Undergraduate Thesis Prospectus

Optimizing Route Schedules for Safety Service Patrols

(technical research project in Systems Engineering)

Drivers in a Driverless Future: The Impact of Autonomous Vehicles on Paid Drivers

(STS research project)

by

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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: The Changing Landscape of Autonomous Vehicles in America

How will autonomous vehicles impact transportation costs in the U.S.?

Autonomous vehicles (AVs) have developed rapidly since DARPA's Grand Challenge competition in 2004, where the most successful AV navigated only seven miles. One year later, driverless cars completed the route (Eno Center for Transportation, 2013). Experts distinguish semi-autonomous vehicles, which operate without a driver only under certain conditions, and fully autonomous vehicles, which are driverless in any condition (McDowell, 2014).

To succeed, fully autonomous vehicles must be properly integrated into society. AVs can offer reduced stress, mobility to those who cannot drive, and reduced costs for fleet operators. Non-users may benefit from increased road capacity. However, costs include more expensive cars, social inequities, employment losses, and possibly increased traffic (Litman, 2019). The policy used to integrate AVs will determine the extent of their costs and benefits.

Optimizing Route Schedules for Safety Service Patrols (SSPs)

How can SSP-monitored routes be optimized?

This Capstone project is led by Professor Michael Porter of the Systems and Information Engineering Department in collaboration with Emma Chamberlayne, Bunny Campbell, Julie Gawrylowicz, Colin Hood, Allison Hudak, and Matthew Orlowsky.

Traffic accidents present immediate physical danger to the passengers involved and substantial costs to the U.S. economy. In 2017, traffic incidents in the U.S. cost $433.8 billion and resulted in 40, 231 casualties (National Safety Council, 2017). This estimate fails to account for indirect factors like wasted time and fuel from traffic. In 2013, the cost of traffic was estimated to be $124.2 billion in the U.S. (CEBR, 2014). To reduce traffic costs, the Virginia

Department of Transportation created Safety Service Patrols (SSPs) to patrol routes where collisions are most likely and help clear away accidents quickly.

Current SSP routes are outdated and do not incorporate modern traffic patterns. We will optimize current route schedules to minimize SSP response time, thus increasing road safety and reducing traffic costs in Virginia. VDOT’s budget and manpower constraint us to consider only interstate highways and work shifts of greater than eight hours.

Research into SSPs focuses on their ability to improve safety and decrease congestion. They are perceived as cost effective, since an annual investment of $2.4 million into SSPs will yield $11.1 million in traffic-related savings and can relieve congestion by 25% (Dickey, 2011). Yet they exist only in a few states, as of 2002 SSPs patrolled only 50% of freeway miles in the largest 78 metropolitan areas in the U.S (Dougald & Demetsky, 2008). Prior research focuses on analyzing the current performance of SSP programs and does not consider how these programs can be improved. While we only consider interstate highways in our analysis, future work can focus on expanding this network.

Our analysis will use data provided by VDOT. First, we will calculate current performance measures to identify areas to improve upon. We will then use R and Excel to generate probability models for incidents per mile marker by time of week. Lastly, we will generate visualizations to present VDOT our new route schedules. Through this we hope to reduce incident response time in Virginia, leading to less injuries and reduced traffic costs.

Drivers in a Driverless Future: The Impact of Autonomous Vehicles on Paid Drivers

How are truckers, ride sharing companies, taxi companies, and public transportation agencies reacting to autonomous vehicles in the U.S.?

Truckers

AVs may save fleet operators money, but professional drivers may lose their jobs. Sixty-five percent of US domestic freight is transported by trucks. The operating cost of fully autonomous trucks may be 45% less, saving between $85 billion to $125 billion (Chottani et al., 2018). Chris Spear, President and CEO of the American Trucking Associations, the largest national trade association for the trucking industry, claims that "the world of automated vehicles will still have an important role for drivers" since the words 'autonomous' and 'driverless' are not synonymous (ATA, 2017). Autonomous Trucks (ATs) may not replace truckers in the future but may change their roles. The ATA claims ATs will not displace drivers and contends that trucking companies should determine how to integrate automation (American Trucking Associations, 2017).

Ride Sharing Companies

Ride sharing companies entered the market as competitors to taxi companies. Drivers use their own vehicles, reducing costs. AVs may lower costs further by displacing paid drivers. Uber and Lyft have invested heavily in developing their own autonomous vehicles. Lyft filed for its IPO with the SEC on March 1, 2019, stating it has "incurred net losses each year since our inception and we may not be able to achieve or maintain profitability in the future" (United States, 2019). Lyft has not reached profitability, in part due to high labor costs. It has therefore invested heavily in AVs. According to one outdated forecast, shared electric AVs may account for 25% of miles driven in the U.S. by 2030, generating higher profits (BCG, 2017).

Uber's autonomous business, known as Advanced Technologies Group (ATG), has reported losses of between $100 million to $200 million per quarter (Isaac et al., 2017). In 2017 Uber announced plans to begin testing autonomous taxis in Phoenix, chosen for its wide streets and low pedestrian traffic. Uber stopped the program after a pedestrian was run over and killed by one of the AVs, then reinstated it just nine months later (Bensinger, 2017). It is a testament to the expected profitability of autonomous vehicles that Uber has retained the AV research business and the Phoenix pilot program despite their cost.

Public Transport

Unlike private ride sharing companies, public transport has an obligation to make safe and affordable transit available to all, regardless of age, income, or ability (Gindrat, 2019). The American Public Transportation Association (APTA) reports that every $1 invested in public transportation generates $4 in economic returns, while saving Americans 4.2 billion gallons of gas and 37 metric tons of carbon emissions annually (Hughes-Cromwick, 2019) AVs may compete with transit for passengers. Such a diversion would worsen congestion and emissions (Litman, 2019). AVs could serve as transit vehicles. APTA is conducting research on the integration of AVs, hoping it will "lead to improved operations, more efficient cost structures, and enhanced safety" (Hughes-Cromwick, 2019).

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