CENTER FOR CONNECTED AND AUTOMATED TRANSPORTATION

UTC Project Information	
Project Title	A Virtual Reality Framework to Measure Psychological and Physiological Responses of the Self-Driving Car Passengers
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Funding Source(s) and Amounts Provided (by each agency or organization)	50% Center for Connected and Automated Transportation 50% Purdue University
Total Project Cost	78,738.79
Agency ID or Contract Number	69A3551747105
Start and End Dates	01/01/2019 – 12/31/2019
Brief Abstract of Research Project	The aim of this proposal is to develop a virtual reality framework and incorporate virtual reality technology to examine and understand the physiological and psychological responses of self-driving car passengers. After developing the virtual reality framework, volunteers will be asked to participate in studies examining their anxiety levels and other psychological and physiological responses. Participants will act as car passengers in a virtual self-driving car and be immersed in a virtual reality trip. Participants will be asked to wear a head-mounted display (HMD) and enjoy the trip in the self-driving car. During the experiment, the participants' anxiety will be captured by recording the electrodermal responses using galvanic skin response (GSR) sensors.
Most Relevant CCAT Research Thrusts (choose all applicable)	_____ Enabling Technology _____ Planning and Policy __x___ Human Factors _____ Infrastructure Design and Management _____ Control and Operations _____ Models and Implementation

Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The first steps in this project will focus on creating a flexible and modifiable virtual reality framework to measure car passenger responses during the experiments. To optimize the framework's value for research, it will (1) be easily modifiable to introduce new variables into the virtual environment and (2) contain specific virtual reality features designed to measure car passengers' physiological responses. The first design feature will ensure that the framework is flexible enough to use in a variety of research projects. The second design feature will address the unidentified issues in research on passenger–self-driving car interaction, a topic that lucks attention to the best of the PI's knowledge. Instead of requiring a tightly-coupled set of functionalities, the developed framework will use a system for combining multiple predefined functionalities in a user-friendly and adaptable pipeline and an extensive virtual reality design architecture for developing both individual functionalities and complex interactions between components. The proposed framework will be developed in Unity3D engine, an easy-to-use and extensible environment that can be used for the development of virtual reality applications. The Oculus Rift HMD and its associated software development package (SDK) for Unity3D will be used to project the virtual content to the participants. A baseline scene in Unity3D will also be developed to provide the basic capabilities needed (e.g., virtual reality self-driving-car, path planning methods, etc.) before building the required scenario. Multiple virtual environments (both urban and rural) for the driving simulation will be designed in Autodesk 3Ds Max and provided to the researchers. Additionally, the Google Maps application program interface (API) for Unity3D will be incorporated to import real-world environments. Pre-scripted cars, pedestrians, and traffic lights will also be provided. Because minimal effort will be required from each user, simple drag-and-drop manipulations will be used to interface the inputs and the outputs, as well as for the design of the virtual environment and the components within it with which the experiment will be conducted. Finally, the GSR sensor will be interfaced with Unity3D using its API in order to be controlled by the experimenter.

Impacts/Benefits of Implementation (actual, not anticipated)	This study will benefit not only the virtual reality community but also transportation agencies to help establish frameworks and regulations for the role of the driver and the behavior of the car to reduce the anxiety of passengers in self-driving cars. In addition, an understanding of passenger anxiety can help us find ways to make passengers feel more comfortable interacting with self-driving cars. The findings of this study will help to expand the newly formed research area on human-autonomous vehicle interaction (human factors) in virtual reality, which is a research direction that is worth investigation since self-driving cars will soon become a part of everyday life.
Web Links • Reports • Project website	ccat.umtri.umich.edu