Research on Intelligent Multiple Interchange Induction System of Huadu to Dongguan Highway

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Abstract: Urban expressway is an important part of the urban traffic network, which is also the main artery of urban traffic system. The rationality of interchange has a direct impact on the functions of “rapid patency” and “safety comfort” of urban roads. This paper taking Taicheng multiple interchange as the research object, which from expressway Huadu to Dongguan, focuses on improving traffic efficiency, induction accuracy and safety. This research is carried out from making the lines and mark, making high-precision navigation map, and making guidance system to provide solutions for Taicheng interchange.

1. Introduction
With the increase of the proportion of overpasses in urban roads, the safety problem becomes more serious. The main problems are the small space between overpasses and the difficulty in driving correction. The accuracy of the navigation system is insufficient and the level is not obvious, which increases the difficulty of driving, easily leading to congestion and traffic accidents, and aggravating regional traffic problems.

The accident statistics at home and abroad show that human error is the main cause of traffic accidents. According to the study on the causes of accidents in major countries in the world, the average ratio of drivers in traffic accidents is 70.8%. Among the factors of drivers, perception error accounts for nearly 50%, judgment error accounts for 36%, and reflection error accounts for 7.9%. More than 90% of the information acquired by drivers is visual information, and drivers mainly perceive speed and distance through visual information of the external environment.

The total length of the Huadu to Dongguan expressway is 65.165km. There are sixteen interchanges on this way, with an average interval of 4km, among which the minimum interval is only 1km. Taicheng interchange is located in Renhe town, which is the start point of this way. It intersects with Guangzhou expressway, airport north line, G106 national highway and other provincial way, forming a multiple interchanges with six lines. This interchange has a large scale, multiple levels of structure and complicated traffic diversion, which is rare in the expressway interchange of our province.

2. Study area
The Huadu-Dongguan expressway project is a key construction project of Guangdong province and Guangzhou city, and it belongs to the seventh important highway in Guangzhou high speed expressway network. The route starts from the south exit of Baiyun airport in Guangzhou and is
connected to the airport expressway. It goes east through Renhe town and Zhongloutan town in Baiyun district, Zhongxin city and Jilong town in Huangpu district, China-Singapore town, Yongning Street, Xiancun town and Shitan town in Zengcheng district, and ends at Shitan town and is connected to Zengguan Shenzhen expressway. The completion of this project will better enhance the traffic capacity of Baiyun international airport and is of great significance to the economic development of Guangzhou airport economic zone, China-Singapore knowledge city and Zengcheng national economic development zone.

3. Problem analysis
Huadu to Dongguan highway is expected to have a large traffic flow and a fast speed along this way. There are many overpasses. So there is a great demand for traffic guidance information. Drivers are easy to hesitate, pause and make wrong judgement in the entrance or exit of the interchanges. A little carelessness will cause huge losses or even inevitable major accidents. Therefore, the research on intelligent traffic guidance technology of complex interchanges has a great significance. There are sixteen interchanges, the average spacing is 4km, the maximum spacing is 8.1km, and the minimum spacing is only 1km. If the vehicle speed is calculated according to 80-120 km/h, the minimum distance is 1km, and the time needed is about 30-45seconds. The average time between all interchanges is between 120 to 180 seconds. In such a short time, there will be a lot of information to process. At the same time, processing these information will cause fatigue to people. If driver has a little slack, the driver will miss the interchanges, take a detour, and stop at the interchanges, reverse and the other illegal behaviours, and even cause greater safety risks.

4. Research contents
(1) Reasonable and clear road traffic information indicator sign setting research.
Traffic signs are designed to ensure smooth and safe driving, provide drivers with concise, clear, timely and sufficient information, and have certain reflective performance to meet the needs of night driving. Signs in the interworking area mainly include interworking exit warning signs, interworking exit signs, speed limit signs, entrance warning signs, location distance signs, location direction signs, prohibition signs, no entering signs, speed limit signs, traffic safety warning signs, split-merge guidance signs and line of sight guidance signs. The structural forms of the logo are column type, cantilever type, portal type and adhesion type, etc. In addition to meeting the requirements of sign vision and structural stress, structural design should also be coordinated with traffic volume, traffic composition and surrounding environment. To meet the requirements of aesthetics and vision, a disintegrating energy dissipation structure is adopted for the lighter single column logo.

The purpose of setting road markings is to guide the traffic and use them in conjunction with traffic signs to give drivers necessary warnings, restrictions and instructions, so as to make the vehicles go their own way in a smooth and safe way. As a supplement to traffic signs, traffic marking plays an important role in guiding traffic, ensuring traffic separation and conveying information to highway users. Track comparatively highway main scope of each vehicle is relatively complex, marking the type is various, so each line has become an important part of highway line, its content includes lane, lane edge line dividing line, the confluence of end a zebra crossing, guide arrow, ramp speed hump, deck bridge pier facade tag, etc.

