GNIUS
Unmanned Ground Systems

Ronin

DRIVEN BY INNOVATION

Ronin Autonomous Robotic Vehicle for Urban Missions

DARPA Urban Challenge 2007 - Technical Demonstration Program

Technology

The Need

Meeting the behavioral requirements of autonomous vehicles in the urban environment requires an enormous leap in the capabilities of the autonomous vehicle.
Not only that the vehicle is required to precisely travel in narrow lanes, using sparse and incomplete mapping information and intermittently perceptible GPS signal, but it also has to deal with a highly dense & dynamic environment.
Although every robot is supposed to comply with certain well-defined traffic and behavioral rules, the interpretation of these rules and their implementation in algorithms, software and sensors is highly uncertain and one should expect to encounter a highly stochastic "game" in which a large number of unpredictable events interact with each other.
This scenario dictates that the design of the autonomous vehicle should have a robust set of rules spanning as many envisioned situations as possible and sound decision-making logic. Any decision-making system can only be as good as its source of information. In the case of the autonomous vehicle the source of information comes from the vision sensors.

System Description

Vehicle

The vehicle is a commercial SUV, Jeep Wrangler Unlimited 4 wheel-drive, Engine: 3.8 Liter, 6V SMPI Engine, 4 speed automatic transmission meeting DARPA definitions.

Vehicle Control

The concept of the control system of the vehicle is based on a hierarchical control system with three levels:
1. Low Level Control (LLC) which is used to activate the various vehicle actuators
2. Medium Level Control (MLC) or auto-driver control. Its task is to regulate the desired speed and rate of turn while maintaining the vehicle dynamic stability.
3. High Level Control (HLC). It is used to guide the vehicle along the desired path by translating the vehicle's deviations from the desired route into speed and rate of turn commands.

Navigation

For navigation the vehicle uses an INS coupled with a DGPS receiver, via a centralized Kalman filter implementing a closed-loop error compensation. Magnetic compass and odometer data are used as the main source for aiding the INS during intermittent DGPS outages.
To further improve accuracy, a SLAM type of aiding method is employed.

Obstacle Detection and Avoidance Module

The Obstacle Detection and avoidance Module (ODM) is used for detection of unexpected obstacles in the vehicle's driving path and to plan the close proximity avoidance path.

Vision Sensors

The system was designed to provide all weather sensing and driving capabilities. To achieve this, a suite of sensors are employed. The sensors used are fixed laser line scanners, rotating laser scanners, MMW radars and video cameras.

Path Finder Module (PFM)

The Path Finder Module (PFM), and computes the nominal route for the mission at the start of the mission and in any other case when the vehicle can't continue along the planned route.

Autonomous Decision-Making Module (ADM)

The Decision-Making Module is a real-time computing algorithm that supports autonomic decision-making using information that is coming from several sources. Static information such as: type of route and lanes, drive rules and Dynamic information such as: Obstacles in driving lane, oncoming vehicles, etc.

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GNIUS Unmanned Ground Systems
An IAI & Elbit Systems Company

e-mail: marketing@g-nius.co.il • www.g-nius.co.il