UNIVERSITY TRANSPORTATION RESEARCH CENTER

RESEARCH BRIEF

PROJECT TITLE: COMPUTATIONAL MODELING OF DRIVER SPEED CONTROL WITH ITS APPLICATIONS IN DEVELOPING INTELLIGENT TRANSPORTATION SYSTEMS TO PREVENT SPEEDING-RELATED ACCIDENTS

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Speeding is commonly recognized as exceeding the posted speed limits or driving too fast for conditions. National Center for Statistics and Analysis (NCSA) reported that speeding is a contributing factor in about one-third of all fatal traffic crashes in the United States and costs society an estimated $40 billion annually in 2004. In the U.S. DOT's Region II, speeding is the leading contributing factor in fatal motor vehicle accidents in NY State and more than 34 percent of all fatal accidents were due to unsafe speed in 2009 (Summary of Motor Vehicle Accidents, NY State Department of Motor Vehicles, 2009).

In theory, speed control is a complex behavior of longitudinal vehicle control consisting of speed perception, decision making, motor control, vehicle dynamics modeling, and individual driver differences. However, there are few existing models that can integrate all of these aspects, in a cohesive manner. To address this problem, this work introduces a mathematical model for a driver's speed control with analytical solutions based on a rigorous understanding of the human cognitive mechanisms involved in driving (See Figure 1).

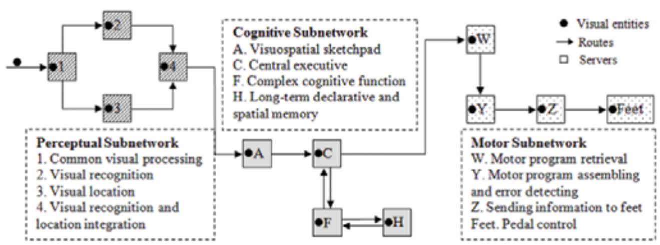

Figure 1. The new speed control model

This model includes an integrated queuing network-model human processor structure, and the rule-based decision field theory. This new model consequently provides new predictions with regards to several components involved in driving: driving speed, throttle/brake pedal angle, acceleration, and the frequency of speedometer inspection.

A laboratory session involving a driving simulator was conducted to validate the current model. The model accounted for over 99% of the experimental speed of the average driver, and over 95% of the experimental speed for the majority of individual drivers (See Figure 2).

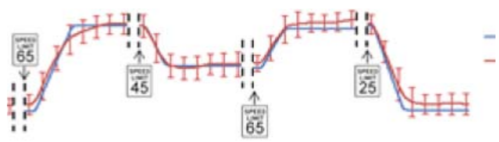

Figure 2. The predicted speed by the model (blue line) and the measured speed in the experiment (red line)

Based on the model, we designed an intelligent speeding prediction system (ISPS) to prevent the occurrence of speeding in advance before it occurs (See Figure 3).

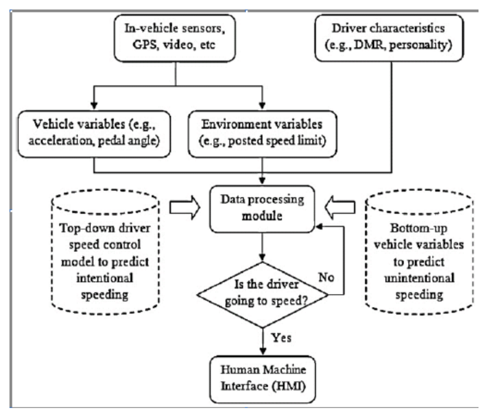

Figure 3. The intelligent speeding prediction system

An experimental study is conducted to compare no speed assistance system, pre-warning system developed based on the ISPS, post-warning system ISA, and combined pre-warning and ISPS system. Both pre-warning and combined systems led to greater minimum time-to-collision. The combined system resulted in slower driving speed, fewer speeding exceedances, shorter speeding duration, and smaller speeding magnitude.

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http://www.acsu.buffalo.edu/~seanwu/IEEE_SMCA_Speed%20control_final2.pdf

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http://www.acsu.buffalo.edu/~seanwu/IEEE_SMCA_Speed%20control_final2.pdf