The Urban Road Traffic Facilities Design for Automatic Ban

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Abstract

In order to reduce freight influence on urban roads, traffic and city appearance, what's more, to reduce traffic management workload, the design of urban road traffic facilities for automatic ban is designed in this paper. By using the probability method and the driver's driving characteristics, set the number and position of roadside warning signs. The use of Lippl visual software provides us recognition of license plate color and license plate number, and we get detection of large trucks and buses by method of combining shift mean segmentation and edge detection. On the basis of the fixed Longmen frame, combined with detection information, realize automatic lifting of Longmen frame with high speed motor as power, and achieve the automatic design of the urban road traffic facilities. Examples and simulation analysis show that the design results are feasible and can be implemented.

Keywords

Urban road, Automatic ban, Probability theory, Lippl visual software, Longmen fram.

1. Introduction

Trucks into the city road has brought a greater impact on urban road, traffic and the appearance of a city with the rapid development of social economy and technology[1]. Today, prohibition of large trucks into the city is a traffic management measures taken by most cities in our country, but Existing facilities are generally difficult to achieve the automatic lifting of the Longmen shelf, and the number of warning signs or setting up is not reasonable enough. The urban road traffic facilities design for automatic ban has important significance on improving the efficiency of the facilities, Protecting the normal passage of the bus and reducing the traffic management personnel input.

2. Number and Location of Signs

2.1 Analysis of roadside sign setting

In order to remind the truck driver that the road ahead is prohibited the passage of truck, we should set up a warning sign in front of forbidden facilities, thus the driver diverted to other routes in time. Warning sign position setting is not reasonable, may lead to too late to take relevant measures, and even lead to traffic accidents[2].

2.2 A single roadside sign position setting

In the absence of large trucks, signs setting position and the driver's visual recognition process as shown in Figure 1.

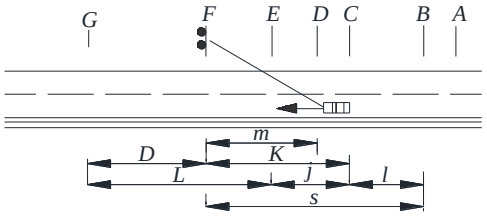

Figure 1 Signs reading process(single side)

In Figure 1, F is a roadside sign position setting, setted in a distance from the front of the Longmen shelf. Usually, drivers found signs F in the visual recognition point A, start reading sign information at point B, and finished at point C, then make a decision to take action, at this time, the vehicle is traveling to the point E. The distance From the point of action E to the point G is called the action

distance L. Drivers must safely and smoothly complete the relevant action in this distance, such as changing direction, slowing down, etc.

The distance from the B point to the mark F point is called the visual recognition distance s, the distance from the C point to the mark F is known as K , the distance to the mark after reading. If the distance K is shorter than the vanishing Distance m, it means not easy reading signs, and the driver could not accurately interpret the signs within range of C point to vanishing point. According to figure 1, we can get visual distance s, judgment distance J, lead distance D, read distance *l* and action distance L:

$$s = L + j + l - D = K + l \tag{1}$$

$$j = V_1 t_3 \tag{2}$$

$$D = L + j - K \tag{3}$$

$$l = V_1 t_2 \tag{4}$$

$$L \geq (V_2^{\,2} - V^2_{\,1})/2a \tag{5}$$

In the formula: V_1-speed near the Longmen shelf; n-lane number; V_2-the speed to reach the Longmen shelf; t_2-the time required to read the mark; t_3-the time required to take measures; a-deceleration, general take 0.75~1.5m/s^2.

D must meet the condition:

$$D \geq \frac{V_1^{\,2} - V_2^{\,2}}{2a} + j - K \tag{6}$$

D , that is, the minimum lead distance when only have one sign.

2.3 Multiple roadside signs position setting

In the process of vehicle passage, because of the outside lane vehicle occlusion, the driver can not find the roadside warning signs, this time we should set up a number of roadside traffic signs[3], As shown in Figure 2.

