Study on Driving Safety Influence of Rampway Length

Jinjian Xiao  
School of automobile and Transportation  
Tianjin University of Technology and Education  
Tianjin, China

Yingna Xie  
Graduate Office  
Tianjin University of Technology and Education  
Tianjin, China

Abstract—The driving safety influence formation was effected distinctly by the highway ramp length. The ramp length and automobile velocity were adopted to build driving safety influence formatting model in the highway ramp environment. The fuzzy logic reasoning rules were applied to construct the computing layers of driving safety cognizing formatting neural network. The driving safety influence experimental samples in the different ramp length were gained under different experimental automobile velocity.  
Weights of fuzzy-neural network layers were trained and was to analog compute effects on the driving safety influences under different ramp length with different experimental velocity. The resulting analyzing to prove that the relations between the typical ramp length and driving safety influence were calculated accurately. The trained neural network structure of driving safety influence based on the utilizing fuzzy inferences is helpful to improve driving safety influences of the highway ramp under different automobile velocity.

Keywords—rampway length, driving safety influence, velocity, fuzzy rules, neural network

I. INTRODUCTION

The small ramp length non-complete transition curve have been frequently used in the entrance ramp design of large-sized interchange in the city highway, especially in the expressway. The highway ramp section is most commonly used as the corridor linking with the main way, and changing the ramp length would affect greatly on driving safety operation and influences [1, 2]. When automobiles are running with different velocity in the traffic system, drivers are changed into the information receivers, decision maker, and operators. Drivers have to get continuously traffic information from surrounding environment as driving automobiles. Surrounding information is dealt to be cognize exactly and to drive automobile correctly [3].  
The ramp way length not only effects on the automobile velocity, but also effects on the drivers’ safety influences being made by the driving feeling, feedback and decision. The study on the changing ramp way length effects on the driving safety influences under different velocities[4]. It is favorable for ramp way length fitting design and operating velocity on the highway ramp. Fitting ramp way length would lead to the decline of traffic accident occurrence[5,6]. In the driver-automobile-road environments traffic system, the driving safety influence forming process is built up with the self-learning neural network and fuzzy logic rules of inside and outside correlative factors[7]. The method and model provide effective means for resolving driving safety influence’s simulation and application analysis.

II. RAMPWAY INFLUENCING FACTORS

The highway ramp length is the visually directed leading role in the highway traffic system. While automobile are running in the ramp way, the driver have to be adjusted the automobile’s direction and velocity constantly. The driver would become more sensitive to ramp way environment. As the automobile’s velocity couldn’t be controlled to match with the ramp way length, not only driving judgments and operations would be affected, but also the serious spirit pressure on driving influence would be produced. The driving safety influence and driving estimation have been take into account when the highway design stage ramp way length affection caused by. In ramp way length design criterion, when the velocity road designed velocity is higher than 40 km/h, driving safety under the target velocity on the highway ramp length needs to be evaluated. Moreover, some foreign researchers study show that the driving safety influence in different ramp way length have an obvious effects on the automobile running speed being over 96km/h[8]. As the automobile velocity is more bigger, the influences gradually become more important. Driving safety influence is a result of the interactions between ramp way length and drivers’ physiology activities. From these analysis, study, judgment of drivers, the safety influence forming process is shown in figure 1.

Figure 1. Rampway driving safety influence forming

III. RAMPWAY DRIVING SAFETY INFLUENCE

The ramp way driving safety influence is set up using the feed forward neural network and is improved by the fuzzy logic rules as figure 2. And the driving safety influence is emulated in Matlab.
The rampway length \((m)\), driving years \((\text{year})\) and velocity \((\text{km} \cdot \text{h}^{-1})\) are inputting samples as figure 3. Driving safety influence, the fuzzy logic space \([\text{NB}, \text{NS}, \text{PS}, \text{PB}]\) are outputting variables. The fuzzy membership function space is \([0, 1]\). The simplified expression formula is as (1).

\[
\text{if} \ x^k_1 \text{ and } x^k_2 \text{ and } x^k_3 \text{ then } y^k
\]

