DARPA Urban Challenge on Autonomous Driving

Prof. Raj Rajkumar
ECE and CS
raj@ece.cmu.edu
http://www.ece.cmu.edu/~raj

DARPA Grand Challenges

DARPA Grand Challenge I
Barstow to Primm
March 13, 2004
142 miles
10 hours

DARPA Grand Challenge II
Desert Classic
October 8, 2005
132 miles
10 hours

DARPA Grand Challenge III
Urban Challenge
November 3, 2007
60 miles
6 hours
Prizes & Tracks

• First Place: $2,000,000 (if Congress authorizes)
• Second: $500,000 (if authorized)
• Third: $250,000 (if authorized)

• **Track A**: Receive up to $1 million technology development funds. Program ends at end of National Qualifying Event (NQE). Successful qualifiers invited to compete in final event.

• **Track B**: Submit application, send video, get selected for DARPA site visit. Teams that succeed at the site visit receive $50,000 to participate in NQE. Teams that succeed at NQE receive $100,000 to participate in final event and compete in final event.

A 2005 GC Site Visit

Test Course
- 8 meters wide
- 200 meters long
- 11 gates
- Obstacles
National Qualifying Event

California Speedway, Ontario, CA
September 27 – October 5, 2005

The 2005 GC Course

Length: 2.2 - 2.7 Miles

Narrow Underpass
Lake Beds
Rough Roads

Long Tunnels
Narrow Gates
Close Obstacles

Start/Finish

131.6 mi
Beer Bottle Run – 123 miles into course

2005 GC Results

<table>
<thead>
<tr>
<th>ID</th>
<th>Team</th>
<th>Time</th>
<th>Distance</th>
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<tbody>
<tr>
<td>3</td>
<td>Stanford Racing Team</td>
<td>6:11.53</td>
<td>131.70</td>
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<td>9</td>
<td>Red Team</td>
<td>7:14.70</td>
<td>131.70</td>
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<tr>
<td>10</td>
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<td>Gray Tech</td>
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<td>Team Tor Max</td>
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<td>Team ENDEC</td>
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<td>The Student Surge / UCLA</td>
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2004 Distance
2007 DARPA Urban Challenge

Autonomous Driving Within City Limits
- Obey traffic laws
- Safe entry into traffic flow
- Safe passage through busy intersections
- Safe following or passage of moving vehicles
- Safe passage of a stopped vehicle
- Drive an alternate route when the primary route is blocked
- Safe U-turn (3-point turn)

Competition

Urban Route Network

All vehicles on the course together, completing equivalent missions by visiting checkpoints.
The “Easy” Case

Road Markings

Other Cases

Excessive delay (> 10 secs) in making progress will be penalized.
The “Difficult” Case

- Unmarked
- Obstacles
- Moving traffic

It’s NOT a Demo
Summary of Challenges

Technical Challenges
• Mission planning
  – Sequence of missions
• Situational awareness
  and vehicle behaviors
  – Excessive aggression vs. caution
• Perception and multi-sensor fusion
• Real-time actuator control

System Challenges
• Develop and integrate multiple technologies
• It’s real
  – Things will go wrong
• Have multiple groups and cultures work together productively
• Do it all in 15 months

DARPA Urban Challenge and CMU
• CMU and General Motors have submitted a Track A team proposal
• Participants:
  – CMU Robotics Institute researchers
  – General Motors R&D
  – GM-CMU Collaborative Research Lab
• Other sponsors are currently being solicited
  – Google, CAT, …