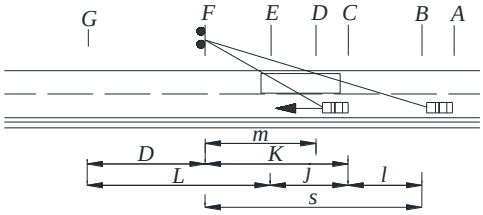

Figure 2 Signs reading process(multiple side)

Therefore, to solve the occlusion problem outside lane, we must calculate the size of the two rectangular firstly, and the probability of a truck in two rectangles. If the probability is small enough to be considered a small probability event, then there is no need to deal with the occlusion problem. Otherwise, relevant measures must be taken. In those continuous roadside signs, as long as there is one not to be blocked, the inside lane driver can successfully read. Assuming that the probability of a cart in the outer rectangular area is P0, the probability that N signs are all covered by large truck is:

$$P = P_0^n \tag{7}$$

Through the above analysis, we can set multiple warning signs to solve the occlusion problem of the truck. When the value calculated by the formula (7) is very small, and there is at least one sign that is not covered by a very large probability, the n value is the set number of roadside signs.

If U represents the minimum distance of roadside sign, when you need to set the number of warning signs, the distance between the first, two or three blocks from Longmen is D+U, D+2U, D+3U respectively, roadside sign's position setting can be rounded.

3. Vehicle Identification System

Vehicle identification uses truck identification method of multi camera collaborative shooting based on far and near[4]. In order to avoid vehicle occlusion and adhesion, the camera is mounted on the top of the road through the support of a sloping downward shot. One of the shooting panorama for vehicle identification, the rest of the close range shooting lane for vehicle license plate recognition. The method consists of three steps: (1) detection and segmentation of trucks; (2) feature selection and extraction; (3) vehicle classification.

3.1 Detection and segmentation of trucks

Make license plate recognition of close range images using visual software, according to the principle of imaging, plate position in the far and near is a fixed function and this function can be pre-off-line. As shown in the formula(8):

$$p\_lpr = f\left(c\_lpr\right) \tag{8}$$

In the formula: p_lpr represents the location of the license plate in perspective, c_lpr represents the location of the license plate in perspective in close.

3.2 Feature selection and extraction

Extract interval number of vehicle body, interval color number, and front window ratio by method of combining shift mean segmentation and edge detection.

3.3 Vehicle classification

Based on a large number of sample statistical analysis, set up membership function of three characteristic of interval number, color number and front window ratio. As shown in the formula (9), (10):

$$BF = BR\left(\mathrm{Re}\,gionNum\right) + BC\left(ColorNum\right) + BW\left(WinR\right) \tag{9}$$

$$TF = TR\left(\mathrm{Re}\,gionNum\right) + TC\left(ColorNum\right) + TW\left(WinR\right) \tag{10}$$

In the formula: $BR(x)$, $BC(x)$, $BW(x)$, are the membership function of the interval number, the color number and the proportion of the front window of the bus. If $TF == \max\left(BF, TF\right)$, the vehicle is a large truck, otherwise bus.

4. Longmen Frame

4.1 Working process of Longmen shelf

When the vehicle is forced through the last sign, the sign issues a warning, Longmen frame start response, lifting beams begin to decline, the time required to ensure that the beam falls to the lowest point is less than the time the vehicle reaches the beam. In order to ensure the safety of the driver, the lowest position of the beam should be higher than the driver's head.

4.2 Longmen power plant

Longmen power plant selects high speed motor over 10000r/min, it has the following advantages: high speed, high transmission efficiency, small noise and fast dynamic response.

