Electric Chair Automatic Navigation with Spoken Commands, Laser Range Finders and Obstacle Avoidance

Adalberto Llarena, Ph.D

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Summary

• Introduction
• Project Goals
• Time Schedule
• Current Research
• Next Activities
Introduction

Adalberto Hernandez Llarena

1985 – First programming experiences. Sigma Commodore 64.
1989 – Professor of Computing Lectures, ENP8 UNAM (High-School, at the age of 18).
1992 – Supercomputing Scholarship. VAX, CRAY-YMP, SGI.
1994 – 1996 Junior Programmer at BITAL Bank
1997 – Own Company, Inter@tivos. Software Development.
2003 – Graduated as Computer Engineer, UNAM. Avg. 9.20
2003 – Start of Master Studies in Computer Engineering UNAM Biorobotics-Laboratory UNAM. Tutor: Dr. Jesus Savage.
Introduction
Adalberto Hernandez Llarena

2003 – 2005 Small-Size Robocup Team Coordination UNAM.
   (2nd Place Mexican Robotic Tournament, 2006).
2005 – Assistant Professor at Biorobotics Lab, UNAM.
   Honorific Mention.
2005 – 2007: Robocup@Home Team Coordination UNAM.
   (1st Place TMR 2005, 6th Place RCP Bremen 2006,
    3rd Place RCP Atlanta 2007)
2007 – 2012: Humanoid Robocup Team Coordination UNAM.
   (2nd – TMR’08, 3rd – TMR’09, 2nd – TMR’10,
    3rd – TMR’12, 1st – FIRA’ 12, 1st – IRC’12 in P.K.)
2011 – Assistant Professor at IIMAS, UNAM.
2012, - Ph.D in Computer Engineering. National Autonomous
   University of Mexico UNAM, Honorific Mention.
Publications


Adalberto LLarena, Boris Escalante, Luis Torres, Verónica Abad, Lauro Vázquez, Rafael Sobrevilla, Virbot@field: taking service robots to play soccer, Team description paper of Pumas-UNAM team, for the Robocup 2008 humanoid league.


ViRbot, Atlanta 2007

Real Environment
- Robot’s Internal Conditions
- Robot’s Tasks

Virtual Environment
- Sensors
- Perception
- World Model
- Goal Activation: Global Goals, Local Goals
- Planner: Global Plans, Locals Plans
- Navigator
- Pilot
- Control Algorithms
- Mobile Robot
- Virtual Robot

Hardwired solutions

Simulator
- Human/Robot Interface
- Cartographer

Knowledge Representation
- Learning
Navigation
Ph.D in SLAM
AliveBot

Autonomous Wheelchair

Adalberto Llarena

FU-Berlin’12

Freie Universität Berlin

Post-doctoral Research
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Main Objective

• Develop an autonomous electric chair capable of navigating in indoor environments by using spoken commands.
Goals

- Build a representation of an unknown environment.
- Assign semantic “labels” regions.
- Basic action vocabulary. “please take me to the kitchen” or “go to the bathroom”.
- Plan a trajectory and avoid unexpected obstacles.
- Send messages through the Internet.
Physical Devices

Otto Bock XENO electric wheelchair

- MS Kinect Sensor for People detection.
- Joystick control. Five gears. Up to 10 Km/h.
- 270-degree SICK S300 laser range finders. (2)
- Internal encoders for motion and current heading estimation.
- CAN-Bus protocol for robust communications.
Main Challenges

• Strict Real-Time data acquisition and wheelchair control.

• Motion constrains imposed by the chair (dimensions, center of rotation, ability for turning, etc.)
Main Challenges

• Strict Real-Time data acquisition and wheelchair control.

• Motion constrains imposed by the chair (dimensions, center of rotation, ability for turning, etc.)

• Motion softness.

• Fast reaction to unexpected obstacles.

• Easy calibration & setup.

