Making Space for Autonomous Vehicles through Interaction Design: application for HCI and Autonomous Vehicles Workshop

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Abstract

UPDATED—February 13, 2016. I am a first year Ph.D. student in the Department of Electrical Engineering and Computer Science at University of California at Merced. My research interest lies at the intersection of Cloud Robotics, Machine Learning and Human-Machine Interaction. Earlier, I have worked as Graduate Researcher in Human-Robot Interaction at Carnegie Mellon University and in Mechanical Engineering at University of California at Berkeley. In my doctoral thesis, I am exploring some of the potential intriguing computational challenges of large scale human - autonomous vehicle interactions. These challenges range from imparting new cognition abilities to the car to system design for long term collaboration of human and car. I am particularly interested in developing a computational framework that can facilitate mutual modeling and can capture the evolution of social relationship between human and autonomous car over lifetime of the vehicle. My goal in CHI and Autonomous Vehicles workshop would be to understand the potential paradigms of human-autonomous car interactions through interaction design, contextual experience and brainstorming with fellow participants.

Author Keywords

Cloud Robotics; Human - Robot Interaction; Autonomous Vehicles

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: This section is required.

Personal Information

I am a first year Ph.D. student in Cloud Lab under Professor Mukesh Singhal, in the Department of Electrical Engineering and Computer Science at University of California at Merced. Prior to this, from 2013 to 2015, I was a graduate student at Carnegie Mellon University, where I worked with Professor Anind Dey, HCII and Professor Aaron Steinfeld, Robotics Institute. I also collaborated with NASA Ames Data Sciences Group during this time on a machine learning problem for smart environment [3]. My M.S. thesis was on a privacy preserving Bluetooth localization for efficient human-robot rendezvous. From 2011 to 2013, I developed a smart lighting system, as a graduate student researcher under Professor Alice Agogino, University of California at Berkeley. See [2] for more information on this work. For more information on my research experience and my latest CV see [1, 9, 4].

Experience with autonomous vehicle research

As part of my doctoral thesis, I am exploring some of the potential intriguing computational challenges of large scale human - autonomous vehicle interactions on road. These challenges range from imparting new cognition abilities to the car to system design for long term collaboration of human and car [1]. I am currently performing a thorough literature survey on human-autonomous vehicle interaction including theory of human-automation interaction [18, 17], interaction design [12, 15], machine learning problems like driver intent prediction [6, 11, 10, 14, 8, 7, 13] and system solutions for potentially enabling large scale interaction [16, 19, 20]. Some human - automation interaction models have been proposed in literature over the last few years. The models of autonomy range from machines with absolute decision making capacity to humans in supervisory role with limited to complete intervention ability. Many of them concur on the need for human - robot systems to maintain mutual models. From my survey I found that there exists a need for developing a computational framework that can facilitate mutual modeling and can capture efficiently the evolution of human - autonomous car social relationship over the lifetime of the vehicle [5]. Apart from autonomous car - passenger interaction, the domain of human - autonomous vehicle interaction spans across other modes which present several unforeseen design challenges. These interactions may include those between semi-autonomous and autonomous cars, between drivers of semi-autonomous cars and surrounding autonomous cars and between autonomous cars and pedestrians. Some example interactions could be: A car directly or indirectly acquiring information about passengers' sense of safety, in scenarios, such as, sudden merging of another car at the traffic signal and the resultant decreased time to braking, sudden appearance of pedestrians and so on. Other potential examples multi-vehicle and human interactions are car coordinating yield with other cars or car drivers, cars inferring pedestrians' intent and pedestrians' trying to understand car's intent. Furthermore, depending on the preferred activities inside car, the passenger's state of engagement in driving or situational awareness must also be inferred. Current autonomous vehicles are embedded with multitude of sensors for perception, localization, mapping, path planning and emergency response. Most of the sensors generate data at high rates (at Gb/s), beyond the bandwidth of wireless connection. Researchers have used in-car driver facing and road facing camera data, the vehicular dynamics, GPS coordinates, and street maps from 1180 miles of natural freeway and city driving to predict driver intent shortly prior to right and left turn and lane changes [10]. Effective collaboration with passengers, pedestrians and surrounding vehicles in autonomous cars will require another suite of sensors like video camera and/or physiological sensors in car. Cloud Robotics can play a major role in facilitating human-robot interaction on road, by hosting, processing and making inferences from sensor data of multiple vehicles at one time.

Abilities in interaction design

I have been pursuing a wide range of research topics in fields as diverse as architectural design, product design, sensor networks, machine learning, human computer interaction and now cloud computing, all of which can find synergy in an efficient human-autonomous vehicle collaboration system. Some of my relevant courses are:

- Green Product Development: Design for Sustainability (ME290H, UC Berkeley)
- Perception (COG SCI 186, UC Berkeley)
- Networked Cyber-Physical Systems (ECE 18848, CMU)
- Crowd Programming (HCI 05899, CMU)
- Machine Learning for Signal Processing (ECE 18797, CMU)
- Machine Learning (MLG 10701, CMU)
- Reinforcement Learning (Udacity)

My prior design brainstorming experiences include conducting weekly sessions as the team lead of a design group at UC Berkeley for a national a national level tech design competition, Max Tech and Beyond. I also taught Wizard-of-Oz and Paper prototyping for I198 UI Prototyping, a DeCal course offered in 2013 at UC Berkeley.

Motivation statement

CHI 2016 workshop on HCI and autonomous vehicles is absolutely relevant and timely for my Ph.D. research. Through my participation in this workshop and the pre-workshop program I would like to achieve the following goals:

- To understand the potential paradigms of human - autonomous vehicle interaction through actual design, interaction with fellow workshop participants and through contextual experience.
- To explore interaction designs for both in-car and across car communications, intended to maintain optimal mental workload for the driver, keep drivers engaged, prevent driver skill-degradation and maintain multi-car collaboration. These designs may include gamification of driving, cheap talk, gaze tracking or human - brain interface.
- To understand the sensing and data aggregation requirements for scaling up the computational framework for these interactions.
- To delineate some of the potential challenges in machine learning and cloud computing around this human - autonomous vehicle interaction for my doctoral research.

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