(2) Study on infrastructure design of different colour pavement at interchange.
Road traffic facilities colour includes: motor vehicle lanes, non-motor lanes, sidewalks, bus lanes and climbing lanes and other parts of the colour. Colour of road appurtenances such as petrol stations, car parks, and vehicle stops (buses or taxis). Road traffic signs and line colours, as well as the colours of the internal traffic facilities (mainly guiding information) of the main stations or transportation hubs. Cover many factors such as history, climate, culture and vegetation, and are a relatively concentrated and complete colour system. Meanwhile, they should be integrated with the surrounding urban construction colours.
Paving different colours of the road in some ways than the vertical traffic signs, it can give the driver a visual signal. For example, red or yellow roads can be paved in areas with frequent traffic accidents to intuitively remind drivers to drive carefully. In the road through the primary and secondary school campus, paved iron red road, so that vehicles slow down, to avoid the occurrence of danger. In the sections of curves, ramps, tunnel entrances and exits of expressways, colour anti-slip deceleration belts are set horizontally according to a certain width to prevent skid deceleration. Different colours of pavement are adopted to make them fresh and eye-catching and enhance the safety of driving. Practice has proved that the rich colour of colour road surface can stimulate the driver's brain, relieve driving fatigue, keep a good mood, and reduce the hidden danger of accidents. Sweden has reduced traffic accidents by 85 to 90 percent by painting some particularly dangerous sections of the Alps red. China has also done relevant tests. In order to reduce the accidents caused by too fast speed, dozens of interlaced white lines were painted on the long road sections. The drivers looked like ripples in the water and felt the speed was too fast through these interlaced white lines, so that the drivers consciously reduced the speed.

![Figure 1: Colour-induced pavement](image)

(3) Research on design technology of humanized variable intelligence board

The humanized variable information board design uses the variable information to realize the variable information prompt function through the variable information display. Starting from the combined setting of "reminder + guidance" function and combining the prompt and guidance function of electronic navigation, the intelligence board studies the form of electronic road sign information release. The initial distance and density of "reminder" information release, the location and density and clarity of "guidance" information release, etc.

(4) Research on high precision navigation map

Rapid 3-D visualization modelling with 3-D laser scanning, flower guan highway CAD drawings and images of remote sensing based data and material, in the presence of a variety of data sources and different resolution images, need before operation according to the range of measurement and image distribution of regional network partitioning laser scanning data, reasonable planning, site laboratory post-production, correction and SMT process, formation is 3-D vector data. The modified RPC parameters, initial RPC parameters and historical DEM results after adjustment were used for orthophoto correction and resampling.
(5) Vehicle-road cooperative system

The vehicle-highway synergetic system will be fully tailored to the climate characteristics of the demonstration highway through the installation of intelligent sensing devices. The system is based on key technologies such as artificial intelligence, machine vision, vehicle-road communication and collaborative control, big data and edge computing. This system realizes the interactive communication among vehicles, roads, people and clouds through the intelligent control equipment, intelligent vehicle-mounted equipment, variable intelligence board and other information service equipment deployed on the road side, and realizes the road risk monitoring and early warning, and the coordinated intelligent control between vehicles and road facilities. Finally, the goal of reducing safety accidents, improving operation efficiency and improving the level of road management refinement is achieved.

Construction has many interface storage and pretreatment, data acquisition, front-end upload multiple upload methods, access authentication and encryption, and other functions of intelligent roadside stations, implementation is based on LTE -v communication development interface, provide vehicles with low latency, high reliable two-way interactive information channel, used for sensor information sharing between end (car) and peripheral driving operating status information sharing, a short-range communication, precise positioning, automatic monitoring, intelligent snatched functions such as intelligent transportation provide car networking (V2X) communications services; Promote the unified access of the roadside acquisition equipment terminal of traditional infrastructure to achieve local storage and processing, decision-making and control capabilities. Build a distributed roadside cloud node for intelligent highway management and service, as well as a security gateway for intelligent vehicles and intelligent terminals on the road network to access the traffic infrastructure network.

The intelligent roadside control station is composed of roadside communication equipment, cooperative control machine, SDH optical switch and other equipment deployed in the roadside chassis. The road side communication equipment (also known as RSU road side communication equipment) is composed of the control network side interactive unit and the road side edge access unit. The cooperative control machine is composed of control network sensing access unit and roadside edge control unit. The intelligent on-board terminal consists of on-board display screen, on-board OBD interface and dual-mode antenna. The installation and deployment of the intelligent road side control station system also requires the installation and deployment of mains power and optical fibre communication interfaces, as well as UPS power supply, equipment cabinet, door frame/pole, infrastructure and ancillary facilities. The intelligent road-side control station can be connected with the road-side Beidou continuous operation reference base station (CORS) system for docking and data exchange and transmission, so as to provide accurate positioning reference information for vehicles. In addition, the roadside control station can also provide relative positioning capability based on Beidou for vehicles.
5. Conclusion
This article embarks from the urban interchanges intelligent guidance system, the research at home and abroad, the investigation will be colour, high precision, variable information board, sign and marking map and intelligent guidance system used in Huadu to Dongguan.

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