The TerraMax Autonomous Vehicle

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Summary. The TerraMax vehicle is based on Oshkosh Truck’s Medium Tactical Vehicle Replacement (MTVR) truck platform and was one of the 5 vehicles able to successfully reach the finish line of the 132 miles DARPA Grand Challenge desert race. Due to its size (30,000 pounds, 27'-0" long, 8'-4" wide, and 8'-7" high) and the narrow passages, TerraMax had to travel slowly, but its capabilities demonstrated the maturity of the overall system. Rockwell Collins developed, integrated, and installed the intelligent Vehicle Management System (iVMS), which includes vehicle sensor management, navigation, and vehicle control systems. The University of Parma provided the vehicle’s vision system, while Oshkosh Truck Corp. provided project management, system integration, low level controls hardware, modeling and simulation support and the vehicle.

4.1 Introduction

TerraMax\(\text{TM}\), a completely autonomous vehicle, was developed by Oshkosh Truck Corporation in cooperation with its partners Rockwell Collins and University of Parma in response to Congress’ goal that one third of military vehicles be unmanned by 2015. The Oshkosh TerraMax\(\text{TM}\) was one of only five vehicles that successfully completed the 132-mile DARPA Grand Challenge course in October 2005 (5th place), and it was the only vehicle whose mission is to provide medium- to heavy-payload logistic support to the battlefield. During the race, the fully-autonomous vehicle was successful in demonstrating obstacle avoidance, negotiating tunnels, narrow roads and cliffs, GPS waypoint following and 28 hours of non-stop continuous operation - all applicable to military missions.

4.2 The Vehicle

The TerraMax vehicle shown in Figure 4.1 is based on Oshkosh’s Medium Tactical Vehicle Replacement (MTVR) MK23 truck platform. The MTVR was designed with a 70% off-road mission profile. It can carry a 7-ton payload off-road or a 15-ton payload on-road. All-wheel drive, TAK-4\(\text{TM}\) independent suspension, and central tire inflation make rocks, dips, holes and crevasses easier to handle.
And the truck can handle 60% grades and 30% side slopes. A 425-hp Cat C-12 engine powers the truck. This kind of vehicle was chosen for the DARPA Grand Challenge (DGC) because of its proven off-road mobility, as well as for its direct applicability to potential future autonomous missions. The TerraMax team participated also to the 2004 DARPA Grand Challenge (Ozguner et al., 2004) with the same vehicle. Two significant vehicle upgrades for the 2005 DGC were the addition of rear-wheel steering and integrated sensor structure/roll cage. Rear steer has been added to TerraMax to give it a tighter 29-foot turning radius. Although this allows the vehicle to negotiate tighter turns without needing frequent back ups, the back up maneuver is required to align the vehicle with narrow passages. The sensor mounting structure/roll cage provided added protection to the sensors as well as key vehicle components.

4.2.1 Autonomous System Integration

The Autonomous System consists of Computers, Communication Network, Sensors, Vehicle Control Interface and the supporting mounting and protection structures. The Autonomous System utilized in the 2004 DGC was completely removed and upgraded for the 2005 DGC.