The Transformation of Vehicle Controls to Drive-By-Wire

Predictive Policing in the US: How Far is Too Far?

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

What are the social implications of artificial intelligence and advanced data analysis systems?

Digital methods such as artificial Intelligence (AI) and advanced data analysis systems automate complex tasks and reveal patterns in vast datasets. AI is well established in diverse fields, including pharmaceutical chemistry (Choudhary, 2021), water treatment and seawater desalination (He, 2021), education (Shaikh, 2021), systems that improve accessibility for persons with disabilities (Chakraborty, 2021), and manufacturing (Zeba, 2021). Yet when digital methods do not merely inform or guide the judgment of experienced experts, but displace it, such techniques can yield deficient results (Petroski, 1985). Their extraordinary capacities can inspire undue confidence, which in turn can tempt administrators to forego the financial and time costs of expert human judgment (Scherz, 2019). Such economies are hazardous, because digital methods depend upon data that require selection, interpretation, and weighting, and each of these steps occasions opportunities for error (Allen, 2001; Rainie & Anderson, 2017). Hence digital methods are best applied as supplements to expert human judgment, whether the problem at hand is vehicle automation, law enforcement, or any other data-intensive human problem.

Adaptation of a 2008 Ford Escape for Drive-by-Wire Teleoperation

How can a 2008 Ford Escape be made into a drive-by-wire vehicle capable of being driven from a computer?

A Ford Escape will be customized for teleoperation via drive-by-wire functionality, with the intent of future teams making it fully autonomous. Our advisor is Tomonari Furukawa, the director of the VICTOR lab in the MAE department. Our team includes students Henry

Goodman, Logan Montgomery, Jacob Deane, Matthew Deaton, Vishal Singh, and TA Siddharth Singh.

Introduction

Autonomous vehicles have the potential to provide a safer, faster, more efficient and more comfortable future of transportation. Autonomous cars could drastically increase safety, as 94% of all accidents are attributed to human error (NHTSA). In addition, autonomous cars could communicate and cooperate to reduce traffic, making driving faster and more energy efficient. They can allow the transportation of individuals who cannot drive themselves, such as the elderly, disabled and inebriated, as well as the driverless transport of goods.

Drive-by-wire systems will also change ground transportation. These systems augment or replace the mechanical controls of a vehicle with electronic systems (Laukkonen, 2021). This in turn means drive-by-wire vehicles are lighter, more fuel efficient, and require less maintenance. Their computer-controlled systems have higher operational accuracy and allow the interior of a car to be completely redesigned, as the controls can now go virtually anywhere in the vehicle (Fuller, 2009; Stevens, 2021).

Most newer vehicle models have some form of by-wire driving systems. Examples include electronic throttle control or electro-hydraulic braking systems. In fact, Tesla has vehicles that are almost fully drive-by-wire. However, there are no current production vehicles that are fully drive-by-wire (Laukkonen, 2021).

Similarly, there are no current production vehicles in the United States that are considered autonomous by the Society of Automotive Engineers (SAE) Levels of Driving Automation standard (Synopsys, 2021). This ranking is split from zero to five, where zero is complete driver control and 5 is no driver input at all. Vehicles level three and above are considered autonomous

(SAE, 2018). Tesla's Autopilot and other similar software systems are ranked as level two, which means they are capable of assisting in or completing multiple driving tasks simultaneously but still require the driver to be in control. The only production level three car is Audi's A8, but it is not sold with the necessary hardware and software to drive autonomously in the US (IEEE, 2020; Synopsys, 2021).

Project Outline

Goals of the project include creating a fully teleoperated drive-by-wire system to control the Ford Escape. This will consist of both external and internal modifications to the vehicle, as well as software creation for the teleoperation controls. A sensor suite for autonomous driving will be planned and, if time permits, installed. Since the project is limited to the Ford Escape, the car's attributes (such as mass, speed, size, setup and wiring) impact how the team approaches the project. All systems must be designed to work within these attributes, making the systems highly customized for this specific vehicle.

