Model for location selection of traffic sign setting in road intersection of mountainous city based on driving characteristics analysis

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ABSTRACT
There are many intersection roads in the urban road, and the intersection is often a necessary place for the vehicle to complete the swerve and for the agminated foot passengers to across the street. Most of the roads in mountainous cities have deformed intersections. Therefore, the location selection of traffic signs at a mountain road intersection is particularly important. Based on the driving characteristics, this paper discusses the location selection of related traffic signs at the intersection. According to the brief analyses on intersection characteristics in mountainous city and based on drivers’ specific visual reaction, the related visual dynamic states for drivers are determined. On the strength of drivers’ visual reference frame, the specific location of traffic sign at road intersection in mountainous city is installed.

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1. Introduction
In accordance with the rapid development of current social economy, the development of the transportation industry is also more rapid. Road transportation is the primary mode of transport today. Although highway transportation has shown increased efficiency, there are many serious traffic problems (Jianwei, 2014). In recent years, the total number of urban roads in China has been increasing. However, the related road planning equipment is not perfect considering the length of urban roads. Therefore, the construction of the urban road network in China is relatively complex. The frequent occurrence of traffic accidents has aroused widespread concern from all walks of life (Jindong, Dangyun, & Jun, 2011). According to the statistics of relevant data, traffic accidents outnumber fire and flood accidents in most of the countries. In China, mountainous areas occupy about 70% of China, and mountainous cities occupy more than half of China. Though the incidence of traffic accidents is less than in mountainous cities than in the plain cities, the mortality of transportation in mountainous cities is much higher than that in plain cities (Lan & Wei, 2015). In the intersection of mountainous cities, the setting of intersections not only connects urban roads but also effectively alleviates the whole urban traffic. Most of the intersections of mountainous cities are not vertical, and many roads have a continuous linear feature. Thus, it is easy to cause more casualty during accidents in the mountain intersection. Setting the correct traffic signs in current locations in the mountainous city roads can effectively guide the drivers to prevent accidents.

2. Characteristics of mountainous cities and intersections

2.1. Traffic characteristics of mountainous cities
The road pipe network in most of the mountainous cities in China presents the characteristics of independent assortment (Fangzheng & Hong, 2012). With the continuous progress of society, most mountainous cities tend to alleviate the traffic snarls effectively, extending the radioactive road for transportation roads in the mountainous urban ring roads and the urban centres. Thus, the radioactive transportation network based on the macro-perspectives and the free combinations of road networks in the city is constructed. For example, Chongqing is a typical mountainous city, so the traffic volume is relatively large, often multi-centre-type roads, bridges and tunnels show ring expressway traffic channel is particularly great, and most of the traffic has often centre traffic and follows the external traffic double tide phenomenon (Chi, Shaowei, & Binghong, 2016).
2.2. Characteristics of road intersection in mountainous cities

In general, the intersection of a plane road is specifically covered by the area of a road intersection of a vehicle’s parking line (as shown in Figure 1). The intersection area will be set up about 5−10 m within the range of the radius of the edge stone, so as to meet the intersection between the two-way road and the overcrossing distance.

In mountainous city road network construction, due to many terrains and landforms, most of the intersections are set as deformed intersections are constructed (Li, 2013). Therefore, the specific comparison between road and the corresponding angle is to complete the road division of the intersection. According to the shape and the specific poor angle of the intersection, the specific division methods include the completion of the division. Intersection is an important and indispensable turning point in the urban traffic network. In mountainous city traffic roads, due to the restrictions of numerous traffic terrain factors, the overall layout and related structural characteristics of plain cities are established. Mountainous city road intersection is often distorted and poor, without road vertical comparison, it can be divided into specific intersection angles of the intersection. The whole mountainous city can be divided into 75° beyond the road intersection, between 75° and 45° and less than (three types of) 45° as follows. The linear majority of the overall intersection in the mountainous city is the intersecting angle, and the specific cross-range longitudinal wave between the intersecting roads.