• Minimal speech training.
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## Working Plan

<table>
<thead>
<tr>
<th>Activity</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>15.Oct.12</td>
</tr>
<tr>
<td>Analysis &amp; Design of the input/output interface with the electric wheelchair.</td>
<td>30.Nov.12</td>
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<tr>
<td>First control tests between the computer and the wheelchair.</td>
<td>31.Dec.12</td>
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<tr>
<td>Laser sensor data acquisition.</td>
<td></td>
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<tr>
<td>Development of the SLAM algorithms.</td>
<td>31.Jan.13</td>
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<tr>
<td>Automatic path calculation and differential drive control.</td>
<td>28.Feb.13</td>
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<tr>
<td>Reactive obstacle avoidance.</td>
<td>31.Mar.13</td>
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<tr>
<td>Speech recognition system training</td>
<td>31.May.13</td>
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<tr>
<td>First tests of the complete system in laboratory.</td>
<td>30.Jun.13</td>
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<tr>
<td>Tests in a real scenario.</td>
<td>31.Aug.13</td>
</tr>
<tr>
<td>Final documentation.</td>
<td>30.Sep.13</td>
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</tbody>
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Robocup@home

• Navigate in dynamic environments
• Fast & easy calibration & setup
• Object recognition
• Object manipulation
• Detection and recognition of humans
• Natural human-robot interaction
• Speech recognition
• Gesture recognition
• Robot applications
• Ambient intelligence (e.g. communicating with surrounding devices like phones)
Robocup@home

• Up to two robots per team
• Qualification materials
  – Qualification video (one successful test)
  – Team’s website
  – Team description paper TDP
• Dates (2012):
  – Feb. 3, 2012 | Pre-registration
  – Feb 28, 2012 | Qualification material
  – Mar 15, 2012 | Notification of Qualification
  – Jun, 24-30, 2013. Competition
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Current Research

1) Communicating with the Wheelchair

- CAN-BUS
- SICK Laser
- Odometers
- Front Wheel’s Heading
- Kinect
Current Research

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   - CAN-BUS
   - SICK Laser
   - Odometers
   - Front Wheel’s Heading
   - Kinect
Current Research

2) Building a Map of the Environment
Bienvenido a Sher-Plan, la herramienta interactiva de Sherwin-Williams donde podrá diseñar su tienda a la medida de sus posibilidades, sin requerir de costosas herramientas de diseño CAD.
Current Research

3) Estimating localization parameters
Real-time Sensor Simulation
SLAM - Steps

1) Autonomous navigation
2) Build a map of the environment
3) Get localized in that environment
Important Issues

Robot Constrains (HW)
Dimensions
Maneuverability (Kinematics & Dynamics)
Perception (sensors)
Energy
Safety
Important Issues

Development Schema (SW)
   Device access (OS drivers) – Physical Layer
   Communication protocols (CAN-bus, rs232, Tcp/UDP sockets) – Link Layer
   Device drivers/controllers (laser, kinect, wheelchair) – Data Layer
   Middleware – Communications - Fault tolerant
   Task manager (sequencer)
   Task planner
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Parallel Activities

1) Gathering of source codes (most recent versions)
2) Documentation of Processes & Protocols
3) Architecture Evaluation
4) Middleware Selection
Next Activities

1) Wheelchair Controller Design
2) Architecture Evaluation
3) Middleware Selection
4) Implementation of New Modules
Next Activities

Wheelchair Controller

- Can-Bus protocol understanding
- Sick S300
  - Packet parsing
  - Ignore blocked data-points
  - Step filter
- Odometry µC access
  - Packet parsing
- Steering Angle µC
  - Packet parsing
Simplified Schema

Main Controller

Middleware

Wheelchair
Simplified Schema

Architecture Evaluation

Main Controller

Middleware

Driver

Physical Device

Driver

Physical Device
Middleware Selection

Orocos Toolchain as Middleware
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