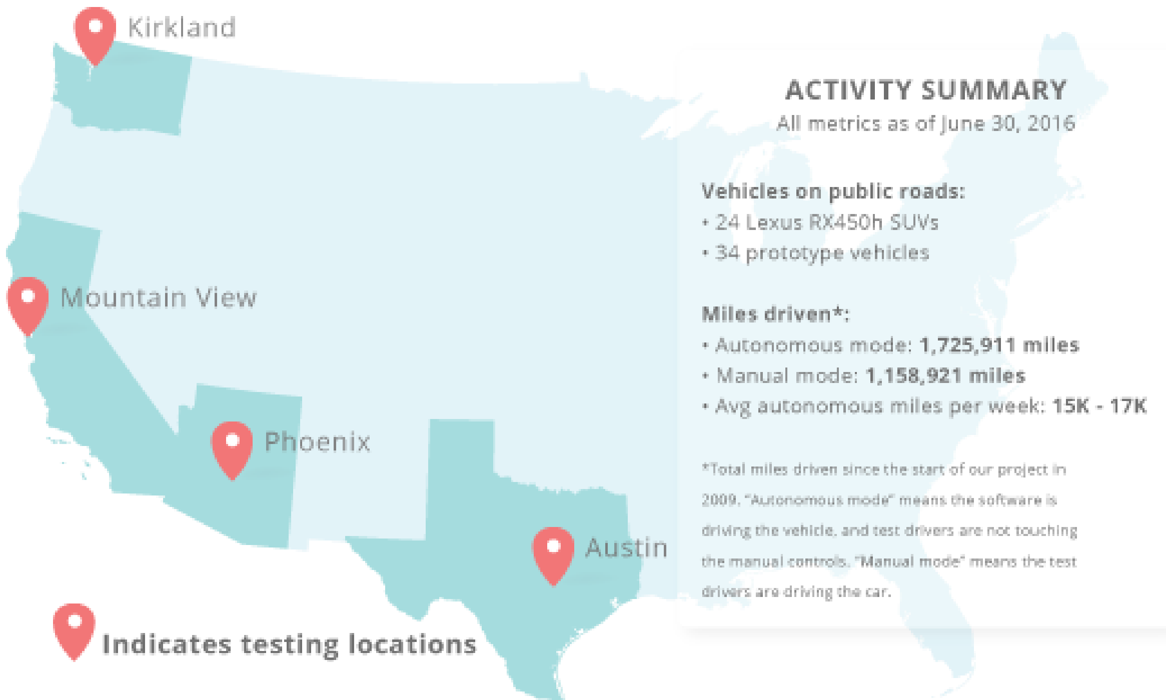
Google Self-Driving Car Project
Monthly Report

June 2016

ON THE ROAD



SAFELY SHARING THE ROAD WITH CYCLISTS

Across the U.S., cities have taken steps to keep cyclists safe on the road, whether with separate bike lanes, buffer laws, or share the road campaigns. Still, cyclists are often at risk. In 2014 alone, more than 50,000 cyclists were injured and over 720 were killed on American roads. As cycling becomes more popular (trips more than doubled in the U.S. from 1.7 million in 2001 to 4 million in 2009), it's important that our self-driving cars share the roads safely with cyclists.

Cyclists are fast and agile — sometimes moving as quickly as cars — but that also means that it's hard for others to anticipate their movements. Our cars recognize cyclists as unique users of the road, and are taught to drive conservatively around them (it helps to have a number of avid cyclists on our engineering team!).

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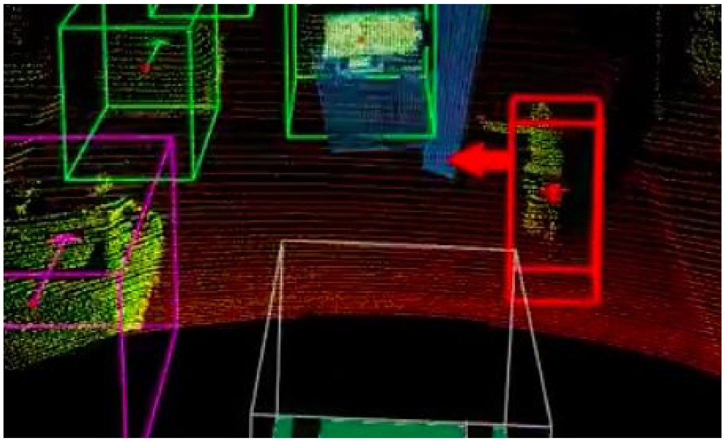
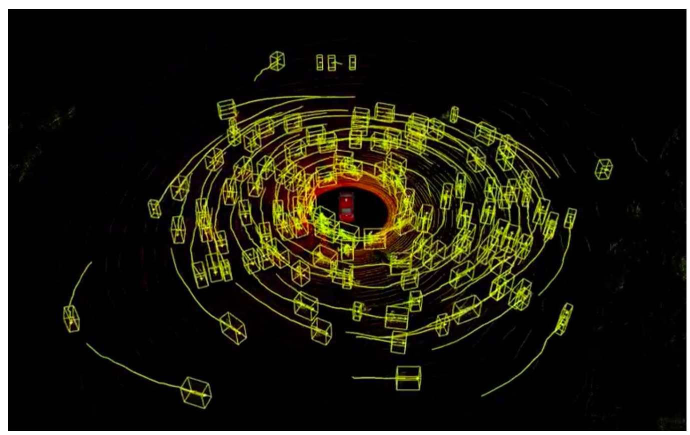