2.3. The problems of intersections of mountainous cities

As the overall transportation landscape of mountainous cities is relatively complex, the transportation planning of mountainous urban roads has been restricted by certain geographical conditions. The current cross-mountainous city road traffic faced some problems, for example, (Jin-jin, 2011) the import and export city route which is often bent and there is a corresponding small angle. To a certain extent, drivers’ reactions and ability to judge have brought great challenges in the situation with slope intersections. Uncontrolled speed greatly increases traffic. The intersection area of mountainous cities is too narrow, which cannot comply with the overall layout of the special lanes. It has a great impact on the overall efficiency of transportation, and it will cause conflict between tasks and vehicles, so it cannot ensure traffic safety. Third, most of the intersections are not designed according to a conventional intersection in plain cities, which results in too much traffic congestion at the intersection. The fourth is that the width of the roads in mountainous cities has been affected, so the setting of bus stops is often too short of reason-ability. Fifth is the appearance of extremely unreasonable traffic sign at the intersections of mountainous city.

3. Traffic sign model of driver identification at the intersection of mountainous city

3.1. Traffic sign model of driver identification at the intersection of a regular section of a mountainous city

At the intersection, road signs or rules often need to be visually attractive (Zhang, 2014) to the driver, so when the driver’s driving sign often needs a transition period, thus the driver can adapt to the object within the scope of achieving the visual acceptance; after the driver receives the relevant traffic signs of visual range, content related to the recognition of traffic signs; and after the driver needs to complete the relevant contents of traffic sign recognition, complete judgment on the content, in order to determine the marker content is useful on its own, after the relevant information is useful to complete a certain degree of processing; and is to determine the specific driver of traffic signs, can be carried out operation on their own driving; finally, the driver can make a demo of the vehicle for the first time, complete the corresponding reaction. There is a certain time gap among this series of response process. This paper, through the driver’s traffic sign recognition for T1 based on the pilot, found traffic sign’s relevant time and the specific time of traffic to read the contents of the time and reaction of $T1 = t1 + t2 + t3$; in the second stage, the driver-specific driving operation time is $T2 = t4$. Therefore, in the third stage of the driver to complete the corresponding response time of the driver of the vehicle: $T3 = t5$. 

![Figure 1. Road intersection of a vehicle’s parking line.](image-url)
3.2. Identification of traffic sign model of road intersection driver in a mountainous city

In the case of mountainous city road intersection, the driver for the identification of traffic signs and the overall effect of linear intersections are affected by the mountainous city road. Then, the specific location of traffic signs can not be set in the right ahead of drivers’ visual position (Xiangke, 2012). In that way, when driver sees traffic sign, the driver has to turn its head; and then see the driver in the traffic sign after the completion of the model, which is identification of traffic signs, so as to form a time period for the visually acceptable time. Moreover, it is for the recognition of traffic signs and visual content. The rules of the road should be followed at intersection, so the driver will need to stay at the intersection and recognize traffic sign, but see again, so as to ensure the driver's line of sight from the traffic signs in front of rotary. Then driver makes corresponding vehicle operation just like the same specific operation in regular road segment.

3.3. Traffic sign setting parameters at the intersection of mountainous cities

Setting up the traffic signs in the intersections following some parameters shows some effects (Bao Hansan, Suping, 2009): First, when the driver is driving in the main traffic it will be much beneficial for him. In the process of setting the specific location of the traffic sign, the specific behaviour of the driver and the visual behaviour should be taken as the main factors of setting the traffic sign. Second, the vehicle will directly affect the traffic signs arranged in the highways. Thirdly, it is the environment of the traffic road, which is a kind of linear belt with constant changes. Then the relevant topographic conditions and the specific forms of sections of the road will have a certain direct impact on the relevant traffic signs.

