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DEVELOPING A DRIVING MODEL FOR WORKLOAD EVALUATION

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ABSTRACT

Driving simulation provides a platform that allows researchers to investigate driving behaviors in a controlled environment. Distracted driving occurs when a driver engages in a driving-unrelated secondary task that detracts their attention from the roadway and the driving task. This study compares driver workload using simulation models as a surrogate for driver distraction. Data were obtained from a study where drivers navigated in a simulated world with varying levels of workload manipulated in the n-back task. The results of the two simulation models, MTAT and IMPRINT, are compared to the human subject data.

1 INTRODUCTION

Automated vehicles have become a technologically viable option for future transportation modes. However, the conversion to fully automated vehicles occurs in stages, and drivers of partially automated vehicles are still required to actively engage in driving tasks. One way to predict driver workload is to analyze driver workload using a robust driving model (Handley & Kandemir 2014). The goal of this study is to create a driving model using the cognitive task analysis software program, the Mission Task Analysis Tool (MTAT) (2021) and comparing those results to another software, the Improved Performance Research Integration Tool (IMPRINT), a human performance modeling tool developed by the US Army Research Laboratory (2004) to replicate the method. Outcomes are also compared to results from a driving simulator.

2 METHOD

The computational model was created by decomposing the driving scenario into three types of primary driving tasks: speed control, direction control, and assessing the environment. Each task was modified to capture the specific roadway configuration for that driving segment, as determined by the roadway length and driver speed. Table 1 presents the scenario components of the modular approach of the computational model. A complete description of the rationale, development, and validation of this methodology to design a driving computational model is described in (Kandemir, Handley, & Thompson 2018).

In order to induce additional workload, a secondary task is also included in the computational model. The *n*-back task involves listening, recall, and response by the driver to an external prompt (Mehler, Reimer, & Dusek 2013). The computational model duplicates the occurrence of the *n*-back task in the driving simulator by replicating the timing of the prompts. To capture workload for both the primary and secondary tasks, the model assigns a value on the visual, cognitive, auditory, and psychomotor (VACP) scale, that represents the allocation of the limited resources of the driver to perform the tasks. The amount of each resource required is estimated on a 7-point scale developed by McCracken and Aldrich (1984). The simulation output of the MTAT tool provided a workload analysis report for the sequence of driving tasks captured in the model. The workload is cumulative when multiple tasks are occurring simultaneously, thus leading to the potential for driver distraction.

Table1. Computational Model Components

Segment Type	Steer	Speed	Situation Assessment
Left Curve	Left	Moderate Decrease	Minimum Increase
Right Curve	Right	Moderate Decrease	Minimum Increase
Straight (after curve)	Straight	Moderate Increase	Typical
Straight	Straight	Steady	Typical
Straight with Intersection	Straight	Minimum Decrease	Moderate Increase
Straight (after intersection)	Straight	Minimum Increase	Typical

3 RESULTS AND DISCUSSION

Table 2 presents results of simulations using MTAT compared to those from a previous IMPRINT simulation (Handley & Thompson 2021); the results from the two sets of simulation model are identical and are compared to the blink rate captured from an eye-tracker in a driving simulator. The percent change in workload from the low workload (n-0) to the high workload (n-2) is similar; percent change is used as the baseline comparison metric. Blink rate as a surrogate for workload is an area of active research (Yahoodik et al. 2020). The result of this research indicates the modeling method can be duplicated across different simulation tools. The modular design mimics the categories of automation that are transferred from driver control to automation as the SAE Levels of Automation increases, i.e., “execution of steering and acceleration/deceleration” and “monitoring of driving environment” (SAE 2018). Thus, the driving model can study aspects of driving in a smart city with increasing levels of automation.

Table 2. Maximum Workload Results Comparison

	N-0	N-2	Percent Change
MTAT	25.8	35.9	0.28
IMPRINT	25.8	35.9	0.28
Blink Rate-Eye Tracker	21.1	30.2	0.30

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