Research Report Summary

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A Machine Vision Approach for Estimating Motion Discomfort in Simulators and Self-Driving Vehicles

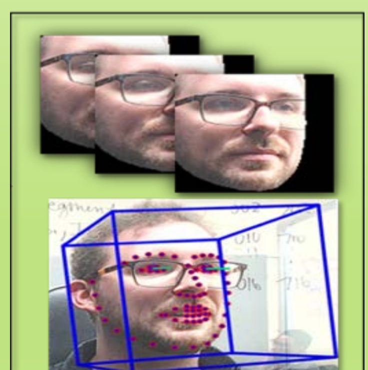
Motion discomfort in highly automated vehicles and simulators represents a persistent problem that might be mitigated if it can be monitored. In driving simulators, motion discomfort can compromise data collection. In highly automated vehicles, motion discomfort can discourage people from riding in such vehicles, undermining the potential safety benefits. The objective of this project is to investigate the potential of machine vision techniques to estimate motion discomfort in real time.

As a first step in developing a real-time measure of motion discomfort, we developed an interactive, computer-aided tool to explore and code drivers' videos. This tool is valuable for video analytics in general; it provides a collaborative platform between machine learning algorithms and scientists. In addition, we examined drivers' facial expressions to determine their potential for real-time estimation of motion discomfort in simulators and highly automated vehicles to replace other, more intrusive measures of discomfort. Finally, we analyzed head posture data, obtained from an in-vehicle camera, and its effect on motion sickness.

Our results suggest that the developed tool is useful for machine vision research and can be used beyond the scope of this project. Also, we recommend careful calibration of participants' seating position in simulators in order to combat motion sickness.

Video Processing and Feature Extraction

Video data of participants in the NADS simulator at the University of Iowa were analyzed

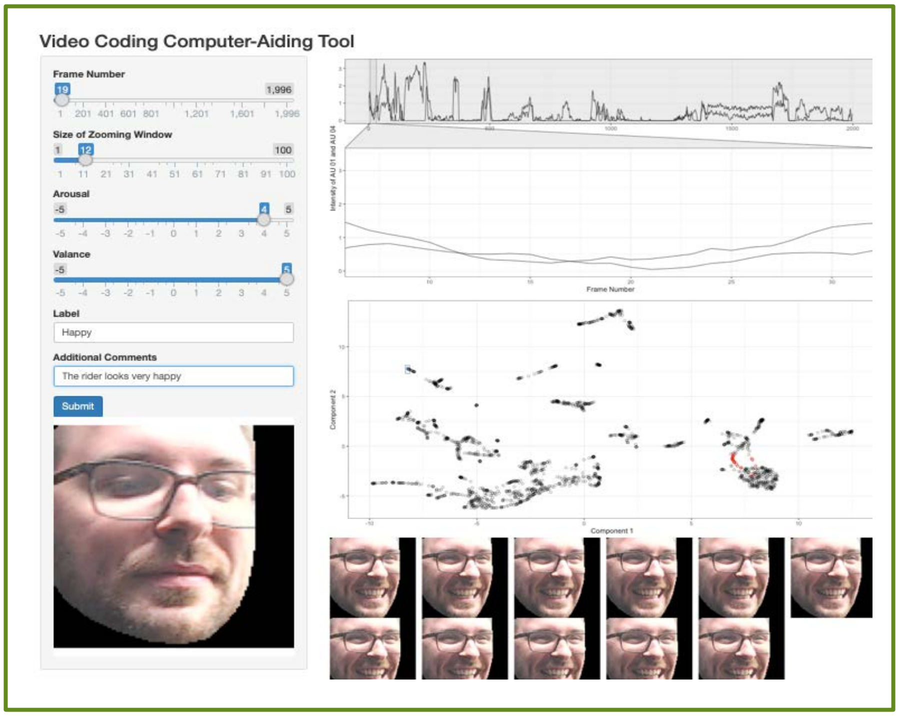


Head pose and facial action units data were extracted using OpenFace toolbox [1]

"Careful calibration of the participant's seating position and eyepoint might combat motion sickness."

The picture to the right shows the developed video coding tool. The tool leverages unsupervised machine learning and human judgment to improve the process of video coding. Based on the resulting clusters from the unsupervised machine learning, the analyst can select a cluster, see the most informative frames within that cluster, and label the entire cluster at once.

This speeds up the coding process and allows scientists to explore video data, identify driver states, and improve driver state monitoring algorithms.



Outcomes

The results of this project showed that careful calibration of participants' seating position in a driving simulator can reduce the severity of motion sickness. It is important to match the participant's eyepoint with the design eyepoint. This recommendation can reduce motion sickness in simulators in future experiments and consequently improve the validity of the collected data.

Furthermore, the tool developed as a result of this project showed a huge advantage in speeding up the process of exploring and coding video data. This tool can potentially improve machine vision research in vehicles and simulators.

Impacts

The outcomes of this project recommend careful consideration of the participants' eyepoint and seating position. This recommendation can potentially guide research in driving simulators and improve the quality of the collected data as well as the experience of the participants.

The developed interactive computer-aided tool will potentially help analysts code and identify driver states. Consequently, this will guide the development of driver state monitoring systems.

References

Baltrusaitis, T., Zadeh, A., Lim, Y. C., & Morency, L. P. (2018, May). Openface 2.0: Facial behavior analysis toolkit. *In the 13th IEEE International Conference on Automatic Face & Gesture Recognition* (pp. 59-66). IEEE.

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