Google Self-Driving Car Project
Monthly Report

May 2015

We've made a lot of progress with our self-driving technology over the past six years, and we're still learning. Every day we head out onto public streets so we can keep challenging and refining our software. Here are some highlights from our recent testing; all metrics are as of June 3, 2015.

Activity Summary

Vehicles

- 23 Lexus RX450h SUVs – currently self-driving on public streets, mainly Mountain View, CA
- 9 prototypes – currently self-driving on closed test tracks

Miles driven since start of project in 2009

"Autonomous mode" means the software is driving the vehicle, and safety drivers are not touching the manual controls. "Manual mode" means the safety drivers are driving the car.

- Autonomous mode: 1,011,338 miles
- Manual mode: 796,250 miles
- We're currently averaging ~10,000 autonomous miles per week on public streets

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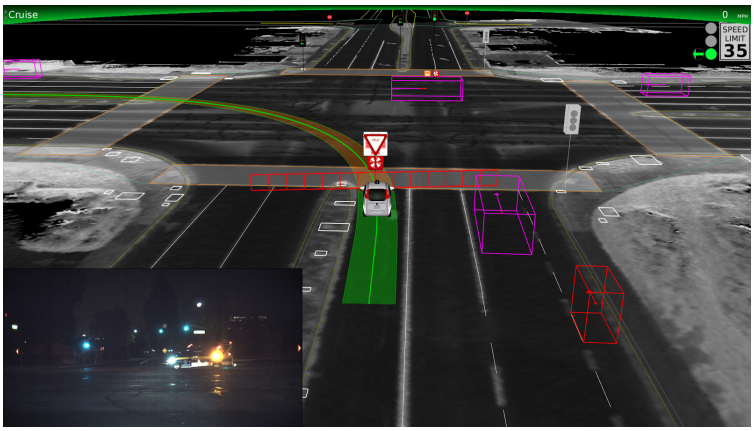
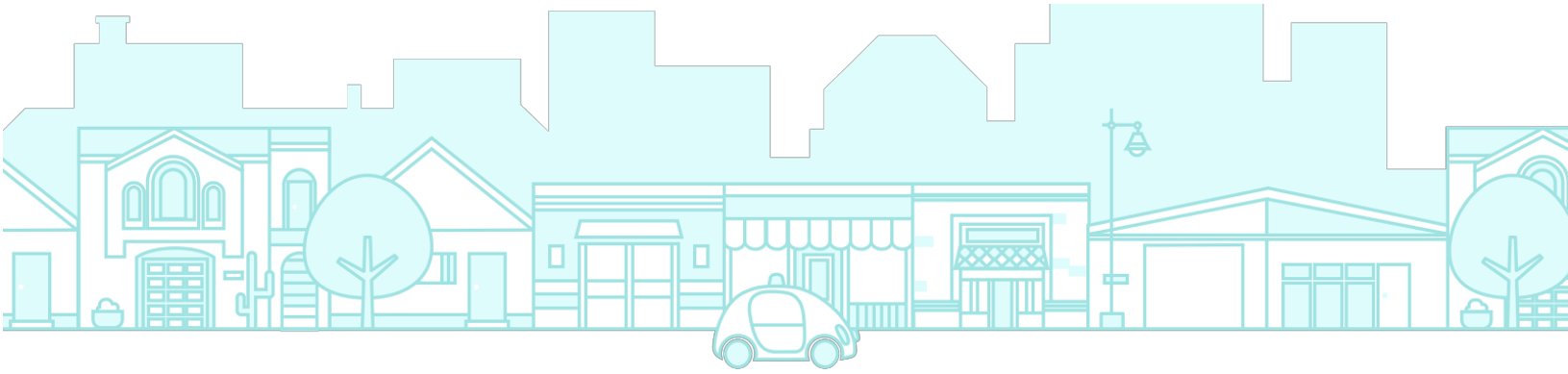
Scenes from the Street - *each month we'll give examples of everyday situations we encounter*

Responding to Emergency Vehicles. Our vehicles understand that emergency vehicles behave differently than ordinary trucks, cars, and motorcycles – and that we need to behave differently around them.



In this example, our car was stopped at a stoplight. Our light had turned green, but we detected an ambulance approaching from the right (the purple rectangle with two little red and white symbols on top), so we remained stopped as it passed through the intersection.



