Project: Truck Driver Fatigue Assessment using a Virtual Reality System

Principal Investigator : Yusuf A Mehta, Ph.D., P.E

Purpose: Develop a fully-immersive truck driving simulator using Virtual Reality to assess the truck driver's level of fatigue typically experience during real-life varying driving conditions.

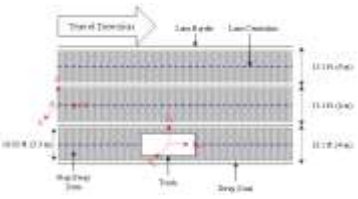
Background: Driver fatigue is a significant contributing factor to numerous fatal traffic crashes resulting in death or injury every year. Fatigue is invisible and there is no single symptom that can be exclusively identified to assess it in advance.

Virtual Reality System: Virtual Reality (VR) is defined as a system for developing and replicating real-life environments using the-state-of-the-art computer graphics and input/output devices. Over the past years, several advanced VR applications have assisted researchers and officials in making complex decisions. Hardware devices are below as shown in figures.

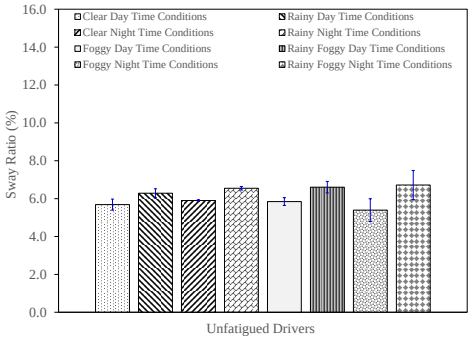
Data Collection: The software component of the VR included a data collection code that allows continuous recording of information while simulation, as such the position of the driver within the roadway, number of lane crossing with/without using signals, the lane in which the truck is located, and simulation environmental conditions. Drivers' reaction time to press a button in response to a simulated change in environment was also recorded during the simulations.

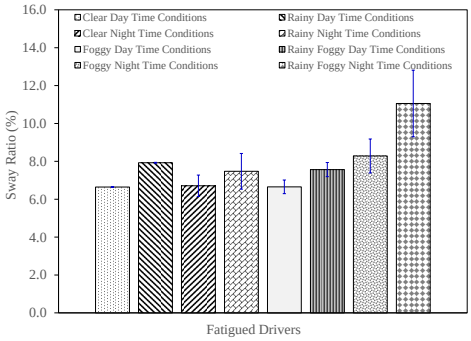
Testing Plan: It involved four drivers run in the simulator at varying driving conditions. These conditions included: (1) clear day time, (2) rainy day time, (3) clear night time, (4) rainy night time, (5) foggy day time, (6) rainy foggy day time, (7) foggy night time, and (8) rainy foggy night time. Each driver was allowed to drive for two hours with the weather conditions varying every 15 minutes The four drivers were classified into two groups: fatigued drivers and unfatigued drivers. The fatigued drivers - who ran the driving simulation after completing eight hours of regular work. The unfatigued drivers- performed in the morning when they were still fresh.

Data Aanlysis: The truck position data was analyzed to compute a sway ratio (the number of occurrences a driver was within the sway zone (when not changing lanes) divided by the number of occurrences a driver was within the non-sway zone) as a fatigue measure. Global and local coordinates for position of the truck are shown in figure. It also defines the sway and non-sway zones. MATLAB Script was developed to analyze the instances where drivers were changing lanes during the simulation. If a driver was changing lanes, position data were considered to be in the non-sway zone. The higher is the sway ratio more fatigued is the driver. Along with the sway ratio, the concept of reaction time was also utilized to assess drivers' fatigue levels. During a simulation, drivers were asked to click a button when a randomly position circular red dot shows up on the simulation screens. The time required for a driver to react and accomplish this activity was recorded at various times throughout the simulation. The higher is the reaction time more fatigued is the driver.



Results: Sway ratios and reaction times for fatigued and unfatigued drivers were computed using a MATLAB script and are presented in Figures below.





Conclusion: The developed VR-based driving simulator along with the introduced drivers' fatigue measures (i.e., sway ratio and reaction time) were found to be successful. As a result, it is concluded that VR-based driving simulators provide a viable alternative to traditional driving simulators when developing technologies that assess drivers' fatigue levels.

Recommendation: Further simulation studies must be performed to fully ascertain these observations.

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