TTControl designs to link unmanned system with victory

TTTech and its subsidiary **TTControl** are part of the Red Team working with **Carnegie Mellon University** (CMU) on the build of an autonomous vehicle for the 2005 **DARPA** Grand Challenge desert race between Los Angeles and Las Vegas. Last month, DARPA evaluators arrived in Pittsburgh, PA, to test whether CMU's H1ghlander—built on a 1999 Hummer chassis donated by **AM General**—had the skills to compete in the 175-mi (282-km) challenge through natural and man-made obstacles that will be part of a "hostile desert terrain" to include mountains, gullies, and dry lakebeds.

According to CMU, DARPA is in the process of evaluating 118 teams, only 40 of which will advance to the next level of competition that will begin in September prior to the October 8 Grand Challenge. At press time, DARPA had not made public its determination on the H1ghlander's worthiness.

However, CMU's plan is to have two pieces of equipment at the starting line of the race, and "one in the winner's circle." Last year, no one was quite that lucky since none of the vehicles finished the race, although CMU's Sandstorm robotic vehicle traveled the farthest and fastest. The winning vehicle this year will be the one that finishes the designated route—which will not be revealed until two hours before the race begins—the fastest within 10 hours.

Good communication is an important part of any winning team, and in the Red Team's case, TTControl has a lot to say about it. Autonomous racing is no easy task. It requires several functions to real-time communication and diagnostics, which is difficult to meet with conventional distributed architectures. To help achieve such requirements, TTControl, a supplier of both event-triggered (CAN) and time-triggered communication systems in the form of its patented Time-Triggered Protocol (TTP), is providing the team with a time-triggered communication network that consists of four multi-purpose control units.

DARPA's 2005 Grand Challenge is a field test through the desert intended to accelerate research and development of autonomous ground vehicles. Carnegie Mellon University (CMU) has high hopes that its H1ghlander, shown during its first attempt at navigating in heavy snow, will win the competition and the $2 million purse.

The H1ghlander maps terrain with seven laser range scanners, one of which is a Riegl scanner that is pointed and stabilized by a three-axis gimbal. Stereo cameras also ride aboard the gimbal, which is protected by a lightweight carbon fiber dome (shown).

All TTControl hardware units have been specifically designed to work under rough conditions, with strong vibrations, in a wide range of temperatures, and under the influence of humidity and water. CMU chose TTTech and TTControl hardware for the integration of a time-triggered by-wire system with other components on the vehicle.

One of many computers in the vehicle, the H1ghlander's active suspension computer modifies the fluid level in the struts to keep the vehicle level and stable.

Three TTC 200 control units will be used to regulate the parking brake, throttle, and transmission, and one TTP-By-Wire-Box will control the H1ghlander's service brake. In addition to the control units, the integrated software suite TTP-Tools is being used by the Red Team as the development and production environment for the design and integration of the time-triggered by-wire system with other components.

Some of those components include electronics from **Caterpillar** to control the speed, regulate tire pressure, govern steering, and communicate with navigation computers. Cat's MorElectric system will generate and distribute power to computers, sensors, and actuators. Ontario-based **Applanix**, a wholly owned subsidiary of **Trimble**, is supplying technology that will estimate the vehicle's location by combining inertial, GPS, and odometry data. Data communication will be based on TTP, which supports very high data rates and fulfills the requirements of hard, real-time systems. One of the primary benefits of TTP is that system extensions or modifications do not require a system-wide retesting.

All those components and others, including seven **Intel** Pentium M computers and one 64-bit Itanium 2, must work together to autonomously sense and drive the H1ghlander around hazards, and to victory. Terrain is mapped with seven laser range scanners, four stereo cameras, and two radar sensors. Some of these are mounted on a gimbal, which operates "like an animal's neck" to stabilize and point the sensors. The gimbal is a collaborative development with Red Team sponsors **HD Systems**, **Phillips**, and **KVH**. **Google**, **Boeing**, and **SAIC** are also among the team's sponsors.

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