# Car Without a Driver

By Abby Vogel

Photo: Gary Meek

Members of Georgia Tech's Sting Racing Team are shown with their vehicle, a modified Porsche Cayenne.

The blue Porsche Cayenne pulls up to a four-way intersection and stops. After it continues through the junction, it approaches a vehicle stopped in its lane. The Cayenne checks to make sure there are no cars approaching in the opposing lane, passes the stopped car and returns to its original lane.

This scene may not sound unusual, but this is no ordinary Porsche Cayenne – it thinks for itself and requires no driver. This autonomous vehicle was designed by Georgia Tech researchers in collaboration with Science Applications International Corporation (SAIC) for the Defense Advanced Research Projects Agency's (DARPA) Urban Challenge.

Georgia Tech's vehicle, named Sting 1, was among 35 vehicles that advanced to the National Qualifying Event held in October 2007 at the former George Air Force Base in Victorville, Calif. However, Sting 1 was not selected to compete in the final challenge.

"As a first-time entrant, the team has done an outstanding job making it to the semifinal round of the world's most challenging robotics competition," says Tucker Balch, team lead and associate professor in Georgia Tech's School of Interactive Computing in the College of Computing.

With six cameras, eight computers, Doppler radar and infrared laser radar on board, Sting 1 was designed to operate without any human intervention and obey California traffic laws while performing maneuvers such as merging into moving traffic, navigating traffic circles and avoiding moving obstacles.

The road to California began in the summer of 2006, when Georgia Tech and 88 other teams signed up to participate in the Urban Challenge.

"Georgia Tech didn't compete in the two previous Grand Challenges, but SAIC did," adds Balch. "Their experience helped us develop software that could have enabled a robot to place well in the previous challenges, and then we took it further with additional capabilities necessary for the Urban Challenge."

The Georgia Tech team, consisting of researchers in Georgia Tech's College of Computing and College of Engineering and the Georgia Tech Research Institute (GTRI), chose the Porsche Cayenne as their vehicle and in August 2006 began to install computers that would drive the car automatically.

Eight computers networked together through two high-speed networks were programmed to know the rules of the road. This included knowing how to stay in a lane, how to overtake another car, how to make turns in city traffic, how to maneuver the waiting patterns at an intersection, how to merge into traffic and how to behave in a parking lot.

According to the racing team, the car really had to think for itself. "The car needed to detect obstacles in its path and then plan and execute a different route around the obstacles," says Tom Collins, electronics lead and GTRI principal research engineer.

SAIC engineers developed methods for visual lane detection and tracking. On unpaved dirt roads, the colors of the road and non-road areas were modeled to identify a path, adapting over time as lighting or surface colors changed. On marked paved roads, a camera kept the car in its lane by detecting the typical white and yellow lines that mark a driving lane. If the vision system was unable to find a lane, the car used lasers to follow the curb. Ten laser range finders sent out infrared laser beams that constantly scanned to provide Sting 1 with an accurate measurement of the distance to any objects, such as curbs and other cars.

At intersections, the team used laser and radar sensors to see other waiting or approaching vehicles. Six off-the-shelf Doppler radar systems used to detect moving objects allowed the car to see as far as two football fields away in all directions. Cameras helped guide the car through the intersections and onto new roadways.

"We had to guarantee that there was at least a 10-second window that would allow us to pull out onto a road, accelerate and get up to a reasonable speed without cutting someone off," notes Henrik Christensen, principal investigator for the team and director of Georgia Tech's Robotics and Intelligent Machines Center.

The Urban Challenge is the third in a series of DARPA-sponsored competitions to foster the development of robotic ground vehicle technology without a human operator, designed for use on the battlefield.

Georgia Tech researchers are already thinking about life after the Urban Challenge.

"We've already talked about expanding this work to other areas," says Vince Camp, hardware lead and GTRI senior research engineer. "We're looking forward to using the technologies in applications such as autonomous lane striping for the Georgia Department of Transportation."

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