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How do Environmental Factors Affect Drivers' Gaze and Head Movements?

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This study considers the effects of different environmental factors on drivers' gaze and head movements in a fully naturalistic platform without any external interference. The most important outcome is the viability, of detection of factors, that have been previously discussed in other fully naturalistic experimental studies. While individuals have differences in their gaze direction and head movements, on average, the effect of environmental factors could be detected in each scenario. Thus, understanding the gaze of the driver requires an understanding of both environmental factors and individual characteristics that affect one's gaze. Another important expectation is the fusion effect of gaze angle and head movement. Together, this can lead to a better understanding of what the driver is doing at any moment. Moreover, the interaction between environmental factors and individualized differences emphasizes the personalization of services that are currently being offered such as routing services. Better optimization for factors such as mental workload, distraction, environmental conditions, and individual differences need to be considered when performing services such as route selection. In addition, by using open-source computer vision-based software, models can be built to detect different patterns in gaze and following distractions. Considering that the analysis has been done by open-source software available for every operating system, the value of such analysis can be done in one's car and help build driving monitoring systems that can be implemented in real-time. This is extremely important when discussing AVs as these vehicles currently rely on the human in the events of failure. In order for autonomous vehicles to have a better interaction with the driver, they must first understand the driver's state, the factors that affect it, and provide for short-term future predictions. A proper understanding of the state of the driver can lead to better collaboration, trust, and outcome of using such semi-autonomous human-in-the-loop systems.

Study Methods

In this research, videos are collected using a naturalistic driving study platform from at least six participants for

more than four weeks of a fully naturalistic driving scenario. The videos of both face and road are cleaned and manually categorized based on weather, road type, and passenger conditions. Facial videos are analyzed using OpenFace to retrieve the gaze direction and head movements of the driver. The system and potential improvements will be then performed and tested through the presented pilot study in this proposal.

A naturalistic driving study platform consisting of facial and road camera, and car CAN bus data logger is developed for this study. The overall view of the system setup and different road and weather conditions are shown in the figure.

From each participant, a joint set of road and facial videos are collected. The road videos are used for assessing the environmental condition in the driving scenario. The environmental condition includes road type, weather condition, and presence of the passenger. As the first step, the videos are manually annotated to be in the categories of road type, weather, and passenger conditions. The road types are categorized as street driving, country road, two-way two-lane highway, and two-way three-lane highway. The weather conditions are clear, cloudy, and rainy. The passenger condition is defined to be a binary of having a passenger or not.

Drivers' gaze and head movements affected by environmental factors and individual differences.

Findings

Results, in overall, suggest that the gaze direction and head movements of the driver is affected by a combination of environmental factors and individual differences. Specifically, results depict the distracting effect of the passenger on some individuals. In addition, it shows that highways and city streets can have the maximum distraction on the driver's gaze.

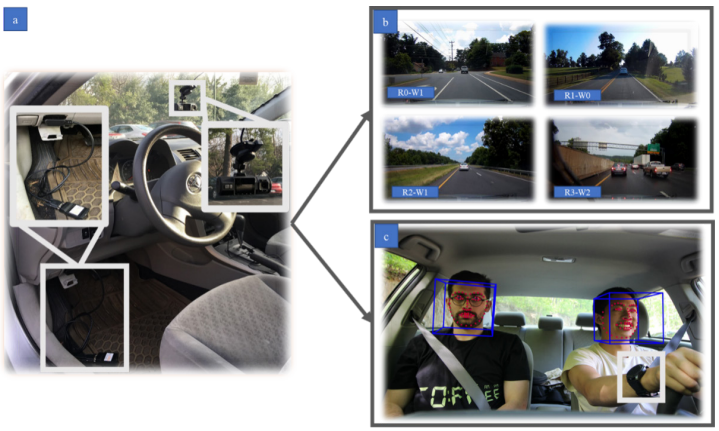

Figure. System Setup and Different Conditions

About the Principal Investigator

PI Vahid Balali, Ph.D., is an Assistant Professor in the Department of Civil Engineering and Construction Engineering Management at California State University Long Beach. Dr. Balali's research focuses on visual data sensing and analytics, virtual design and construction for civil infrastructure and interoperable system integration, and smart cities in transportation for sustainable decision-making.

To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/research/2044**

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