Our software can recognize cyclists' hand signals and slow down to allow the rider to merge

For example, when our sensors detect a parallel-parked car with an open door near a cyclist, our car is programmed to slow down or nudge over to give the rider enough space to move towards the center of the lane and avoid the door. We also aim to give cyclists ample buffer room when we pass, and our cars won't squeeze by when cyclists take the center of the lane, even if there's technically enough space. Whether the road is too narrow or they're making a turn, we respect this indication that cyclists want to claim their lane.

Through observing cyclists on the roads and private test track, we've taught our software to recognize some common riding behaviors, helping our car better predict a cyclist's course. Our sensors can detect a cyclist's' hand signals as an indication of an intention to make a turn or shift over. Cyclists often make hand signals far in advance of a turn, and our software is designed to remember previous signals from a rider so it can better anticipate a rider's turn down the road.

Because our cars can see 360 degrees, we're more aware of cyclists on the road — even in the dark. Take, for example, this tricky situation involving two cyclists at night. Our car cautiously approached a cyclist that veered into our lane and stopped to avoid another that suddenly turned a corner and rode directly at us against the flow of traffic. Our car was able to adapt to this unusual situation, and avoid a potential collision.



Over 100 Googlers pedalling around our self-driving car near our Mountain View, CA campus

Bikes can come in many shapes and sizes, so using machine learning we've trained our software to recognize many different types. Our software learns from the thousands of variations it has seen — from multicolored frames, big wheels, bikes with car seats, tandem bikes, conference bikes, and unicycles — enabling our car to better share the road no matter your choice of ride.

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TRAFFIC COLLISIONS INVOLVING AUTONOMOUS FLEET

Given the time we're spending on busy streets, we'll inevitably be involved in collisions; sometimes it's impossible to overcome the realities of speed and distance. Thousands of minor crashes happen every day on typical American streets, 94% of them involving human error, and as many as 55% of them go unreported. (And we think this number is low; for more, see here.)

In this section, we detail the collisions our self-driving fleet has been involved in while testing on public roads, whether driven autonomously or in manual mode. For collisions occurring in CA, the following summaries are what we submitted in the "Accident Details" section of form OL316 Report of Traffic Accident Involving an Autonomous Vehicle.

June 6, 2016: A Google prototype autonomous vehicle (Google AV) was traveling southbound on Berkman Dr. in Austin, TX in autonomous mode and was involved in a minor collision north of E 51st St. The other vehicle was approaching the Google AV from behind in an adjacent right turn-only lane. The other vehicle then crossed into the lane occupied by the Google AV and made slight contact with the side of our vehicle. The Google AV sustained a small scrape to the front right fender and the other vehicle had a scrape on its left rear quarter panel. There were no injuries reported at the scene.

June 15, 2016: A Google prototype autonomous vehicle (Google AV) traveling Northbound in autonomous mode on Berkman Dr. in Austin, TX was rear-ended. The Google AV was stopped at a red light at E 51st Street for around one minute when the vehicle immediately behind the Google AV rolled forward and collided with the Google AV. The speed of the other vehicle at the time of the collision was approximately 3 mph. The Google AV sustained a minor scrape on its rear bumper. There was no visible damage to the other vehicle. There were no injuries reported at the scene.

WHAT WE'VE BEEN READING

- **Washington Post:** As a senior citizen, a self-driving car will be my godsend
- **San Jose Mercury-News:** Q&A: Google robot-car tester Stephanie Villegas
- **Fortune:** Who Will Build the Next Great Car Company?
- **Vox:** Don't worry, self-driving cars are likely to be better at ethics than we are
- **The Atlantic:** Your grandmother's driverless car