Application of Naturalistic Driving Data in Updating the Wiedemann Car Following Model

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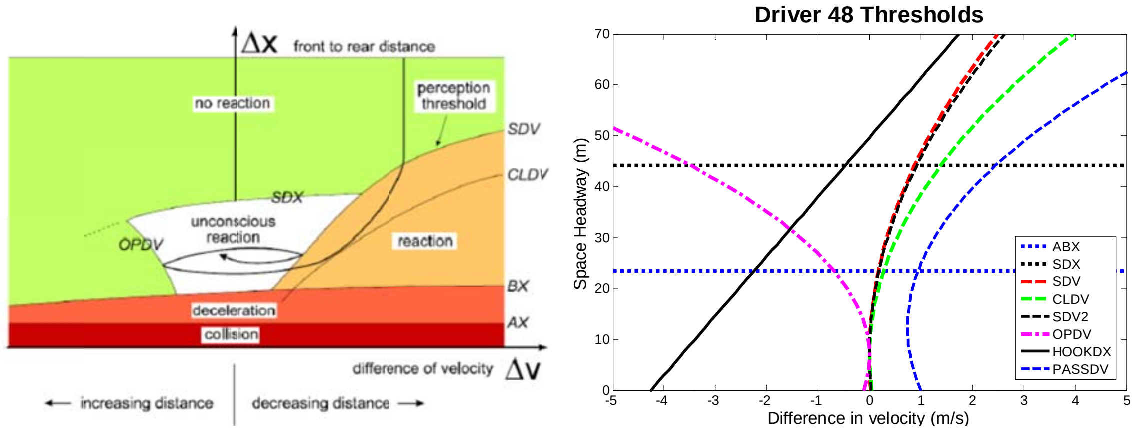
ABSTRACT

The Wiedemann model is known for its extensive use in the microscopic multi-modal traffic flow simulation software, VISSIM. This abstract presents an effort to reconstruct the Wiedemann model for trucks using The Naturalistic Truck Driving Study's (NTDS) conducted by Virginia Tech Transportation Institute. This Naturalistic data was collected by equipping 9 trucks with various sensors and a data acquisition system. The equipment included accelerometers, radar, and vehicle network's existing sensors. The specific variables of interest for the Wiedemann model were the range and range-rate obtained from the radar. Figure1 a shows the subject vehicle approaching a lead vehicle (ΔX decreasing due to higher subject vehicle's speed shown by a positive ΔV), and entering a perception area (crossing the SDV threshold) where it has to reduce speed. The subject vehicle then crosses another threshold (CLDV) where it reacts and reduces speed even further to enter an unconscious reaction car-following episode. The subject vehicle then continues the unconscious car-following episode as long as it remains bounded by the OPDV, SDX, and SDV thresholds. The logic of the Wiedemann model is represented by the different thresholds. Figure 1b shows the reconstructed logic with the addition of pass and hook thresholds as calibrated to a specific driver.



a. Wiedemann Model

b. Reconstructed Model

Figure 1: Wiedemann Car Following Logic *Compared* to Reconstructed Logic

The objective of this research was two-fold. First, an evaluation and adaptation of the Wiedemann model according to the naturalistic data were conducted, generating different perception thresholds for entering and leaving the unconscious driving region. Second, new thresholds were added aiming to represent recurrent phenomena that were observed in the naturalistic data. An example is the hook threshold where the subject vehicle is passed by another vehicle and then decides to speed up and follow this lead vehicle. The data for four different drivers was selected for analysis. The analysis framework consisted of expressing the logic of the Wiedemann model as a series of state transitions. The states are defined by the different thresholds and each state has an equation or parameter for the acceleration. The optimization was performed using an evolutionary algorithm and the optimization function was the minimization of the error between the velocity values calculated according to the Wiedemann model and the velocity values observed in the data.

The results show drastic differences between the drivers, which supports the idea that the modeling car-following behavior needs to be more driver specific than generic .The hook threshold provides clarity for where the decision to “hook” onto a lead vehicle is made. The addition of a pass threshold allows passing decision logic to be represented in the same framework as the car-following logic and thus the transition between the two is smoothed. This threshold also provides a way to force car-following behavior when a lane change is not possible. The addition of the new thresholds and adjustment of the equations that define the model to be driver specific adds value to the Wiedemann model by being more inclusive of “real world” driver behavior. The method shown produces a new perspective to the Wiedemann model to calibrate drivers individually in order to maintain accuracy. The inclusion of a hook following threshold adds value to the model by giving the model the ability to include a significant natural driving behavior.

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Keywords: Wiedemann model, Naturalistic Data, perception, reaction, model reconstruction.