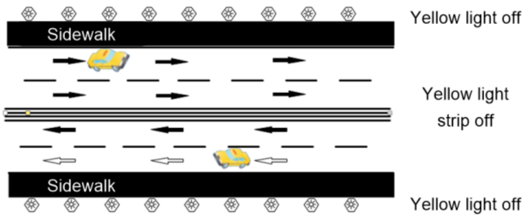

Fig.2. Induction system standby mode

Level2: the function of road contour enhancement mode. When the visibility is greater than 400 and less than 500 meters, the system enters the road contour enhancement mode, the guiding light is always yellow, and the light strip is turned on, as shown in Figure 3.

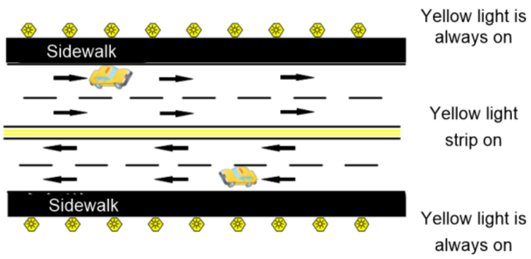

Fig.3. Road contour enhancement mode

Level 3: Active driving guidance mode function. When the visibility is greater than 300 meters and less than 400 meters, the system enters the active driving guidance mode, the guidance light status is the yellow light blinking synchronously, and the blinking frequency is adjustable, as shown in Figure 4.

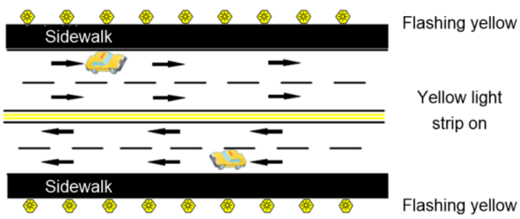

Fig.4. Active induction mode

Level 4: Prevent rear-end collision warning mode function. When the visibility is less than 300 meters, the system enters the rear-end collision prevention warning mode. When there is no vehicle passing by, the yellow light flashes synchronously; after the vehicle passes, the yellow light changes from flashing to red light, forming a red warning section, and the section will be Move forward with the dynamics of the vehicle., as shown in Figure 5.

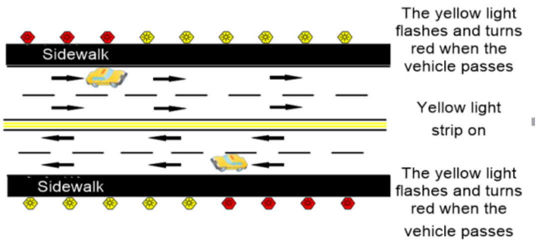

Fig.5. Rear-end collision warning mode

3 system design

3.1 Site master control system

The embedded guidance light control system analyzes and processes the on-site visibility data collected by the visibility meter, and controls the switching of the on-site guidance light beacon working mode according to the preset guidance classification strategy, and transmits the working status and visibility data of the guidance system to the monitoring center allows the remote monitoring center to know the real-time working status of the on-site guide light; at the same time, the remote monitoring center can also control the switching of the working status of the guide light, so as to realize the seamless switch between the automatic operation of the guide light system and manual control.

The on-site control center is installed in the same box with the visibility monitoring system. It is responsible for collecting, analyzing and processing the data of the visibility monitoring system, and controlling the induced lights to respond to different visibility levels according to the visibility degradation grading strategy formulated in advance, and implementing other related management, control function. As shown in Figure 6.

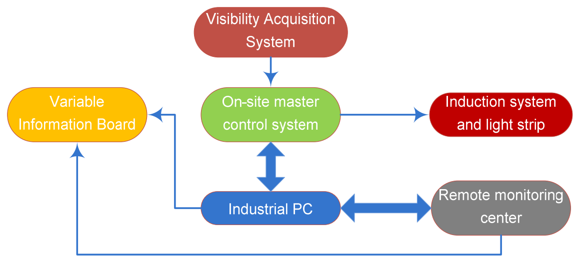

Fig.6. On-site control center collaborative work status diagram

3.2 Remote data transmission system

The main control equipment of the intelligent induction system and all induction node units realize data transmission through wireless ad hoc network, and the intelligent induction system and the remote monitoring center adopt optical fiber or wireless way to realize data interaction, as shown in Figure 4. The main control device of the induction system transmits the system status to the induction unit by broadcast through the 2.4G wireless transmission device, so that it enters the designated working mode; the induction unit adopts point-to-point communication to realize the state synchronization in the wake mode. The remote monitoring center and the main control equipment of the induction system are used for function setting and status query through network transmission.