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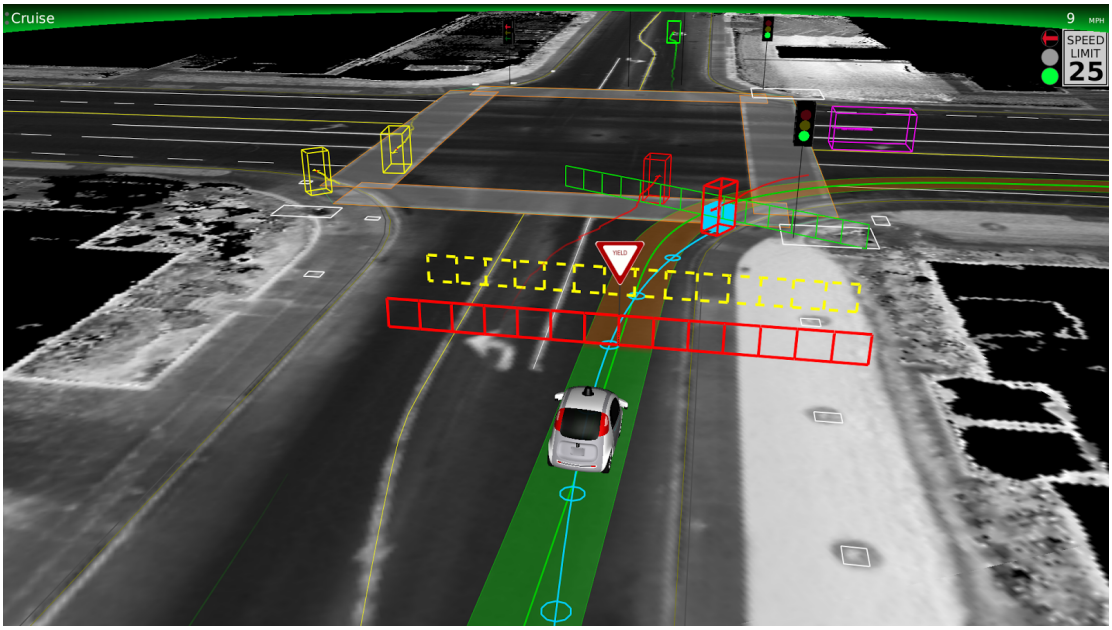
Interesting Situation of the Month. Self-driving cars are good at keeping track of multiple moving objects at once, even at night – skills that were on display in this situation involving two cyclists.



The two red rectangles are cyclists; the red trails behind them indicate the path they've just traveled. The cyclist on the left had entered the left turn lane, but veered back into our path to continue straight across the intersection. At the same time, the cyclist on the right entered the intersection, traveling against the flow of traffic. That cyclist then took a sudden left turn, coming directly at us in our lane. Our car was able to predict that cyclist's path of travel (turquoise line with circles) so we stopped and yielded. This happened at night, when it would have been very difficult for a human driver to see what was unfolding.

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Accidents

Given the time we're spending on busy streets, we'll inevitably be involved in accidents; sometimes it's impossible to overcome the realities of speed and distance. Thousands of minor accidents 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 the six years of our project, we've been involved in 12 minor accidents during more than 1.8 million miles of autonomous and manual driving combined. Not once was the self-driving car the cause of the accident.

(For this first report, we're including summaries of all accidents since the start of our project in 2009. In future monthly reports, we will provide info on accidents in that month.)

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2010

May: A Google Prius model autonomous vehicle (AV) operating in manual mode was involved in an accident on Central Expressway in Mountain View, CA. The Google AV was stopped at a traffic light at Ferguson Drive and was rear-ended by another vehicle. No injuries were reported at the scene. The Google AV sustained some damage.

2011

August: A Google Prius model AV operating in manual mode was involved in an accident on Charleston Road in Mountain View, CA. An employee operating the Google AV to run an errand (i.e., he was not using the vehicle to test our autonomous technology) rear-ended a vehicle that was stopped in traffic. No injuries were reported at the scene. The Google AV sustained some damage.

2012

October: A Google Prius model AV operating in autonomous mode was involved in an accident on Amphitheatre Parkway in Mountain View. The Google AV was stopped at a traffic light and was rear-ended by another vehicle. No injuries were reported at the scene. The Google AV sustained some damage.

