Google Self-Driving Car Project
Monthly Report
October 2015

Activity Summary (all metrics are as of October 31, 2015)

Vehicles
- 23 Lexus RX450h SUVs – currently self-driving on public streets; 19 in Mountain View, CA, 4 in Austin, TX
- 25 prototypes – currently self-driving on public streets; 21 in Mountain View, CA & 4 in Austin, TX

Miles driven since start of project in 2009
"Autonomous mode" means the software is driving the vehicle, and test drivers are not touching the manual controls. "Manual mode" means the test drivers are driving the car.
- Autonomous mode: 1,268,108 miles
- Manual mode: 938,621 miles
- We're currently averaging 10,000-15,000 autonomous miles per week on public streets

Making sure our software won't get spooked by vampires

Halloween's a great time to get some extra learning done. This week, lots of little ghouls, superheroes and even robots were running around Google with their families, so we asked them to hang out around our parked cars. This gives our sensors and software extra practice at recognizing children in all their unique shapes and sizes, even when they're in odd costumes.

We teach our cars to drive more cautiously around children. When our sensors detect children—costumed or not—in the vicinity, our software understands that they may behave differently. Children's movements can be more unpredictable—suddenly darting across the road or running down a sidewalk—and they're easily obscured behind parked cars. So even if our cars can't quite appreciate the effort the kids put in dressing as their favorite character from Frozen, they're still paying full attention!

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Why we're aiming for fully self-driving vehicles

As we see more cars with [semi-autonomous features](#) on the roads, we're often asked why we're aiming for fully autonomous vehicles. To be honest, we didn't always have this as our plan.

In the fall of 2012, our software had gotten good enough that we wanted to have people who weren't on our team test it, so we could learn how they felt about it and if it'd be useful for them. We found volunteers, all Google employees, to use our Lexus vehicles on the freeway portion of their commute. They'd have to drive the Lexus to the freeway and merge on their own, and then they could settle into a single lane and turn on the self-driving feature. We told them this was early stage technology and that they should pay attention 100% of the time -- they needed to be ready to take over driving at any moment. They signed forms promising to do this, and they knew they'd be on camera.

We were surprised by what happened over the ensuing weeks. On the upside, everyone told us that our technology made their commute less stressful and tiring. One woman told us she suddenly had the energy to exercise and cook dinner for her family, because she wasn't exhausted from fighting traffic. One guy originally scoffed at us because he loved driving his sports car -- but he also enjoyed handing the commute tedium to the car.

But we saw some worrying things too. People didn't pay attention like they should have. We saw some silly behavior, including someone who turned around and searched the back seat for his laptop to charge his phone -- while travelling 65mph down the freeway! We saw human nature at work: people trust technology very quickly once they see it works. As a result, it's difficult for them to dip in and out of the task of driving when they are encouraged to switch off and relax.

We did spend some time thinking about ways we could build features to address what is often referred to as "[The Handoff Problem](#)" -- keeping drivers engaged enough that they can take control of driving as needed.   The industry knows this is a big challenge, and they're spending lots of time and effort trying to solve this. One [study](#) by the Virginia Tech Transportation Institute found that drivers required somewhere between five and eight seconds to safely regain control of a semi-autonomous system. In a [NHTSA study published in August 2015](#), some participants took up to 17 seconds to respond to alerts and take control of the the vehicle -- in that time they'd have covered more than a quarter of a mile at highway speeds. There's also the challenge of context -- once you take back control, do you have enough understanding of what's going on around the vehicle to make the right decision?

In the end, our tests led us to our decision to develop vehicles that could drive themselves from point A to B, with no human intervention. (We were also persuaded by the opportunity to help everyone get around, not just people who can drive.) Everyone thinks getting a car to drive itself is hard. It is. But we suspect it's probably just as hard to get people to pay attention when they're bored or tired and the technology is saying "don't worry, I've got this...for now."

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Traffic Accidents Reported to CA DMV

None for the month of October.

What we've been reading

- KQED TV (Panel discussion), "The Road to Self-Driving Cars" (October 2015)
- KQED TV (Documentary), "Self Driving Cars: The Road Ahead" (October 2015)
- Business Insider: Learning more about Google's self-driving cars made me terrified to ever drive again (October 2015)
- MIT Technology Review, "Drivers Push Tesla's Autopilot Beyond Its Abilities" (October 2015)
- San Jose Mercury News, "Google, Tesla, Others Wait for DMV's Self-Driving Car Rules" (October 2015)