Inputting and outputting fuzzy membership functions could be gained with the occurrence frequency table in (1). The driving safety influence neural network is built up using the fuzzy logic rules and functions in the ramp way. Gauss fuzzy membership functions are applied in the fuzzy neural network. The \(\mu_{\text{i}}(x)\) and \(\nu_{\text{j}}(y)\) are the membership functions. Then mean and variance of \(\mu_{\text{i}}(x)\) , \(\nu_{\text{j}}(y)\) are \(a^k_i\) , \(\sigma^k_i\), \(b^k\) and \(\delta^k\). In the figure 3, driving safety fuzzy membership functions are shown.

\[
\mu_{\text{i}}(x) = \frac{1}{\sum_{j=1}^{4} \mu_{\text{j}}(x)} \times \mu_{\text{i}}(x)
\]

The global optimization algorithm function is written as the formula (5).

\[
E^p = \frac{1}{2} \left[ f(x^p) - y^p \right]^2
\]

The inputting and outputting membership functions using gradient descend algorithm shown from the formula (6) to the formula (10).

\[
b^k(t+1) = b^k(t) - \eta \frac{\partial E^p}{\partial b^k}
\]

\[
\delta^k(t+1) = \delta^k(t) - \eta \frac{\partial E^p}{\partial \delta^k}
\]

\[
a^k(t+1) = a^k(t) - \eta \frac{\partial E^p}{\partial a^k}
\]

\[
\sigma^k(t+1) = \sigma^k(t) - \eta \frac{\partial E^p}{\partial \sigma^k}
\]

\[
\gamma(t+1) = \gamma(t) - \eta \frac{\partial E^p}{\partial \gamma}
\]
The training and testing samples were collected from the ramp way driving experiment. Ramp way sections is the city express way. The ramp way length( \( X_1/m \)), the velocity( \( X_2/km\cdot h^{-1} \)), driving years( \( X_3/year \)), and driving safety influence( \( y^P \)) are grouped to be test. The partial driving influence samples are shown in table I.

<table>
<thead>
<tr>
<th>( X_1/m )</th>
<th>346</th>
<th>154</th>
<th>157</th>
<th>164</th>
<th>250</th>
<th>400</th>
<th>192</th>
<th>258</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X_2/km\cdot h^{-1} )</td>
<td>56</td>
<td>34</td>
<td>40</td>
<td>36</td>
<td>46</td>
<td>37</td>
<td>41</td>
<td>33</td>
</tr>
<tr>
<td>( X_3/year )</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>2</td>
<td>12</td>
<td>1</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>( y^P )</td>
<td>1.3</td>
<td>2.2</td>
<td>1.6</td>
<td>1.8</td>
<td>2.2</td>
<td>2.7</td>
<td>1.9</td>
<td>2.7</td>
</tr>
</tbody>
</table>

The 120 groups samples are grouped into training and testing sample by the different ramp way length. The fitting outputting results of the fuzzy neural network and the actual outputting data of the safety influence tests are compared in figure 4.

The driving safety influences can be deduced and calculated precisely by the fuzzy neural network. The inputting sample amount is more large and the fitting results of the neural network is more precise.

**V. CONCLUSIONS**

Via research on the driving safety influenced by velocity, rampway length, and driving years, the driving safety influence fuzzy neural network structure was set up. The driving safety influence could be calculated and forecasted when ramp way are in design stage. The rampway length can be designed actively to make driving safety influence consistent to actual safety design requirements.

With the above analysis, the length of a rampway section connecting with the highway is important safety influence factor in the reconstructed road. The results prove that the driving safety influence is generally fitted by the fuzzy inference and neural network. And the driving safety influence could be calculated and forecasted when ramp way are in design stage. The rampway length can be designed actively to make driving safety influence consistent to actual safety design requirements.

**ACKNOWLEDGMENT**

The driving safety work was supported by 2019 Tianjin transportation science and technology projects (2017A-24) and the research projects of Tianjin University of Technology and Education (XJKC031429).

**REFERENCES**


