Measurement of driver’s viewpoint at crosswalk

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Abstract: We measured transient of the driver’s viewpoint at crosswalk to analyze the difference between well-trained and beginner drivers. Three well-trained and three beginner drivers were selected as the examinee. As the results, the well-trained drivers tend to move the viewpoint horizontally for about 3 seconds before arriving the crosswalk. The beginner drivers tend not to move the viewpoint in the same time.

Keywords: safety driving education, visual search

1. Introduction

When driving, well-trained drivers always pay their attention to the moving objects on a road. On the other hand, beginner drivers even they pay attention to sometimes caused dangerous situation. What difference between well-trained and beginner drivers? Driving operation can be considered three steps. A shown in Fig.1, the driver visually notices moving objects in the traffic situation. Next, the driving action for the automobile is formed by the recognition. Finally, actions such as acceleration and braking, steering control are taken for the automobile. In particularly, visual information is often important at curve, intersection, and crosswalk. Here we focus our research to the visual perception and recognition at crosswalk and we analyze difference in characteristics of viewpoint between well-trained and beginner drivers.

2. Assumptions and problems

This paper analyzes how the driver’s viewpoint moves in driving. In order to analyze the viewpoint behavior, we used an eye-mark camera, as shown in Photo.1. The followings are the assumptions and problems to be considered in this paper.

(A2) The head of examinee is fixed and not moved.
(P1) Investigate eye movement behavior when approaching crosswalk between well-trained and beginner drivers.
3. Measurement system

As shown in Fig.2, 3 CCD cameras set on a cap capture the image around the road and driver’s eye movement that can be superimposed in the real time. Superimposed image stored in the real time in video tape recorder. By installing this equipment on the car, experiments were carried out.

![Fig.2 Measurement system](image)

Fig.2 Measurement system

A purpose of experiment is follows. In the experiment, examinee A-1~A-3 are beginner and examinee B-1~B-3 are well-trained driver. Measurement is configured as shown in Fig.2. The examinee drive an automobile on the road toward to a crosswalk at 40km per hour. As shown in Fig.3 and Photo.2, the movement of driver’s view point was measured 5 seconds before to the crosswalk.

![Fig.3 Situation of experiment](image)

Fig.3 Situation of experiment

<table>
<thead>
<tr>
<th>Examinee</th>
<th>Age</th>
<th>License</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examinee A-1</td>
<td>24 years</td>
<td>3 years</td>
<td>10 times in the year</td>
</tr>
<tr>
<td>Examinee A-2</td>
<td>22 years</td>
<td>1 year</td>
<td>2 times in the year</td>
</tr>
<tr>
<td>Examinee A-3</td>
<td>22 years</td>
<td>3 years</td>
<td>4~5 times in the year</td>
</tr>
<tr>
<td>Examinee B-1</td>
<td>24 years</td>
<td>6 years</td>
<td>3 times in the week</td>
</tr>
<tr>
<td>Examinee B-2</td>
<td>22 years</td>
<td>3 years</td>
<td>4 times in the week</td>
</tr>
<tr>
<td>Examinee B-3</td>
<td>23 years</td>
<td>3 years</td>
<td>2~3 times in the week</td>
</tr>
</tbody>
</table>

4. Experimental results

The steady state view point is determined by the mean value of right and left eyes angle. The horizontal and vertical transient of eye movements by examinee A-1~A-3 are shown in Fig.4 and those by examinee B-1~B-3 are shown in Fig.5. From this point we let the right and upward direction be positive, and the left and downward direction be negative. In the data, unsuitable events such as the blink time data are ignored.

![Fig.4 Change in view point (Examinee A-1~A-3)](image)

Fig.4 Change in view point (Examinee A-1~A-3)

![Fig.5 Change in view point (Examinee B-1~B-3)](image)

Fig.5 Change in view point (Examinee B-1~B-3)
5. Analysis

5.1 Data analysis

The transient of the viewpoint in horizontal direction is considered. The viewpoints obtained by the viewpoint data from driving examinee were divided into four regions. And then, let a sidewalk of left side be "left side region", let a cruising lane and opposite line be "center region" and let the sidewalk of right side be "right side region". As shown Fig.6, how percentage of viewpoint’s appearances in each region in the 1 second interval from 5 second before the crosswalk which obtained two following steps.

( ☑ ) Step1

Count the number of viewpoint’s focused into each region every 1/30 second.

( ☑ ) Step2

These steps are continued repeatedly until it arrives 1 second and the overall step is continued every 1 second as Fig.6.

Interpretations of histogram are follows, the flat histogram means searching. On the contrary, if not, means watching somewhere.

Histogram of examinee B-1~B-3 tend to move left side region, center region, and right side region 2~3 seconds before arriving crosswalk. On the contrary, histograms of examinee A-1 and A-3 tend not to move in the same time.

5.2 Dispersion of view points

From the experimental data obtained by the above procedure, we obtained the vertical and horizontal direction of dispersion from the experimental data. Fig7 shows the dispersion. The degree of the dispersion is defined by the standard deviation given by eq.(2). For the point data \( x_1 \sim x_n \).

\[
\sigma(x) = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2}
\]  

\( \bar{x} \) : Average of \( x_1 \sim x_n \)

Table2 Standard deviation of viewpoint’s movement

<table>
<thead>
<tr>
<th>Examinee</th>
<th>Standard deviation of vertical angle</th>
<th>Standard deviation of horizontal angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examinee A1</td>
<td>( \sigma_v = 3.47 )</td>
<td>( \sigma_h = 2.95 )</td>
</tr>
<tr>
<td>Examinee A2</td>
<td>( \sigma_v = 4.41 )</td>
<td>( \sigma_h = 4.34 )</td>
</tr>
<tr>
<td>Examinee A3</td>
<td>( \sigma_v = 3.01 )</td>
<td>( \sigma_h = 2.59 )</td>
</tr>
<tr>
<td>Examinee B1</td>
<td>( \sigma_v = 4.94 )</td>
<td>( \sigma_h = 3.66 )</td>
</tr>
<tr>
<td>Examinee B2</td>
<td>( \sigma_v = 8.09 )</td>
<td>( \sigma_h = 6.01 )</td>
</tr>
<tr>
<td>Examinee B3</td>
<td>( \sigma_v = 4.51 )</td>
<td>( \sigma_h = 3.41 )</td>
</tr>
</tbody>
</table>

To show the viewpoint movement more clear, here we visualize the histogram on the two dimensional (horizontal and vertical) space in the 1 second interval. These are shown in Fig.8 and Fig.9.
6. Conclusions

The difference between well-trained and beginner drivers were clearly observed in the movement of view points. From Fig.4, Fig.6 and Fig.8, the beginner drivers, even they are only three, commonly show the characteristics that they did not move the view point in the wide area, whereas the trained drivers move their view point widely and frequently. From Fig.8 and Fig.9, well-trained drivers increases the view point movement 3 seconds before the automobile arriving the crosswalk. In short, the trained drivers begin to notice almost 3 second before arriving the crosswalk. On the other hand, the eye movement of beginners is not changed even near the crosswalk.

The value of standard deviation shows the characteristics quantitatively. It was clarified the differences of beginner and well-trained driver’s skill deeply depends on how they capture the visual information. This paper can be used to teach a way of safe driving in such the situation.

7. References