8th International Congress on Civil Engineering,
May 11-13, 2009, Shiraz University, Shiraz, Iran

The Development of a Hierarchical Car-following Model of Traffic Behavior on Freeways and Expressways

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Abstract

Several distance thresholds were defined in the car following algorithm namely safety distance, desired following distance, minimum following distance, and catch up distance. These distance thresholds, plus the angular velocity threshold and the relative speed of vehicle to its front vehicle, were used as the measures to classify the situation of vehicle. Seven different possible situations were defined. For each situation, the proper relationship to calculate the required acceleration of vehicle was proposed. A combination of stopping distance and constant deceleration models was used in the car following algorithm. When the vehicle is moving in the merge area, the resulting acceleration rate may be adjusted to reflect drivers desire to facilitate merging. The results of validation of the developed car-following model indicated that there is a good match between the results of the model and real data under similar conditions.

Keywords: car following, microscopic simulation, close following

1. Introduction

The car following model calculates the required acceleration rate of each vehicle at time intervals equal to the reaction time of its driver. A review of car following models deployed in the current simulation models including stimulus based models (e.g. Skabardonis, 1985), stopping distance models (e.g. Benokohal, 1986), and constant deceleration models (e.g. Miyahara, 1994) showed that none of the models can adequately predict the reaction of drives in all of the situations.

A new car following algorithm was developed in which the vehicles are categorised to different possible situations. Several distance threshold measures as described in the following section were used to identify the situation of each vehicle. In each situation, the appropriate car following model and the mechanical limitations of vehicle used to calculate the required acceleration rate of vehicle. The developed car following model is based on the measurable vehicle and driver characteristics and is designed to replicate the dynamic of traffic flow especially in the merge area.

From the real driving behaviour, it has been observed that in the close following situations, some drivers accept a small time headway, which is even smaller than their reaction times. Hence if the leader applies a hard deceleration rate, a collision will be unavoidable. Thus there must be other stimuli to which drivers react by distinguishing emergency situations from the close following situations (Maruyama, 1992; Miyahara, 1994). One stimulus could be the effect of vehicles further ahead in the traffic stream, which influence the driver's decision in some situations. By involving the effect of a second vehicle ahead in some situations, this aspect of drivers' behaviour is considered in the car following model. In addition, this behaviour is reflected in the model through the reduction of reaction time of driver in the following situation when the second vehicle ahead is braking.

2. Car Following Algorithm

The following measures are used to specify the situation of each vehicle.

2.1 Perception threshold

It is well known from physiology that the movement of an object can only be perceived when the reflection on the retina exceeds a certain minimum speed threshold. Similarly in the case of a motorist on a road, the