3.4. Full range of drivers’ visual search

Considering safety as the main starting point of traffic signs, drivers often pay close attention to the proper location of vehicle traffic during driving to get much information. The driver can observe the proper driving position of the vehicle through gaze, then the marking of some visual reactions to him by saccade is finished and then a series of information about the traffic signs through gaze is acquired. The drivers’ overall visual search is a complex cognitive process. It has a strong stimulation effect on a variety of ways that the visual perception of the external information is completed. It achieves the overall purpose of landmark establishment (Figure 2).

4. Experimental design of traffic sign position at the intersection of a mountainous city

4.1. Experiment and result analysis

By using the camera to record the specific behaviour of the driver while driving, the angle of the different traffic signs and the specific speed of the driver at different driving speeds and the time to go back are also recorded. The angle roadmap of the intersections of the mountainous city is set to 45° and 75° by choosing the restricted nature of the topography. The two road to road traffic speed, specific 60 km/h, respectively set up five drivers in accordance with the speed of 60 km/h running a total of five times, after filming the action of the driver, after the traffic signs in different angles at different, in order to observe the driver turned back the time-related data analysis.

After the experiment, the data were as follows: in the process of the driver when the vehicle speed is guaranteed in 60 km/h, when the intersection angle is 45°, the average length of time the driver turned to 0.773 s, observe the traffic marker is 0.385 s, after the return is the average length of 0.747 s. When the intersection angle is 75°, the average turning time of the driver is 0.257 s, while the traffic sign is 0.365 s while the average time to go back is 0.286 s. It can be seen that at the intersection of $t_1 = t_4$ at the same corner, the time of $T_1$ and $T_4$ will change with the angle of the angle when the drivers’ driving speed is ensured.

4.2. Application of experimental data

Through the road intersection of the mountainous city, the drivers’ specific operation time is set to three time periods, $T_1$, $T_2$ and $T_3$. The $T_1$ time period includes $T_1$ (turning head), $T_2$ (visual reception), $T_3$ (recognition), $T_4$ (back), $T_5$ (judgment), $T_2$ including $T_6$ (driving operation), $T_3$ including $T_7$ (vehicle response). According to the specific formula, the drivers’ turn head and head turn back, and the time of recognition is about 1 second. Then $T_1 = 1 + 0.4 + t_1$, $T_4$ time vehicle specific exercise distance $S_1 = (2T_1 + 1.4)r/3.6$; the specific driving operation of the market drivers for 1.5 seconds, then $T_2 = 1.5$ seconds, driving car specific distance is $S_2 = 1.5r/3.6$; after the occurrence of operational errors in vehicle safety signs must be stopped, so,

$$S_3 = \frac{r^2}{254(\varphi + f + \ell)} \quad (1)$$

Figure 2. Driver models during the driving process.
According to the above three formulas, the formulae for setting up specific traffic signs at the intersection of mountain urban roads are as follows:

\[
S = S_1 + S_2 + S_3 = (T_1 + 1.4) \frac{r}{3.6} + 1.5 \frac{r}{3.6} + \frac{r^2}{254(\rho + f + i)}
\]

(2)

5. Epilogue

According to the mountainous city road intersection characteristics and based on the recognition of driver model for the drivers’ perspective of the mountainous city intersection traffic sign, the appropriate traffic sign set position is determined by means of analysis of experimental results of mountainous city road intersection traffic sign set-specific parameters. As a mountainous city road intersection traffic, the specific location of sign setting provides a theoretical basis of parameters. The main problem of this study effectively combines the road intersection traffic signs and mountainous city highlights. Then the video frame is gradually tested to give some analysis. And it finds out that the driver in the driving process for traffic sign recognition procedures gradually includes text, pattern and blank. According to the characteristics of the mountainous city and combining with the driver in the driving process for traffic sign recognition procedures, a traffic sign model is built. The research work provides referencing theoretical basis and has a practical value.

Disclosure statement

No potential conflict of interest was reported by the author.

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