Robot Soccer Autonomous Car

Learning Agents Research Group
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May 02, 2012

RoboCup

- One of the largest annual robotics competition in the world
- Started in 1997.
- Goal:
  - *"By mid-21st century, a team of fully autonomous humanoid robot soccer players shall win the soccer game, complying with the official rule of the FIFA, against the winner of the most recent World Cup"*
- 8-11 different leagues:
  - We participate in the standard platform and 3d simulation leagues.

Robot Soccer

Aldebaran Nao

Aldebaran Nao (http://www.aldebaran-robotics.com/)

About the Nao

- 58 cm high
- 21 degrees of freedom (25 if you have articulated hands)
- 1 GHz Single Core Atom processor
- Sensing: 2 cameras, sonar, gyros, accelerometers, FSRS on the feet, proprioception
- Pros: Pretty cheap ($4000 per robot for the RoboCup edition)
- Cons: Certainly not the best humanoids around.

AustinVilla Robot Soccer Team

Todd Hester
Samuel Barrett
Katie Genter
Jacob Menashe
Yuchen He
Piyush Khandelwal
Peter Stone

Mohan Sridharan
Michael Quinlan

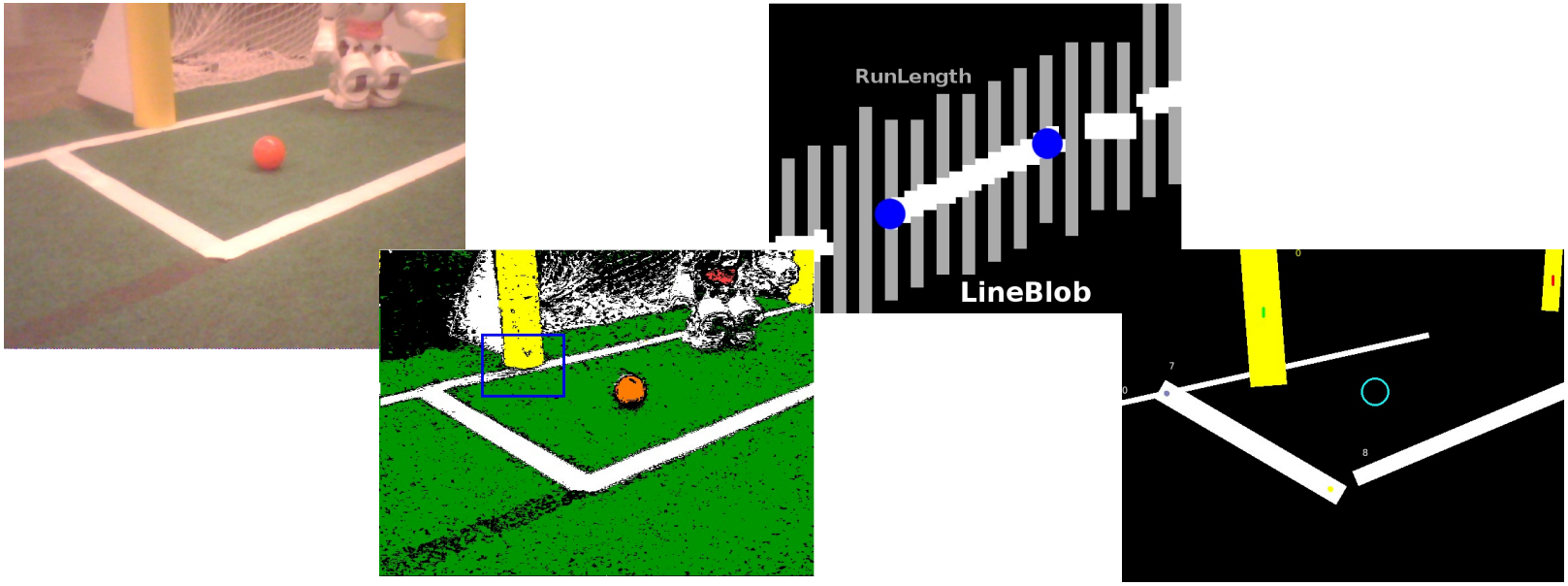
Challenges

Main problems we try and solve:

- Perception - Vision/Sonar
- State Estimatation - Markov Localization
- Motion - Kicks/Walk
- Software Architecture

Perception

- Earlier in this group there was a presentation on the general object detection pipeline through vision. *Too computationally intensive for us.*
- We use color segmentation and scan-line based approaches to detect lines.



Localization

- Absolutely necessary to know your own position in the field
- Based on the locations of lines, goal posts and the center circle we try and maintain an estimate of our own position

Two main methods for Markov Localization:

- Monte Carlo Localization (Particle Filters)
- Multi-Modal Extended Kalman Filter

Particle Filter Localization

Localization

- 2012 will be a challenging year for localization
  - Both goals are yellow - all landmarks are symmetric
- We now have a "fancy" multi-modal Kalman filter shared between all team-mates
  - Allows a lost team-mate to relocalize
  - Also causes a lost team-mate to confuse other players

Motion

- We can provide joint angles to the robot to be executed at a particular time.
- These commands are executed using PID controllers.
- Most challenging task for us - mostly our lack of expertise and ability to filter poor sensor data.
- The Germans do this extremely well.

