Lecture Notes

Connected and Autonomous Vehicles
Impacts on Transportation Models

Raj Bridgelall, Ph.D.

Overview

The National Highway Traffic Safety Administration (NHTSA) estimates that issues related to the human driver is the cause of 94% of all crashes. Fatalities jumped 6% from 2015 to 2016. AI drivers won't get drunk or distracted, and for the most part, we'll program them to obey traffic laws. They have sensors that can detect pedestrians, cyclists, and road workers to avoid running into them. Studies show that just 5% of self-driving vehicles in a traffic flow can reduce congestion. If autonomous vehicles don't crash, than we will eliminate one-third of all congestion causes. They will probably do a better job at real-time route planning to reduce travel time and increase travel-time reliability. They may not need as wide a lane as humans do, and they can platoon at high speeds. So when we redesign our highways, capacity will increase. Vehicles that can park themselves and find remote parking facilities will bring us an opportunity to repurpose city and street parking facilities.

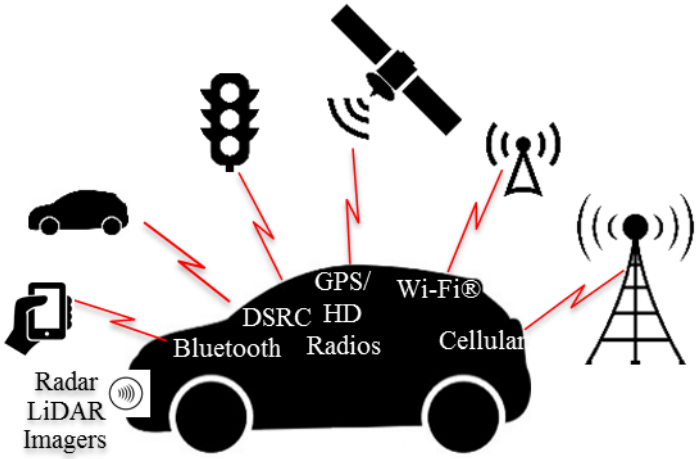

Figure 1: Connected and Autonomous Vehicles.

Summary of Potential Impacts

The following is an outline summary of how connected and autonomous vehicles (CAVs) will likely affect our existing transportation models:

1. Highway Capacity Models
    a. Cities and states are likely to collaborate and introduce dedicated lanes for CAVs.
    b. Higher speeds with platooning will increase lane capacity.
    c. Infrastructure geometries could change (narrower lanes, shoulders, medians) if only artificial intelligence (AI) drivers are using them.
2. Traffic Flow Models

   a. Research shows that just a few CAVs in the traffic stream smooths out the congestion waves and regulates traffic flows because of the automated braking and acceleration capabilities.
   b. Traffic flow volume and density models will change to account for platooning, or in mixed driving scenarios.

3. Land Use Models
   a. Traditional gas stations will transition to other uses as vehicle electrification (a trend coupled with CAVs) dominates internal combustion engines.
   b. Street parking, city garages, and parking lots currently occupy 31% on average of city spaces. Planners will repurpose them when CAVs transition to parking in remote facilities, if needed.
   c. Reduced pollution (emissions and noise), coupled with the repurposing of city spaces could change existing city livability and population growth models.
   d. Cities will introduce new dedicated spaces for shared mobility pick-up/drop-off to reduce/eliminate conflict with regular traffic.
   e. States may remove sound barriers because CAVs can/will be quieter and need not turn on their lights.
4. Travel Demand Models
   a. Shared mobility (self-driving Ubers, micro-transit, shared ownership, etc.) will increase accessibility for the aged, disabled, and young, thereby spurring demand for trips.
   b. Convenience of first- and last-mile (door-to-door) transport at reduced cost (due to high competition and electrification) could potentially decrease demand for traditional public transit.
   c. Conversely, having a first/last mile solution could spur demand for public transit in certain settings and situations.
   d. Traffic could increase due to zero-occupancy vehicles that spend very little time parking or idling (e.g. driverless taxis).
5. Law Enforcement
   a. Agencies will need to introduce cybersecurity education and disaster response training.
   b. Officers will need to be trained to interact with CAVs and their occupants.
   c. City revenues from parking, speeding, and DUI violations will decline.
6. Insurance
   a. Clients will transition from individuals to vehicle manufacturers or the suppliers of the AI driver.
   b. Risks will transition from crashes to cyber-attacks.

c. Manufacturers will need insurance to cover failures in cloud computing systems (for over-the-air software updates, 3D maps, etc.) and infrastructure sensors/equipment (for real-time navigational aid, road condition, etc.)

d. A portion of the CAV population will advance shared mobility (ride sharing) services, so business models will move towards insuring entire fleets.

7. Commerce

a. Ubiquitous connectivity (V2V, V2I, V2P, and V2X) is a trend that is coupled with autonomous vehicles; it will proliferate cloud computing and cloud services.

b. People will use free time in vehicles to engage in online commerce (movie downloads, shopping, social media, etc.)

c. Freight movements (autonomous trucks) will become more efficient and cost-effective (reduced driver cost, reduced hours-of-service restrictions).

d. Professional drivers (e.g. truck, bus, taxi, etc.) will need to retrain for other work.

e. Conversely, people who drive as part of their jobs (real-estate agents, law-enforcement, package delivery, etc.) will realize benefits.

f. Traditional rental-car companies will transition to fleet maintenance companies.

g. Hotel lodging demand could change if vehicle interiors change to accommodate driver-less long-distance travel.

h. Collision repair shops will see reduced business if CAVs are involved in significantly fewer crashes.