

Trust and Control in Autonomous Vehicle Interactions

Chandler Creech, Suresh Kumar Jayaraman, Lionel Robert, Dawn Tilbury, Xi Jessie Yang, Anuj Pradhan and Kate Tsui

I. INTRODUCTION

Autonomous vehicles have the potential to reduce traffic accidents and improve road safety. Ironically, public skepticism due to the risk and safety considerations remains one of the major barriers to the widespread adoption of autonomous vehicles. Therefore, trust is vital to the promotion of the acceptance of this new technology.

This abstract summarizes some recent research on trust in autonomous vehicles and our proposal to promote trust between autonomous vehicles and pedestrians. We aim to develop a trust framework based on expectations, behaviors and communication between the pedestrian and the autonomous vehicle. We describe a user study that is designed to determine the effects of driving behavior and situational characteristics on a pedestrian's trust in autonomous vehicles.

II. TRUST IN AUTONOMOUS VEHICLES

A. Related Studies

The problem of trust in autonomous vehicles is not a completely new topic. Current research has primarily focused on the problem of ensuring that the driver trusts the autonomous vehicle [1], [2]. These studies demonstrated that communicating the intent of the vehicle to the driver was an effective method for improving the driver's trust in the autonomous vehicle. However, autonomous vehicles will also have to interact with other road users such as pedestrians, cyclists, other vehicles, etc. Despite this, we know very little regarding issues of trust between autonomous vehicles and these humans outside of the autonomous vehicles who also share the road.

Even though some recent research focusses on developing explicit communication interfaces such as LED message boards, LED lights, speakers, etc., for conveying the vehicle's intent to the surrounding road users [3], [4], the effects of this intent communication on road users' trust is not studied. Also, there is currently no research exploring road users' trust based on the autonomous vehicle's implicit intent communication (such as vehicle driving behavior).

B. Research Objectives

This research work aims to understand how to promote trust between autonomous vehicles and pedestrians (Figure 1), who are the most vulnerable road users. To accomplish this, we aim to develop a framework using trust models to control the vehicle characteristics (which includes driving behavior, explicit intent communication, etc.) to promote trust between autonomous

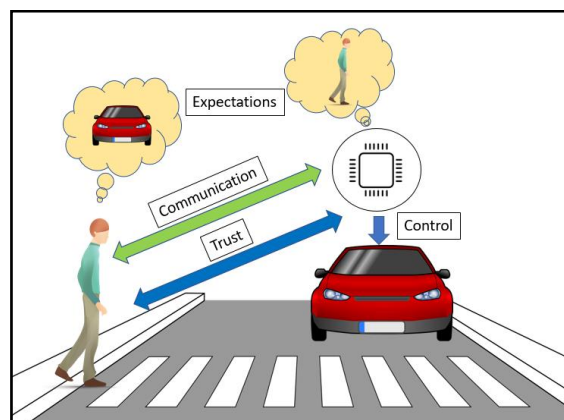


Figure 1. Trust Interaction between an autonomous vehicle and a pedestrian

vehicles and pedestrians. The framework will be based on the expectations, behaviors and communication between the pedestrian and the autonomous vehicle [5].

A user study will be conducted to identify factors which can promote trust. The user study will focus on determining the impact of driving behavior and situational characteristics on a pedestrian's trust in autonomous vehicles. Details of the user study will be explained in the following section.

III. USER STUDY

In this user study, we consider the interaction between a pedestrian and autonomous vehicles at a midblock crossing. In addition to vehicle driving behavior (defensive, normal or aggressive), the study also aims to analyze the effect of crossing type (signalized or unsignalized) on the trust of pedestrians.

The hypothesis of this study is that pedestrians will exhibit more trust towards autonomous vehicles at signalized crossings when the vehicle exhibits more defensive driving behavior.

A. Method

This study will employ an experimental design using virtual reality. Participants will act as pedestrians tasked with getting across a mid-block crossing with several autonomous vehicles approaching. There will be six conditions (2 x 3) represented by the type of autonomous driving behavior (defensive, normal, aggressive) and the type of crossing (signalized, unsignalized). Autonomous driving behavior will be manipulated by the vehicle acceleration and jerk profiles.

B. Experimental setup

The participants will be placed in an immersive virtual reality environment utilizing an omnidirectional treadmill [6] and a virtual reality headset to act as a pedestrian in a simulated urban environment as shown in Figure 2.

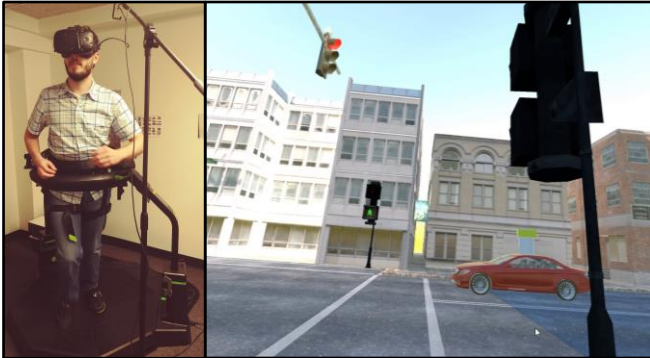


Figure 2. Virtual Reality setup for user study

C. Measurements

The study will collect attitudinal, behavioral and physiological measures. The attitudinal measures include trust [7], [8], mood [9], propensity to trust, simulation sickness [10] and task load [11], which are measured through surveys. The behavioral measures include waiting time, crossing time, walking speed of the participants, etc., which will be collected from the simulation. The physiological measurements of heart rate variability and eye tracking will be taken during the experiment.

IV. FUTURE WORK

The user study is expected to support the notion that vehicle driving behavior and situational characteristics are important factors in promoting pedestrian trust. The study can be extended to evaluate the effects of driving behavior on different categories of pedestrians (age, physically disabled, blind, etc.) or groups of pedestrians. Similar user studies can be conducted to evaluate effects of other vehicle characteristics such as explicit intent communication, pedestrian recognition, etc.

The most significant pedestrian trust factors would be revealed by these user studies, which could be used to model

pedestrian's trust in autonomous vehicles. The same trust modelling framework can be later extended to include other road users such as cyclists, other drivers, etc.

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