Embedded electronics steer autonomous cars through dangerous tasks

By Hermann Strass

Tackling the inner city and rural terrain

Fourteen teams from several European countries participated in various urban and non-urban settings at the Civilian European Land Robot Trial (C-ELROB) August 13-16 near Monte Ceneri, Ticino, in Switzerland. The teams' vehicles were autonomous or remote controlled, some in combination with Unmanned Aerial Vehicle (UAV) support from above.

Civilian elrob 2007

In the first scenario at a non-urban setting, vehicles had to follow a predefined route and locate targets at certain points of interest. Heavy rainfall made this task especially challenging. Telerob, a German team, won this part of the trial with a remote-controlled robot that normally searches for explosives in buses, aircraft, or railway cars. Figure 1, courtesy of the University of Wuerzburg, Germany, shows the University of Wuerzburg team's vehicle, which finished third in the non-urban scenario.

Figure 1

In the second scenario located at an urban setting, vehicles had to search for and identify objects located around and inside buildings at a crowded marketplace. The third scenario involved a combined unmanned ground and air vehicle operation that included fire incidents and a search for nuclear, biological, and chemical materials. The fourth scenario challenged vehicles to perform autonomous reconnaissance, such as security patrolling, on urban and non-urban routes. Figure 2, courtesy of the University of Siegen, Germany, pictures the automatic cameras mounted on the University of Siegen team's vehicle (AMOR), which won the automatic reconnaissance scenario.

Figure 2

Image processing guides the way

C-ELROB is a capability trial, not a contest, and winners do not receive any financial reward. The purpose of this particular C-ELROB trial was finding out how to drive a vehicle autonomously.

Some of the ELROB tests involve a distance of 8 km (5 miles), which is very short compared to the U.S. DoD Advanced Research Projects Agency (DARPA) Grand Challenge, in which autonomous ground vehicles attempted to travel a distance of more than 200 km (120 miles) in the Mojave Desert. ELROB is extremely demanding because it simulates an emergency mission, including the assumption that satellite navigation is not available. Consequently, GPS systems are not used during the contest. Vehicles have to find their way mainly through image processing. Using sensors and embedded electronics, vehicles must identify obstacles such as trees, rocks, and human beings as well as read road signs to reach their destination, not unlike how humans drive cars by looking at the road, road signs, and other cars in their way.

On the first day, the ELROB teams tested a combined flying (UAV) and driving robot. The UAV guided an unmanned car robot driving on difficult mountainous countryside. The team from the University of Bremen, Germany, was the only group to finish this scenario. Teams from the University of Oulu, Finland, and Chemnitz University of Technology, Germany, had to bow out because of damage to equipment. Figure 3 (next page), courtesy of AirRobot, Germany, shows an AirRobot UAV supporting the University of Bremen team's autonomous vehicle. Figure 4 (next page), courtesy of the University of Oulu, displays the Finnish vehicle approaching a mud hole after heavy rains in the Swiss Alps.

One of the contestants, a team from the University of the Federal Armed Forces in Munich, used a Volkswagen Tuareg (MuCAR-3), the same type of vehicle that won the 2005 DARPA Grand Challenge. They completed the run in the fastest time. Other

competitors were slower but more precise in finding objects along the route. MuCAR-3's camera and Light Detection and Ranging (LIDAR) images were processed into 3D images using three computers. At 10 rpm, the LIDAR system provided 1 million pixels per second (about 10 Mbps). The vehicle had to be driven manually across some critical intersections; however, the team managed to drive 90 percent of the distance autonomously.

Difficulties to overcome

A group of Polish contenders called *Team Robotics Inventions* encountered a typical European problem. Team members were held up by customs and arrived two days late, too little time to get their equipment in good working condition. Another European dilemma is funding the trial. DARPA sponsors the Grand Challenge with several million dollars in pre-challenge support and prize money. The ELROB organizing team had a budget of € 3,000 (U.S. $2,300). Though these two events have similar challenges, the mountain forest terrain in the Swiss Alps is more difficult to manage than the Nevada desert.

Figure 3

Figure 4

One important observation during this trial was the fact that dirt or water drops on camera lenses can render an autonomous vehicle almost useless. Windshield wipers or blowers are needed to keep the lenses clean. Backup cameras also help. Sensors and algorithms must be improved further before the technology can be used in private cars on public roads. Experts are forecasting that we can expect to see some of this technology on public roads 15-20 years from now.

For more information, contact Hermann at hstrass@opensystems-publishing.com.