To Drive Is Human

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Cornell University researchers offer an insider's perspective on the issues the DARPA Grand Challenge competitors faced in creating a humanlike driver—without the human.

We humans have been driving poorly for more than 100 years now; isn't it time we gave computers a turn at the wheel? In 2005, the Defense Advanced Research Projects Agency did just that, challenging teams across the country to build autonomous ground vehicles (AGVs) to race across 132 miles of unknown desert terrain—no humans allowed.[1] DARPA originally received 195 team registrations; 43 made it to the California Speedway semifinal, 23 pulled away from the starting line at Primm, Nevada, and five made it back in one piece.

As we watched the dust-covered robots triumphantly roll across the finish line, we couldn't help but appreciate the hard work that went into writing this latest chapter of man and machine. Given these accomplishments, however, it's natural to pose the question: Why don't we have robots that chauffeur us to work, taxi us home from the airport, or make that long drive to grandma's house?

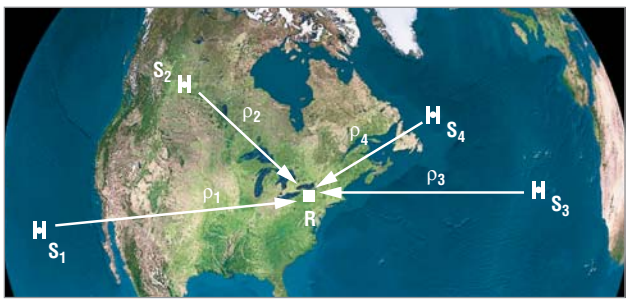

Figure 1. A GPS receiver R calculates its position by determining the range between itself and four or more satellite beacons. All Grand Challenge entries used a GPS receiver to partially solve the localization problem.

DRIVING FACTORS

The answer to that question lies not in the nuts and bolts that make up the Grand Challenge racers, but rather in what they're trying to replace: humans. We perform an enormous number of functions while driving, and a computer trying to match a human driver must face all of them. In preparing for the Grand Challenge, Cornell University's team divided the driving problem into three basic tasks:

- localization—knowing where you are,
- sensing—seeing what's around you, and
- path planning—determining how to get to a destination.[2,3]

At first glance, the list seems exhaustive: If you know where you are, you can see your path on the road, and if you know where you want to go, then you should be able to get there. However, a set of directions is useless if you don't know where you are or can't find the road, and being able to see the road isn't very helpful if there are no signs or maps to tell you where the road goes. Creating a vehicle capable of driving itself therefore required finding computational solutions to each of these three tasks.

Localization

The localization problem is at least well-defined, albeit not easy to solve. Regardless of the particular approach used by an AGV design team, the localization system must be able to represent the vehicle's position. All Grand Challenge teams partially solved the localization problem with a GPS receiver.

A GPS receiver calculates its position by determining the range between itself and four or more beacons—in this case, the network of GPS satellites orbiting about

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