Those Germans!!

This year

- RoboCup in mid June in Mexico City
- We have given up on trying to develop our own walk, but are using a walk available through a public code-release.

Simulation League

The UT team won the 2011 competition scoring a total of 136 goals and 0 goals against. The goalie did not touch the ball once during the competition.

Patrick MacAlpine
Adrian Lopez-Mobilia
Nick Collins
Peter Stone

Daniel Urieli
Shivaram Kalyanakrishnan
Yinon Bentor

DARPA Urban Challenge

Grand Challenge History

DGC I

Barstow to Primm

March 13, 2004

142 miles, 10 hours
$1M; no winner
Best result 7 miles (CMU)

DGC II

Desert Classic

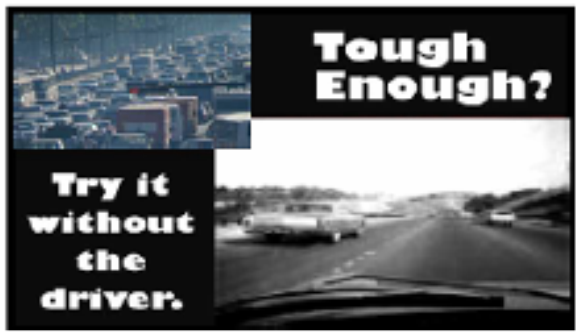
October 8, 2005

132 miles, 10 hours
195 contestants
5 finishers
$2M Stanford wins

DGC III

Urban Challenge

November 3, 2007



60 miles, 6 hours
89 contestants
$2.75M (1st, 2nd, 3rd)

Previous Challengers

Even the top teams had problems...

H1ghlander

September 19, 2005

7 days before National Qualification Event

DARPA Urban Challenge overview

Program Objective

Safe autonomous driving in traffic

- Safe
  No collisions
- Capable
  Turns, stops, intersection, passing, merging, parking, following
- Robust
  Blocked roads, erratic drivers, sparse waypoints, GPS outage

Austin Robot Technology (ART)

- Group of local hobbyists
  - Built the car for the 2005 Grand Challenge
    - Made it to the semi-finals that year
  - They own the car.
    - So listen to them if they are around
- Team members:
  - Arturo Martin-de-Nicolas founder
  - Juan Martin-de-Nicolas mechanic / fix-it guy
  - Don McCauley electronics and computers
  - Jack O'Quin low-level/high-level software and testing
  - Jorge Martin-de-Nicolas - low-level software
  - Others: Jon Brogdon, Dave Tuttle etc.
- In 2007, the CS378 class (led by Prof. Peter Stone) joined the ART team, several of which attended the national event.

Marvin


austinrobot.com
The answer is 42!
42
AMD
64
Opteron
University of Texas
UTCS
Computer Sciences
Austin Robot Technolo
42

Specific Challenges in Urban Driving

- Need to sense far ahead in order to safely navigate at 30 mph
- Need to detect static and dynamic obstacles around vehicle
  - Ignore (mostly) approaching vehicles in other lanes
- Need to obey traffic laws, re-plan at road blocks

2007 Results: First steps

- 89 teams were accepted in 2006
- Site Visit (Basic navigation and intersection management; no moving traffic)
  - Track A teams automatically got site visit
  - Track B teams (including us) had to submit video of the vehicle autonomously driving a loop and passing a stalled vehicle (class goal for cs378 in Spring 2007)
- 35 teams passed site visit
  - ART was one of those teams
  - Much of the ART code was created by the juniors/seniors in cs378

2007 Results: National Qualifying Event

- After Site Visit, most code above the driver level was re-written
  - 3 months
- 35 teams at NQE
  - Decommissioned Air Force base in Victorville, CA
  - 3 test areas
    - Merging into and across moving traffic
    - Long term navigation/parking/gauntlet
    - Site visit style test
- 20 teams were supposed to make the final
  - Only 11 teams ended up in final
    - We placed somewhere between 12th and 21st.

NQE Team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DARPA
URBAN
CHALLENGE

Videos

- On-board video compilation from our vehicle
  - http://www.youtube.com/watch?v=sHbdr3LAEfg

Next Challenge

- There is not another planned DARPA competition.
  - The MAGIC (Multi Autonomous Ground-robotic International Challenge) Competition in 2010 was close to the scale of the DARPA Grand Challenges.
- The 2007 Urban Challenge was a big step forward, but . . .
  - No pedestrians
  - Final race much easier than NQE events
  - Teams still rely heavily on expensive computing/sensing capabilities
  - Vehicles that work 9/10 times are not good enough
- We now do research outside of the DARPA competitions through the FRI stream