

Modeling of Cyclist's Speed Decision Based on Acceleration and Deceleration Judgments at Unsignalized Intersection

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Bicycle use has been increasingly encouraged for its benefits to health and the environment. However, the proportion of traffic accidents involving bicycles has increased in recent years. Therefore, reducing bicycle-related accidents is an important issue for improving traffic safety. In response to growing demands for traffic safety, various technologies have been developed, including automated driving systems, advanced driver assistance systems, and intelligent transportation infrastructure. To improve the safety of traffic environments involving bicycles, it is necessary to develop and evaluate safety functions that explicitly account for cyclist behavior. Simulation-based evaluation is particularly important for efficient development of such functions, as it enables the safety performance of different systems under various scenarios to be assessed prior to real-world implementation. However, reliable simulation of mixed traffic environments requires cyclist behavior models that can reproduce the characteristic dynamics and decision-making processes of cyclists.

In our previous study, we focused on cyclists' pedaling and braking behaviors as indicators of their acceleration and deceleration decisions. Experiments were conducted at unsignalized intersections by integrating a cycling simulator with a driving simulator, enabling the measurement of cyclist and driver behavior under interactive conditions. Based on the experimental data, we developed a cyclist acceleration-deceleration decision model using logistic regression, in which pedaling states and braking operations were used to characterize cyclists' decisions. The proposed model achieved an accuracy of approximately 80% on the evaluation dataset, demonstrating its ability to reproduce cyclists' acceleration and deceleration decisions in interactions with vehicles at unsignalized intersections.

Building upon these findings, the present study focuses on the development of a speed determination model that translates cyclists' acceleration-deceleration decisions into their subsequent speed changes. This approach is intended to extend the decision model developed in our previous study toward a cyclist behavior model that can be directly incorporated into traffic simulation environments. The proposed speed determination model estimates the cyclist's acceleration based on three acceleration-deceleration states: Pedalon, Pedaloff, and Brakeon. The cyclist's speed is then determined from the estimated acceleration. Simulation results show that the proposed model can reproduce the acceleration and deceleration behavior of cyclists with reasonable accuracy.

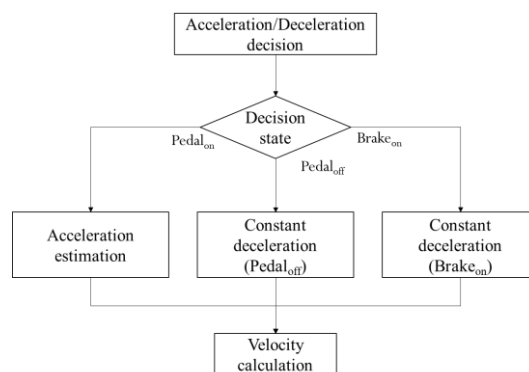


Fig. 1: Velocity determination process of proposed model

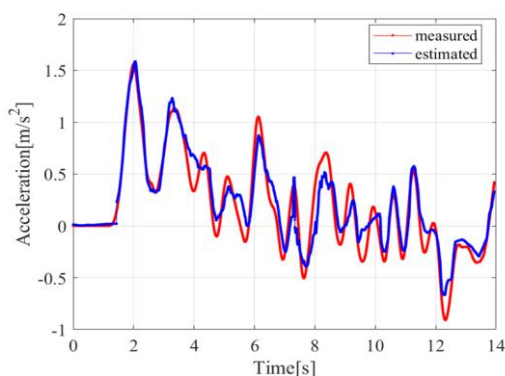


Fig. 2: Estimation result of acceleration using proposed model

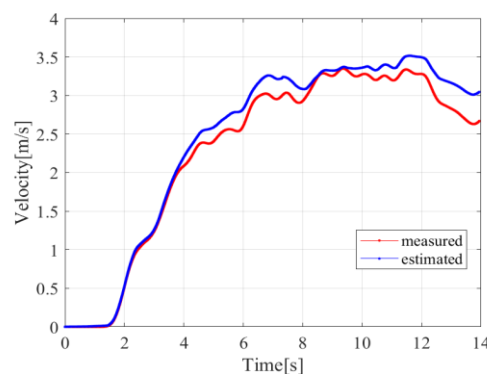


Fig. 3: Estimation result of velocity using proposed model