講演番号	251

文献番号	20226251

Utilization of pedestrian model considering multi interaction in traffic simulator

Ryo Wakisaka [1)] Kazunori Ban [1)] Takuma Yamaguchi [2)] Hiroyuki Okuda[2)] Tatsuya Suzuki [2)]

1) Toyota Technical Development Corporation
1-9 Imae, Hanamoto-cho, Toyota, Aichi, 470-0334, Japan
2) The University of Nagoya, Graduate School of Engineering
Furo-cho, Chikusa, Nagoya, Aichi, 464-8603, Japan

KEY WORDS:**Human engineering, Judgment,** Pedestrian model, Traffic simulator [C2]

The mixed traffic with the vulnerable road users such as the pedestrians and cyclists is one of most important issues on the development of the autonomous driving(AD) cars to realize the safety driving in the urban road environment. Systematic evaluation of the safety of the AD functions is necessary in the realistic dangerous scenes at the development stage. Since it is difficult to carry out the experiment in the dangerous situations in the real mixed traffic with real VRU from the viewpoint of safety and reproducibility, the effective simulation considering the realistic behavior of VRU is necessary and attracting a great amount of attention.

In order to evaluate the safety of AD by simulation, it is necessary to express the behavior of traffic participants in addition to the targeting vehicles in a virtual space. In the actual traffic environment, traffic participants decide their own actions based on their interaction with each other. Thus, it is necessary to express the interactive behavior among the traffic participants in the simulation. The relationship between the pedestrians and the AD cars are especially important from the viewpoint of safety.

In this study, we focus on the decision of the path of the pedestrian under the interactions. In order to construct a pedestrian model that can express various pedestrian behavior with intuitive parameter setting, we defined the cost functions for path decision based on human behavioral characteristics. Then, the method to find the dangerous situation using the mixed traffic simulation by utilizing the constructed pedestrian model was developed and examined.

The proposed pedestrian path decision method consists of two steps of decision. First, the cost to change its direction calculated from the following function is used to determine the direction to avoid (to left or right) based on the relative position relationship with surrounding obstacles and VRUs.

$$C_{avoid} = w_t C_t + w_p C_p + w_c C_c + w_o C_o \tag{1}$$

where, C_t is the cost to reach the target point (-1 for the targeting direction, 0 for other direction), C_p is the number of passing pedestrians, C_c is the number of crossing pedestrians, and C_o is the number of pedestrians traveling in the same direction. The avoidance cost (C_{avoid}) is the sum of each terms multiplied by the weighting factor w. Next, a target path is selected from the path candidates in the avoidance direction using the cost for path selection calculated by the following function.

$$C_n = w_1 \frac{1}{\frac{D_n}{p}} + w_2 \frac{1}{\frac{Dmin_n}{p}} + w_3 \frac{\theta_n}{\frac{\pi}{2}} + w_4 \frac{\theta err_n}{\frac{\pi}{2}} \tag{2}$$

where, D_n is the average distance to other people or obstacles when path candidate n is selected, $Dmin_n$ is the minimum distance to other people or obstacles, p is the distance which is called personal space, θ_n is the traveling direction of path candidate n, θerr_n is the error between the traveling direction of path candidate n and the target direction, and w is the weighting factor. The path which has minimum C_n is selected as the target path. Finally, the direction of travel is determined according to the selected target path. By adjusting the weighting factor of each cost function, individual tendency of path decision is expressed.

Figure 1 shows the result of walking simulation with two parameter sets (α is emphasized direction cost, and β is emphasized distance cost) for path selection cost. From the results in Fig. 1, it was confirmed that the difference in the pedestrian's path selection tendency could be expressed by changing the weight parameter of path selection cost function. Figure 2 shows the result of discovering dangerous scenes by using the proposed model in the mixed traffic simulator. From the results, it was confirmed that the proposed model enables to simulate the dangerous behavior of the pedestrian successfully toward the virtual safety experiment for AD vehicle.

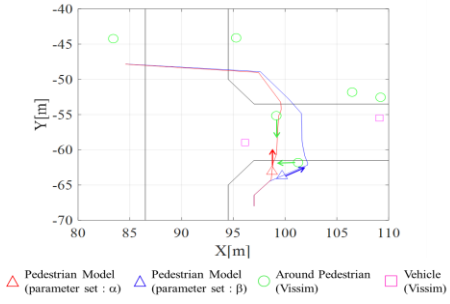

Fig. 1 Results of walking simulation

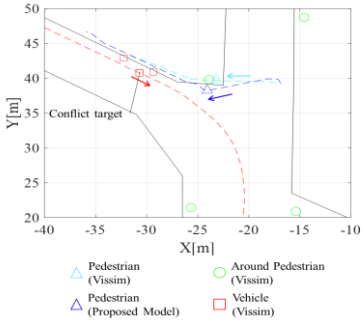

Fig. 2 Simulation result of model replacement