Documentation has been made to assess the project needs and guide the technical design process. These include researching customer needs and existing technologies, creating a quality function deployment chart and a general system diagram, and investigating past team efforts. Technical work will begin with observations about the car, including its properties and changes from past teams' efforts. These observations will be useful in determining the specifications for hardware needed to operate the vehicle. The Robot Operating System (ROS) middleware suite will be used to teleoperate the vehicle and connect various hardware systems. Once appropriate hardware is collected, software will be written to test their operations and ensure they work as expected. After sufficient testing, these systems will be installed in the vehicle.

If successful, the final product will allow for the full teleoperation of the vehicle from an onboard system computer. This will help to determine effective ways to make a vehicle drive-by-wire, both from the hardware of the car, sensing systems and actuators to the software needed for the communication of these components. Since the vehicle will already have the ability to drive itself without physical human interaction, the addition of an autonomy would simply be the addition of software that can analyze the surroundings of the vehicle and act on them.

Predictive Policing in the US: How Far Is Too Far?

In the U.S., how are advocacies, law enforcement agencies, and tech companies competing to determine the proper extent and applications of predictive policing?

Over the last decade, police forces in the U.S. have begun to use software to identify crime trends and assist in law enforcement (Lee, 2020). These methods use entered data to "predict where and when specific crimes are most likely to occur," or even whether certain people will be involved in crime (Predpol, 2020; Sandhu, 2020). Police forces can use these predictions to distribute their officers to areas deemed at-risk of crime. Yet such deployments have been controversial, especially after decades of abuse of minorities at the hands of police officers.

In predictive policing, analysis of vast data reveals relationships that would otherwise go unnoticed. Because the algorithms use historical crime data, correlations are subject to the social biases of real-world law enforcement. Jefferson (2016) states that "reliance on official crime statistics works to further entrench and legitimize the geographic knowledge and practices of racialized policing." In a negative feedback loop, more local policing leads to more arrests, yielding data the software may use to recommend more local policing.

In a study of predictive policing in Chicago, Jefferson (2016) concluded that "predictive crime mapping does not incur more precise applications of police force but rather legitimizes the widespread criminalization of racialized districts" (Jefferson, 2016).Egbert (2018) contends that "algorithmic output triggers possibilistic thinking, as police officers patrolling in the designated area are guided by the expectation that there must be a [criminal] around." According to Egbert, law-abiding residents in the area are consequently subjects of suspicion because of the "speculative connection between the spatiotemporal crime prediction and the risk potential of the people present at that location."

Vendors of predictive policing software such as PredPol and ShotSpotter (PredPol, 2020) argue that current policing is "too subjective," and that their products "help officers objectively determine where and when to police and, therefore, more effectively ... prevent crime" (Sandhu, 2021). Yet software cannot offer objective policing recommendations, because the data it analyzes must be selected, weighted, and interpreted. Software cannot understand and account for the data's context. Meijer (2019) contends that so-called theory-driven programs that distinguish cause from correlation may help, but most policing software is data driven (Meijer, 2019).

Critics of predictive policing contend that the systems encode bias, lack transparency, and subject nonwhite populations to disproportionate policing. They argue that "the algorithms take form" in response to data that reflect persistent social inequities (Benbouzid, 2018; Gilbertson, 2020). Advocacies use audits and litigation to pursue accountability and transparency

(Benbouzid, 2018). They include activists, researchers, and even those who help make the software (Castelvecchi, 2020; Durán, 2019).

In response to public objections, some large police departments phased out predictive policing; others have developed their own systems (Gilbertson, 2020; Lau, 2020).

Advocacies that oppose predictive policing tend to fault American policing in general (M4BL, 2021). They argue that funding now committed to policing would be better spent on "housing, health care, income support, employment, and community-based safety strategies that will produce genuine and sustainable safety for all" (Community Resource Hub, 2021).

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