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The Robotics Institute

Technologies for Safe and Efficient Transportation
A U.S. DOT UNIVERSITY TRANSPORTATION CENTER

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SENATE AND HOUSE TRANSPORTATION COMMITTEES

JULY 14, 2015 JOINT HEARING ON

ENHANCING THE SAFETY OF HIGHWAY WORKERS, DRIVERS AND PEDESTRIANS

TESTIMONY OF

BERNARDO PIRES, PHD
PROJECT SCIENTIST
THE ROBOTICS INSTITUTE
CARNEGIE MELLON UNIVERSITY

Chairman Rafferty, Chairman Taylor, Chairman Wozniak, Chairman Keller and members of the Senate and House Transportation Committees – Thank you for inviting me to discuss emerging technologies to control and mitigate distracted driving. It is my intention to read these prepared remarks and then be available to answer questions or provide elaboration as the joint committee might require.

My name is Bernardo Pires and I am a Project Scientist at the Robotics Institute, Carnegie Mellon University. For this testimony, I will give a brief overview of the current research and emerging technologies to mitigate distracted driving and point out some noteworthy research efforts in the university and industry. **I will place particular emphasis on three projects currently under development at CMU and funded by the Center for Technologies for Safe and Efficient Transportation (T-SET) and Traffic21 Institute.**

T-SET and Traffic21 are sister organizations that lead a multi-disciplinary research effort at CMU and UPenn to design, test, deploy and evaluate technology based solutions to address the problems facing the transportation system both regionally and nationally. T-SET is a USDOT National University Transportation Center for Safety and the organizations have research partnerships with PennDOT, PA Turnpike, and the City of Pittsburgh.

Overview

Distraction detection systems have the ability to save lives by determining the driver's alertness and sounding warnings and adjusting automatic systems such as lane keeping, collision warning, and adaptive cruise control to match the driver's state. As we move closer to self-driving cars, measuring the driver's inattention as

also been proposed as a guideline on when to trigger the self-driving technology. On the other hand, some consensus is emerging that the self-driving systems will not be able to handle all the road conditions. In this case, knowing the driver's state is a fundamental pre-requisite to deciding whether the self-driving system can transition command back to the driver.

Broadly speaking, emerging technologies to mitigate distracted driving can be divided into three categories based on the inputs used to detect distraction: **(1) Vision-based systems, (2) Acoustics-based systems, and (3) Physiological sensing-based systems**. I will now discuss each of these systems in more detail.

Vision-based distraction detection

The traditional focus of vision-based systems has been on the detection of driver's gaze. Volvo has recently announced a driver state estimation system, "which casts infrared light upon the driver's face, monitored by sensors that detect the driver's eye gaze, head movement, head angle, and how open his or her eyes are" [1]. A similar project was developed at CMU, led by my colleague Fernando De la Torre, in collaboration with General Motors [2]. The system reliably detected Eyes Off the Road without using infrared light and was able to accurately estimate the driver's focus of attention by installing an inexpensive vision-based system on the steering wheel column.

An emerging trend in the vision-based systems, which is the focus of the research currently being developed by my group, is the installation of cameras that capture more of the car interior. **In particular, my current research aims to use**

overhead cameras to automatically detect if the driver is holding or using an electronic device.

A further advantage of the presence of interior looking cameras is that the system can obtain a better estimate of what is occurring inside the vehicle and possibly detect other dangerous driver behaviors. We should be mindful that, despite the epidemic of cell phone use, according to a recent AAA study [3], for teen drivers, interactions with passengers still account for more moderate-to-severe crashes than cell phone use (attending to passengers accounted for 14.9% of crashes *versus* 11.9% due to cell phone use).

Acoustics-based distraction detection

Complementary to vision based system, there has been recent research into distraction detection by analyzing the driver's speech. It is now well known that headset cell phone use is not substantially safer than hand-held use [4]. In particular, we are starting to realize that the safety of hands-off devices is often more directly related to the task at hand and the driving conditions.

Research lead by my **CMU colleague Maxine Eskenazi and her group, in partnership with Yahoo! and the DOT is working to create a distraction detector for hands-off devices based on acoustics alone.** The system does not necessarily need to understand the driver's speech, but instead uses variances in pause length, hesitations, fillers, and fluency, to detect distraction and stop the hands-off device.

Physiological-based distraction detection

Another detection method relies on physiological sensors. Traditionally physiological methods can be cumbersome, as they often require the sensors to be strapped on to the driver. However, in recent years, we have seen innovative solutions from both the industry and the research community. Some approaches add sensors to the steering wheel, in particular heart rate sensors, such as the one announced by Toyota in 2011 [5].

My CMU colleague Hae Young Noh is leading research, in partnership with Renault and Lucas Physical Therapy and Fitness, to add vibration-based sensors to the driver's seat and use that to determine the high-level driver status. The sensors will be able to sense posture, movement, and also muscular activity and cardiovascular function so as to determine the attention, fatigue and stress level of the driver.

Conclusion

In conclusion, the three categories described – vision-based systems, acoustics-based systems and physiological sensing systems – encompass much of what is being done in the distraction detection space. **It is my opinion that significant change can be attained in the short and long term to prevent many types of distracted driving accidents and I look forward to be able to work towards safer roads**. I thank you for providing me with the opportunity to speak with you today and am at your disposal to answer any questions that you may have.

References

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