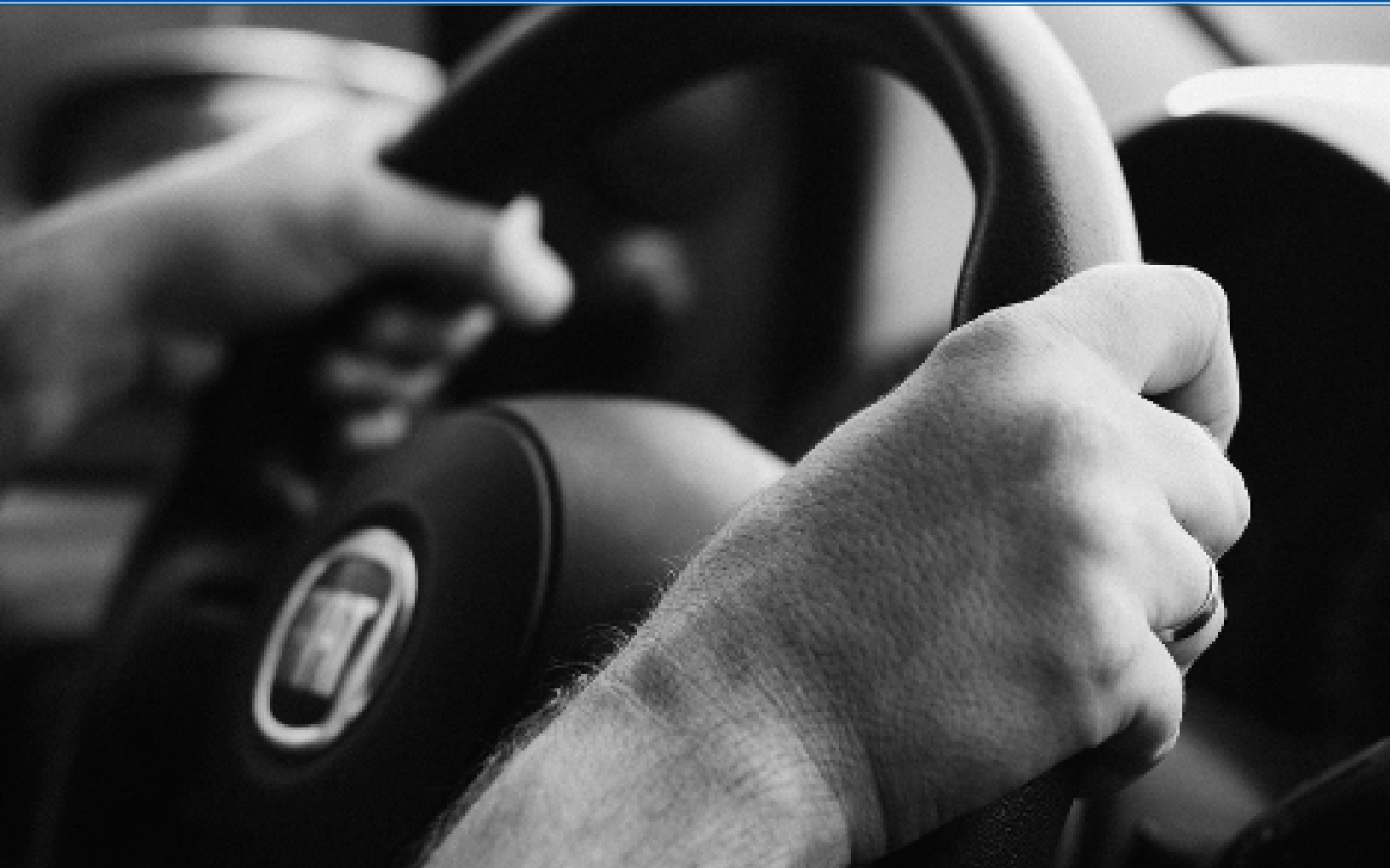


## A Multimodal Approach for Monitoring Driving Behavior and Emotions

Project 1928  
July 2020

Arash Tavakoli, PhD, Vahid Balali, PhD, and Arsalan Heydarian



All of us have felt or witnessed the effects of road rage at some point during our daily commute, but studies suggest that all kinds of emotions, including happiness, can affect driving behavior. Likewise, emotions can be significantly influenced by a variety of environmental factors, including the surrounding landscape, music, and social interactions. For this study, we wanted to know more about how environmental and contextual factors, including road type/condition and type of vegetation, influence drivers' emotion and behavior.

### Study Methods

We used a variety of monitoring methods to collect data and analyze human behavior in a natural driving environment. These methods include the use of environmental sensors to analyze factors like road type and weather conditions. We also collected trip details from the vehicle's Controller Area Network (CAN) serial bus, such as when and how hard the driver accelerated or braked. In addition, we collected video of the driver and used facial-recognition software to identify facial

expressions and analyze related emotions. This data was used in correlation with the driver's heart rate data, which was collected from smart watches. These methods helped us better understand the effect of environmental conditions (e.g., different road types) on driving behavior metrics (i.e., the number of hard accelerations, hard brakes, and so on). The pilot study presented in this paper aims to test a new approach to studying emotion and behavior relation while people are driving and understand potential improvements to future research in this field.

*Nearly 80 percent of drivers in the United States experience some form of road rage annually, but even happiness can affect how we drive.*

### Findings

Results from our study indicate that environmental factors significantly affect driving behaviors.

Our heart rate data show that driver heart rate can vary significantly in certain situations, which could be a strong indicator of emotion and changes in behavior. Additionally, the results of emotion detection in the analyzed videos reveal valuable insight with respect to overall emotion recognition. However, we also found inspecting the videos frame-by-frame reveals situations for which facial recognition is not sufficient for understanding emotions.

Overall, analysis of multiple data points suggest weather conditions and road type may significantly change driver emotions and driving behavior. However, more naturalistic driving data from different drivers are needed to better identify the influence of emotions on driving behavior.

### Policy Recommendations

This paper also proposes a novel automated approach for understanding the effect of environmental factors on drivers' emotions and behavioral changes. Our research can be used by Caltrans and other transportation authorities to develop safer and more efficient transportation,

such as advancing a healthy collaboration between humans and autonomous vehicles.

Further research should be conducted to replicate results with statistical significance and better identify the influence of emotions on driving behavior. We recommend that further research include considering the heart rate data from the hours before and after driving. We also recommend increasing the accuracy of semantic segmentation to automatically examine more properties of the road, weather, and traffic.

### About the Author

Arash Tavakoli is a PhD candidate, Engineering Systems and Environment (ESE) at the Link Lab of the University of Virginia.

Vahid Balali, PhD, is an Assistant Professor in the Department of Civil Engineering and Construction Engineering Management at California State University Long Beach.

Arsalan Heydarian is an Assistant Professor in the Department of Engineering Systems and Environment at the University of Virginia and he's part of the UVA Cyber-physical systems lab, theLink Lab.

### To Learn More

For more details about the study, download the full report at [transweb.sjsu.edu/research/1928](https://transweb.sjsu.edu/research/1928)



The California State University Transportation Consortium (CSUTC), led by the Mineta Transportation Institute, fosters synergies across the entire California State University system to conduct impactful transportation research and engage in workforce development initiatives that increase mobility of people and goods and strengthen California's economy.