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Stanford's robotic Audi to brave Pikes Peak without a driver

The Center for Automotive Research at Stanford has developed a new contender for the Pikes Peak course: a robotic car that drives itself.

BY CHRISTINE BLACKMAN

When the Pikes Peak race of Colorado Springs began in 1916, drivers ascended the dusty switchbacks hoping their car would not overheat or fall apart before reaching the 14,000-foot summit. This September, a new kind of car faces the peak: one without a driver.

A team of researchers at the Center for Automotive Research at Stanford (CARS) has filled the trunk of an Audi TTS with computers and GPS receivers, transforming it into a vehicle that drives itself. The car will attempt Pikes Peak without a driver at race speeds, something that's never been done.

The Stanford Racing Team won its first autonomous race in 2005 with Stanley, a car developed for the Grand Challenge held in the Mojave Desert by the Defense Advanced Research Projects Agency (DARPA). Their second car, Junior, took second place in DARPA'S 2007 Urban Challenge.

The Audi that will attempt Pikes Peak is named Shelley after Michèle Mouton, the first female driver to win the uphill climb. Unlike Stanley and Junior, who sense the road with radars and cameras, Shelley will follow a GPS trail from start to finish. The trick will be to stay on the road at race speeds while sliding around the corners.

L.A. Cicero

Shelley was named after Michele Mouton, the first woman to win the race up Pikes Peak.

Though not afraid of the engine overheating, Shelley's team, like the racers of the early 1900s, hopes their autonomous car will make it around the turns and up the mountain in one piece.

"Our first goal is to go up Pikes Peak at speeds resembling race speeds, keep the car stable around the corners and have everything work the way we want it to," said Chris Gerdes, program director of CARS and leader of the graduate research team. "We're not going to put it on the mountain until we can do it safely."

Shelley has reached speeds of 130 miles per hour without a driver on testing grounds at the Bonneville Salt Flats in Utah. At first glance, the car seems like a normal Audi, but a closer look reveals advanced computers, GPS antennae and a missing driver.

How the car drives herself

Shelley knows exactly where she is on the road by using a differential GPS. Unlike a standard GPS system, hers corrects for interference in the atmosphere, showing the car's position on the Earth with an accuracy of about 2 centimeters. Shelley measures her speed and acceleration with wheel-speed sensors and an accelerometer, and gets her bearings from gyroscopes, which control equilibrium and direction.

"The computer puts all this information together and then compares it to a digital map to figure out how close the car is to the path that we want it to take up Pikes Peak," Gerdes said.

Many control features already exist on the stock Audi. For example, the computers in Shelley's trunk will plug into the car's existing electric steering system. The car moves into action with stock automatic gear shifting and brakes with an active vacuum booster, a feature that normal cars use for emergency braking.

The researchers have programmed Shelley to

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handle like a racecar by using a set of computer calculations called algorithms. For example, as the car approaches a turn, it calculates a best guess on steering and acceleration. Audi's steering system normally responds to the steering wheel, but since there is no driver, it responds to algorithms that combine information such as the GPS path and inertial movement picked up from its sensors.

As the car approaches a corner, another set of calculations corrects the handling through the turn and prepares for what might happen next.

Graduate research team leader Chris Gerdes shows off the systems carried onboard the autonomous car, a modified Audi TTS.

High-speed hill climb

Other autonomous cars have crossed the finish line of the Rocky Mountain road, but only at about 25 miles per hour. The 12.4-mile paved and gravel track has 156 turns and a climb of 4,720 feet. An official contest for human drivers will take place in June this year, but Shelley will attempt a timed race in September, when she can get the track to herself.

"Our goal is to show that we can do this," Gerdes said. "There are some sheer drops at Pikes Peak in which any sort of self-preservation kicks in and you slow down a bit. We want to go up at the speed that few normal drivers would ever think of attempting."

The team has developed almost all of the algorithms needed to climb the hill successfully and will test them before trials at Pikes Peak. They have gathered data from the course with a similar car and have tested Shelley on comparable terrain, but not yet on large hills. If anything goes wrong on the summit, someone on the team can flip the "kill switch," Shelley's only remote control feature.

In addition to high-tech racing, research at Gerdes' Dynamic Design Lab may lead to safer cars that respond to human error. "We hope this project demonstrates that the technologies of stabilizing the car and helping the car stay in its lane will work with each other all the way up to the very limits of the vehicle."

CARS is funded by Volkswagen, Bosch, Honda, Toyota and Nissan.

Christine Blackman is a science-writing intern at the Stanford News Service.

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