D28 Autonomous Vehicle Control Systems and Human Factors

Stephanie Domitrovich, JD, PhD, Sixth Judicial District of PA, Erie County Court House, 140 W 6th Street, Rm 223, Erie, PA 16501; and Laura L. Liptai, PhD*, BioMedical Forensics HQ CA/FL, 1660 School Street, #103, Moraga, CA 94556*

After attending this presentation, attendees will better understand the control systems of autonomous vehicles, explore what the future of Highly Autonomous Vehicles (HAVs) will entail, and gain familiarity with some of the legal and ethical issues involving autonomous vehicles. In an increasingly connected world, vehicle control technology has the potential to lead to safer vehicles, once the issues of security, reliability, and ethics are addressed.

This presentation will impact the forensic science community by helping attendees: (1) learn the current capabilities of autonomous vehicles and forecast the future of autonomous vehicles; (2) understand how forensic engineering may contribute to control systems design; and, (3) gain a better understanding of the dynamic relationship between HAV technology and related ethical issues.

The increased integration of technology in vehicles, coinciding with the exponential increase in computing power, has led to the advent of the HAVs. Computers process data substantially faster than humans, leading to decreases in automotive braking times, quicker avoidance of hazards, and generally increasing occupant safety.

In 2014, more than 32,000 people lost their lives on the road in the United States (Figure 1), according to the Fatality Analysis Reporting System (FARS) for 2014.[1] This decline is partially attributable to the numerous safety features automobile manufacturers have added to vehicles to reduce deaths from traffic accidents. The most well-known vehicle safety features are pretensioners and airbags. These two features have reduced mortality in head-on collisions by more than 80%.[2] As the level of technology increased through the turn of the century, additional safety features, such as Blind Spot Detection, Lane Departure Warnings, and even Adaptive Cruise Control, have been added to assist or alert drivers to avoid accidents. The results of a 2008 National Highway Traffic Safety Administration (NHTSA) Crash Causation Survey to Congress revealed that 75% of collisions were due to either recognition or decision errors (Figure 2). Recognition errors were defined as inadequate surveillance, distraction, or general inattention. Decision errors were defined as speeding, illegal maneuvers, following too closely, etc.

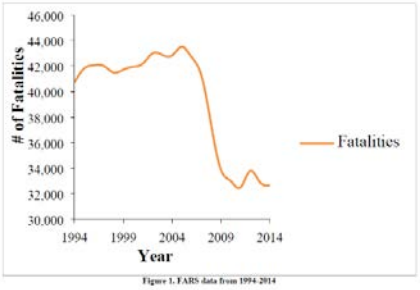

Figure 1. FARS data from 1994-2014

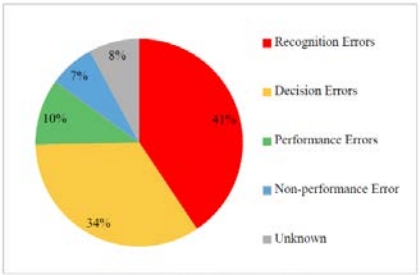

Figure 2. 2008 NHTSA Crash Causation Survey to Congress

Examination of state laws regarding the use of HAVs on public roads reveals a myriad of regulations ranging from permissive to unauthorized use. Such chaos creates issues for the smooth operation of commerce between states and could violate an individual's human rights. The NHTSA's proposal for states to adopt a Model State Policy could create uniformity and partially solve some of these issues.

A major difference between present and future vehicle accident forensics concerns the amount and accessibility of HAV-related data. Two petabytes (10^{15} bytes) of data accompanies processing and responding to the environment around one HAV annually; however, designers of HAV control systems dictate vehicle responses to these input data. This raises new ethical issues because, while human drivers may be "forgiven for making an instinctive but nonetheless bad split-second decision … programmers and designers of automated cars don't have that luxury, since they do have time to get it right and therefore bear more responsibility for bad outcomes."[3] A novel issue is thus raised regarding how will such ethical decision-making be programmed into autonomous vehicles. This will require more thorough dialogue with government, industry, academia, and the public. Other questions will likely also arise from the interface of HAV technology with society. These questions may include: (1) Can HAVs fully replace human drivers?; (2) What will be the socioeconomic impacts of implementing HAVs?; and, (3) Will HAVs disrupt the balance between individual privacy and public security?

This presentation will demonstrate how HAV electronic control systems are tested, including modeling, human simulation, and full-scale experimentation. Exciting and significant performance information will be illustrated with these modeling and testing examples.

Reference(s):

1. https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars.
2. Crandall, C.S.; Olson, L.M.; and Sklar, D.P. 2001. Mortality reduction with air bag and seat belt use in head-on passenger car collisions. *Am J Epidemiol.* 153: 219–224.
3. Patrick Lin. The Ethics of Autonomous Cars. *The Atlantic*. 10/8/2013.

Autonomous, Ethics, Controls

*Presenting Author