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December: A Google Lexus model AV operating in manual mode was involved in an accident while driving on Highway 101S in Mountain View near the Moffett exit. The Google AV was driving past a disabled vehicle and emergency vehicles, which were stationary on the shoulder, when it was rear-ended by another vehicle traveling at approximately 20-25 MPH. No injuries were reported at the scene. The rear of the Google AV sustained some damage.

2013

March: A Google Lexus model AV operating in autonomous mode was involved in an accident while driving on highway 680S in San Jose. The Google AV was driving at 63 MPH when another vehicle traveling in the adjacent right hand lane veered into the side of the Google AV. At the time of impact, the test driver took immediate manual control of the Google AV via the steering wheel. No injuries were reported at the scene. The Google AV sustained some damage.

October: A Google Lexus model AV operating in manual mode on Rengstorff Avenue in Mountain View was involved in an accident. The Google AV was traveling at 2 MPH, gradually slowing to a stop at an intersection, when it was rear-ended by another vehicle. No injuries were reported at the scene. The Google AV sustained some damage.

2014

March: A Google Lexus model AV operating in autonomous mode traveling on Highway 101N near Belmont was involved in an accident. The Google AV was stopped in traffic when it was rear-ended by another vehicle. The vehicle that struck the Google AV was initially hit from behind by another vehicle. No injuries were reported at the scene. The Google AV sustained some damage.

July: A Google Lexus model AV operating in manual mode was involved in an accident on Phyllis Avenue in Mountain View. The Google AV was stopped on Phyllis Avenue waiting to make a right turn onto Grant Avenue when another vehicle struck the rear bumper of the Google AV. No injuries were reported at the scene. The Google AV sustained some damage.

2015

February: A Google Lexus model AV was travelling northbound on El Camino Real in autonomous mode when another vehicle travelling westbound on View Street failed to come to a stop at the stop sign at the intersection of El Camino and View Street. The other vehicle rolled through the stop sign and struck the right rear quarter panel and right rear wheel of the Google AV. Prior to the collision, the Google AV's autonomous technology began applying the brakes in response to its detection of the other vehicle's speed and trajectory. Just before the collision, the driver of the Google AV disengaged autonomous mode and took manual control of the vehicle in response to the application of the brakes

by the Google AV's autonomous technology. The Google AV was in manual mode. No injuries were reported at the scene. The Google AV sustained some damage.

April: A Google Lexus model AV was involved in an accident in Mountain View while travelling northbound on Castro St and making a right turn onto El Camino eastbound. The car was operating in autonomous mode at the time of the accident. The Google AV was travelling northbound in the rightmost lane of Castro St and came to a complete stop for a red light at the intersection of Castro St and El Camino Real. The Google AV then proceeded to make a right turn on red by creeping forward to obtain a better field of view of cross traffic on El Camino Real approaching from the left. While creeping forward, the Google AV detected a vehicle approaching eastbound on El Camino Real and came to a stop in order to yield to the approaching vehicle. The Google AV was just starting to move (<1 MPH) when the vehicle following immediately behind it, which was also attempting to make a right turn onto El Camino Real, failed to brake sufficiently and struck the Google AV's bumper at approximately 5 MPH. All occupants of both vehicles involved were uninjured in the collision. The Google AV sustained minimal body damage and the other vehicle sustained no visible body damage.

April: A Google Lexus model AV was stopped for a red light at an intersection of California Street and Shoreline Boulevard in Mountain View when another vehicle tried to pass from behind on the right side of the Google AV. The driver of the other vehicle slightly brushed one of the sensors on the Lexus AV with its driver side mirror. The Google AV was in autonomous mode. No injuries were reported at the scene, and there was no damage to either the sensor or either vehicles.

May: A Google Lexus model AV was travelling southbound on Shoreline Boulevard in Mountain View in autonomous mode and was stopped behind traffic at a red light at the intersection of Shoreline Boulevard and El Camino Real. A vehicle approaching from behind collided with the rear bumper and sensor of the Google AV. The approximate speed of the other vehicle at the time of impact was 1 MPH. There were no injuries reported at the scene by either party. The Google AV sustained minor damage to its rear sensor and bumper. There was no visible damage to the other vehicle.

What we've been reading

- The Atlantic CityLab, "Google's New Self-Driving Car Is About to Hit the Streets," May 2015
- San Jose Mercury News, "What It's Like to Ride In Google's Jittery New Robot Car," May 2015
- The New York Times, "Some People Do More Than Text While Driving," May 2015
- Wired, "Self-Driving Cars Are Legal, But Real Rules Would Be Nice," May 2015