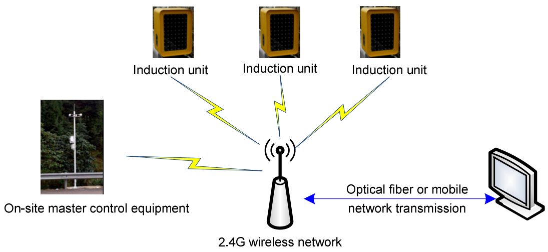

Fig.7. Schematic diagram of data transmission system

3.3 Visibility monitoring system

It is mainly composed of a visibility meter and an information acquisition processor. Due to the existence of the extinction principle, the particles in the atmosphere have varying degrees of influence on the atmospheric extinction coefficient and visibility. The monitoring system can monitor the road visibility environment in real time, and classify it according to the level of visibility, thereby determining the working mode of the guidance light at the corresponding level, so as to ensure that the vehicle can drive safely under different visibility conditions[7-8].

3.4 Intelligent guide lighting system

It mainly includes the guidance units placed on both sides of the expressway. According to the control strategy we have previously compiled, different measures are taken for different visibility levels, so as to achieve the purpose of corresponding vehicle guidance.

(1) For better visibility conditions, that is, when the visibility value is greater than 500 meters, the driver has a better view and does not need light guidance, so turn off the guidance light and the light guidance system is in standby.

(2) When the visibility is between 300-500 meters, the system enters the road contour enhancement mode, and the yellow guidance light is on, thereby displaying the road alignment guidance in a low-visibility environment in a high-contrast manner.

(3) When the visibility is 200-300 meters, the system enters the active induction mode, and the whole road section of the induction light equipment enters the yellow light to flash synchronously, and the flashing frequency is adjustable.

(4) When the visibility is less than 200 meters, the system turns on the anti-collision warning mode. When there is no vehicle passing by, the yellow light flashes synchronously; after the vehicle passes by, the yellow light changes from flashing to red light, forming a red warning section, and this section will move forward dynamically as the vehicle moves.

3.5 Cloud control

On-site visibility data, guiding light working status and various sensor data are summarized to the cloud through the network, allowing users to understand the road environment and the working status of the guidance system anytime and anywhere, and to remotely manage and control the system conveniently and quickly.

The client software adopts the currently popular nodejs+electron architecture, which is very suitable for running data-intensive real-time applications on distributed devices. In addition, it has strong compatibility and scalability and can be easily customized for different user needs. modify. The system operation interface is concise and clear, which can view the working status of the on-site system in real time, and can remotely control the on-site equipment. The client software is mainly composed of 3 parts: home page (environmental status), mode setting and threshold setting.

Home page can display real-time environmental information of the system installation location, such as visibility value, brightness value, and real-time display of environmental parameters in the form of graphs. The working state parameters of the system can be modified in the mode setting to adapt to the requirements of various use environments. And by setting an appropriate threshold, the DAS system is in the best working condition, and it can switch states in a timely and reliable manner according to the visibility and light conditions of the on-site environment, so as to complete the guidance in a timely and reliable manner.

4.System setting plan

4.1 Equipment layout plan

The intelligent guiding light beacons are installed in pairs on the central separation belt and the road side, with 4 sets for each section in both directions, and the driving direction is arranged at equal intervals of 32m. Therefore, each highway section needs 124 guide lights (the distance between the guide lights can be increased or decreased according to the site conditions, thereby increasing or decreasing the data volume of the lights).

4.2 Communication and power supply scheme

(1) Power supply plan

The intelligent guiding light adopts built-in solar energy or external solar power supply system (in areas with poor sunlight conditions, it is recommended to use an external solar power supply system or AC220V power supply), and no separate electricity is required. The visibility tester and on-site controller are powered by solar energy.

(2) Communication plan

In order to facilitate management and deal with emergencies in time, this design sets up a set of management software in the monitoring center, and the data signals of the front-end equipment are transmitted to the monitoring center through optical fibers along the line. The wireless communication scheme is adopted between the foggy road safety guidance devices, and the communication is realized by the built-in wireless module. The field controller communicates with the command center via optical fiber or 4G network.

5 Conclusion

The intelligent fog area guidance system has been tested and tested in some sections of the expressway. The construction of the intelligent guidance system for driving safety in fog has prevented and reduced the occurrence of highway traffic accidents under low-visibility weather conditions. The expressway safety guarantee capability has been significantly enhanced, protecting the lives and property of the broad masses of people, improving the technological level and service level of expressways, and laying a solid foundation for the sustainable development of my country's expressway construction.

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