Team Caltech in the DARPA Grand Challenge

Improvements on the arbiter

Henrik Kjellander (Lund Institute of Technology, Sweden)

Introduction

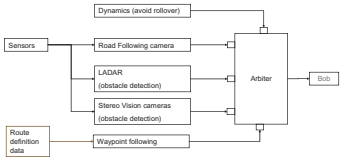
In 2002 DARPA (The Defense Advanced Research Projects Agency) announced a race for autonomous vehicles would be held in March 2004. The course was from LA to Las Vegas and there was a $1 million cash prize for the winner. From Caltech a team driven by students applied for the race. One year of hard work resulted in a fully autonomous vehicle that ended up #5. No one completed the course and another race has been announced for October 2005.

Arbiter

This project is about software research in new techniques about how to decide which direction the vehicle shall go, depending on sensor data. A module called the arbiter makes these decisions. The project consisted of four parts:

1. integrating simulation tools for testing
2. redesign and documentation of old code
3. experiments with a genetic algorithm
4. assisting in system administration

Planning architecture (simplified)



Modules sends “votes” to the arbiter, which decides where to go

Simulation

An open source robot simulation engine, originally developed at USC, called Player/Gazebo was integrated to the current path planning software suite. Player is an interface that is meant to either connect to real hardware or the simulation engine, called Gazebo. This way the planning software is unaware of the lower level details and this way testing becomes alot easier. Gazebo can simulate many different devices, like stereo vision camers, laser radar, GPS etc.

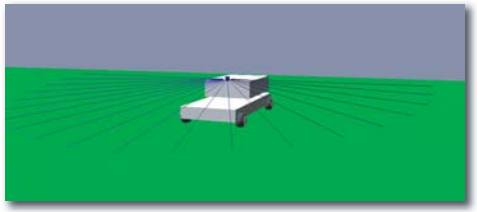
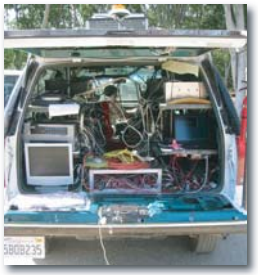
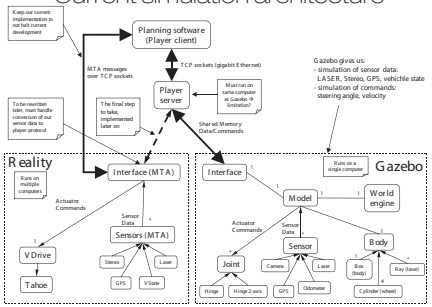


Image from Player/Gazebo. The blue lines are a way to display simualted laser radar beams



Rear view of Bob. Alot of computers and cables!

Current simulation architecture



Simulation architecture. The dashed arrow is not implemented yet but might be as a future project for full transparency.

Research

Although most of the time of the project was spent on getting into the system, integrating the simulation environment and administrative tasks, new research was also performed. The arbiter has weights which decides how much it shall listen to the different voters (sensor modules). By recording the behaviour of a human driver driving in terrain and postprocessing the data with a genetic algorithm, we will get weights that imitates the human driver.

Experiments / Results

During the field test, lack of time, hardware- and software failures limited the possiblity to collect enough data, so another try will be performed during the next field test. Not until this data has been retrieved, can any useful results can be presented.

Future work

Another idea proposed in the project, was develpment of mode management that makes the vehicle react differently depending on which kind of environment it is in. Lack of time made this objective impossible to achieve.

Participants in Team Caltech at the summer’s first field test at El Mirage.

Contact / Information

Author

Henrik Kjellander
Computer Science student
Lund Institute of Technology, Sweden
kjelland@caltech.edu

Mentor

Prof. Richard M. Murray
Caltech
murray@caltech.edu

Team Caltech website

http://team.caltech.edu

Platforms

Bob - a Chevy Tahoe

The original competitor in the first DARPA Grand Challenge race was Bob. Built during a whole year almost entirely by students he made a good 5th position in the race.

Homer - a Go-Kart/ATV

Bob is a large vehicle and also not street legal. This makes it very clumsy to use for testing and collecting of sensor data. For this purpose Homer was created.

Peggy - an RC-car

For simple waypoint following with GPS signals, a RC-car was customized for that purpose.

Bob, the vehicle that ran for Team Caltech in the first DARPA race.

Homer, our new sensor testbed. Easy to drive around at campus collecting sensor data.

Peggy, a small RC-car created for testing mainly waypoint following using GPS-signals.