Graduation T&P

Would you drive the same when you interact with a self-driving vehicle in traffic?

by Shubham Soni

Consider a situation where you are driving your vehicle in a normal traffic situation. Suddenly you see a vehicle merging from an on-ramp in front of you. You very well recognize this brand of vehicle and it's a self-driving vehicle. This vehicle is also giving visual cues that it is running in a self-driving mode. Given the information that the vehicle driving in front of you is being run by a computer, would you rather make different driving decisions? Would you be more cautious while interacting with this vehicle or curious to know more about the vehicle? Would you be more stressed while driving near this vehicle or more relaxed with the fact that this vehicle is continuously monitoring the environment and programmed to drive safely? Or more interestingly, would you drive and interact with this vehicle in the same manner as you would normally do with any other human-driven vehicle?

Participants waiting to participate in the experiment interacting with self-driving vehicle

The Purpose

With improvements in technology, Self-driving vehicles are slowly becoming a reality. It is not too far in the future when these driverless robots will be a part of normal high-speed daily traffic. We have seen several examples of running prototypes of SAE level-4 self-driving vehicles (mainly in the US) which can be clearly identified by its massive LiDAR on top or stickers on the sides of the vehicle. Apart from that, a lot of research is currently ongoing which is trying to find optimal ways to communicate the state and driving intention of self-driving vehicles to other road users. With all these visual elements and indications, it would be rather easy to recognize the type and driving mode of a particular vehicle in traffic especially in the early phases of automation. This ability to identify the self-driving vehicle insinuate towards a potential behavioral adaptation of human drivers when they interact with a self-driving vehicle on road.

Another important aspect is that self-driving vehicles drive, behave, and interact with other road users in a different manner (more tending towards safe driving), and assuming a decent penetration of these vehicles in traffic, it is expected that they would bring more safe and efficient traffic flow. However, in reality, the potential behavioral adaptation of human drivers towards these vehicles has not been considered yet in such studies. This gives rise to many questions. Would there be a positive or negative influence of this potential behavioral adaptation of drivers on the traffic flow and safety of the system? How would this potential behavioural adaptation change over time with more information and interation with these vehicles? Should the manufacturers of self-driving vehicles try to build the systems in a way that these vehicles drive and behave like a human-driven vehicle or is robotic driving beneficial? Should these vehicles look different and try to communicate their intent with other drivers in traffic or is it better to design these vehicles in such a way that they are personally unidentifiable?

To find answers to these questions, Shubham Soni, a master student of Transport and Planning at TU Delft, is currently working on his thesis to understand any such potential behavioral adaptation of drivers when they interact with self-driving vehicles. His project is a part of the SAMEN project (a 4-year project led by Dr. ir. Haneen Farah) in collaboration with Royal HaskoningDHV. This unique study is being carried out by conducting a controlled field test.

The Experiment

This research aims to understand behavioral adaptation mainly for three driving maneuvers: Gap acceptance at intersection, Car-following, and Overtaking. A controlled field experiment was carried out in late July to collect data for the research. A total of 18 participants took part in the experiment where they were asked to drive their private car from point A to point B interacting with a normal and a self-driving vehicle in different scenarios. During the experiment, Toyota Prius of Smart Vehicle Laboratory of CiTG, TU Delft was used as a test vehicle which was equipped with cameras, LiDARs, and GPS logger. To indicate self-driving mode, the test vehicle (always driven by a driver) was decorated with a sticker as well as a fake LiDAR on top.

The experiment began when the participant was asked to wait at the edge of the parking lot (point A) and look for an approaching vehicle. In one scenario, the approaching test vehicle was human-driven whereas, in other scenarios, it was faked as a self-driving vehicle. The participants were first asked to indicate the last moment when they feel safe to cross before the vehicle with the help of a hand gesture. Once the test vehicle crossed in front of them, they followed the vehicle for around 1 km driving at a speed of 60 kmph. At a certain random point after 1 km, the test vehicle was made to start slowing down inciting the participants to overtake the vehicle and reach their destination (point B). Each participant completed 10 similar runs in different scenarios and after each run of the experiment, participants were asked about their stress level and trust in the interacting vehicle. The presence of other road users added to the realism in the experiment.

The experiment resulted in a collection of a large amount of driving data with around 180 km of car following, 170 instances of gap acceptance, around 130 instances of overtaking (interestingly, not everyone did overtake) along with multiple questionnaires before during and after the experiment.

The most interesting observation during the experiment was that the participants felt that the self-driving vehicle was driving differently than a human-driven vehicle whereas, in reality, the vehicle was always driven in a similar fashion by the same driver. Many participants admitted that they were more cautious while interacting with the self-driving vehicle and drove a bit differently. This gives us a first positive indication of the potential behavioral adaption of drivers towards the self-driving vehicle which needs to be further consolidated with data analysis. Hopefully, the findings of this research will help in better design of such vehicles contributing towards more safe and efficient future mobility.

A participant starting to follow the test vehicle.