4.3 Rationalization of the decline of Longmen

Suppose the mass of the movable beam of Longmen is m, the initial Longmen height is H, the final drop height is h, high speed motor power is P, speed is n, drive wheel radius is r_1, driven wheel radius is r_2, the distance to the Longmen shelf is D+U, which is close to the Longmen shelf, truck design speed is V_0, Rotating speed is V_1, the descent speed of the beam is V_2, whether or not to meet the requirements of Longmen forbidden shelf can be calculated as follows:

$$t_1 = (D+U)/V_0 \tag{11}$$

$$t_2 = \left(H-h\right)/V_2 \tag{12}$$

$$V_1 : V_2 = r_1 : r_2 \tag{13}$$

$$V_1 = 2\pi r_1 n/60 \tag{14}$$

Will (13), (144) into (12), to:

$$t_2 = 30\left(H - h\right)/\pi n r_2 \tag{15}$$

The tension generated by the Longmen stand is:

$$F = P/V_1 \tag{16}$$

Will (14) into (16), to:

$$F = \frac{30P}{\pi n r_1} \tag{17}$$

When $F > mg$, $t_2 < t_1$,the Longmen shelf design is reasonable.

5. Example Analysis

Taking Pingdingshan city to Jiaxian road as an example, the average daily traffic volume is 28,000vel/d. The rate of large trucks was 50%, car design speed is 100km/h, truck design speed is 80km/h.

5.1 Sign number calculation

(1) Take the road vehicle speed for $V_1 = 80km/h$, and the speed at which the danger is reached for $V_2 = 0km/h$, according to the 85% parking spaces speed , reduction rate a take 1m/s^2, thus:

$$I = V_1 t_2 = \frac{80}{3.6} \times 2.6 \approx 58m$$

$$j = V_1 t_3 = \frac{80}{3.6} \times 2.0 \approx 44m$$

$$D = L + j - K = 247 + 44 - 46 = 245m$$

(2) Assuming the truck on the road, middle lane accounts for 1/3, right lane accounts for 2/3, and the probability of the influence of the middle and right lane on the rectangle is J_1, J_2 respectively, the probability of a large truck in the two lane as follows:

$$P\left(J_1 \cap J_2\right) = p_1 p_2 = 0.9608 \times 0.8869 = 0.8521$$

Assuming the probability of at least one large truck in the middle lane and the right lane is J_3, J_4 respectively, probability of truck exsitting in rectangular in the middle lane as follows:

$$p_3 = 1 - p_1 = 1 - 0.9608 = 0.0392$$

probability of truck exsitting in rectangular in the right lane as follows:

$$p_4 = 1 - p_2 = 1 - 0.8869 = 0.1131$$

the probability of there is at least one lane exsitting truck as follows:

$$P\left(J_3 \cap J_4\right) = 1 - p\left[J_1 \cap J_2\right] = 1 - 0.8521 = 0.1479$$

(3) According to the formula(2), n=3.

5.2 Sign's position determination

From the above analysis can be obtained, the shortest distance from roadside traffic signs to the Longmen location frame is 245 meters. By formula (3) can get the minimum distance between the roadside traffic signs as follows:

$$I + V_1 \times 2.5 + j = 58 + \frac{80}{3.6} \times 2.5 + 44 \approx 158m$$

Thus, just set 3 signs in front of the Longmen shelf 2, 1, 0.403km.

6. Innovative Features

(1)The number of signs in front of Longmen is determined, provide accurate and timely information to the driver.

(2)The use of visual software realizes the quick and accurate identification of freight cars.

(3)Longmen frame can be automatically lifted.

7. Conclusion and Deficiency

The following conclusions are obtained through the analysis of this paper:

(1)From the angle of driver's psychology, the driver's identification of traffic signs and the operation of the vehicle is divided into 6 stages, 7 points, article get the basis of traffic sign position setting and the theoretical model of operating action distance L, at last, set the number and location of the roadside sign was determined.

(2)Propose truck identification method of multi camera collaborative shooting based on far and near, solve the problem of the distinction between large passenger cars and large trucks.

(3)Using high speed motor, combined with the front sign detection information, realize the fast automatic lifting of the Longmen shelf.

Deficiency:

Due to many aspects of the restrictions, unable to make the physical model, need to continue to improve the follow-up study.

Reference

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