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34º JAI - Jornadas de Atualização em Informática

CSBC2015

De 20 a 23 de julho de 2015.

XXXV CONGRESSO DA SOCIEDADE BRASILEIRA DE COMPUTAÇÃO

a internet de tudo, toda observada

RECIFE | PERNAMBUCO | BRASIL

Simulação de Robôs Móveis e Articulados: Aplicações e Prática

Fernando Santos Osório
Rafael Alceste Berri

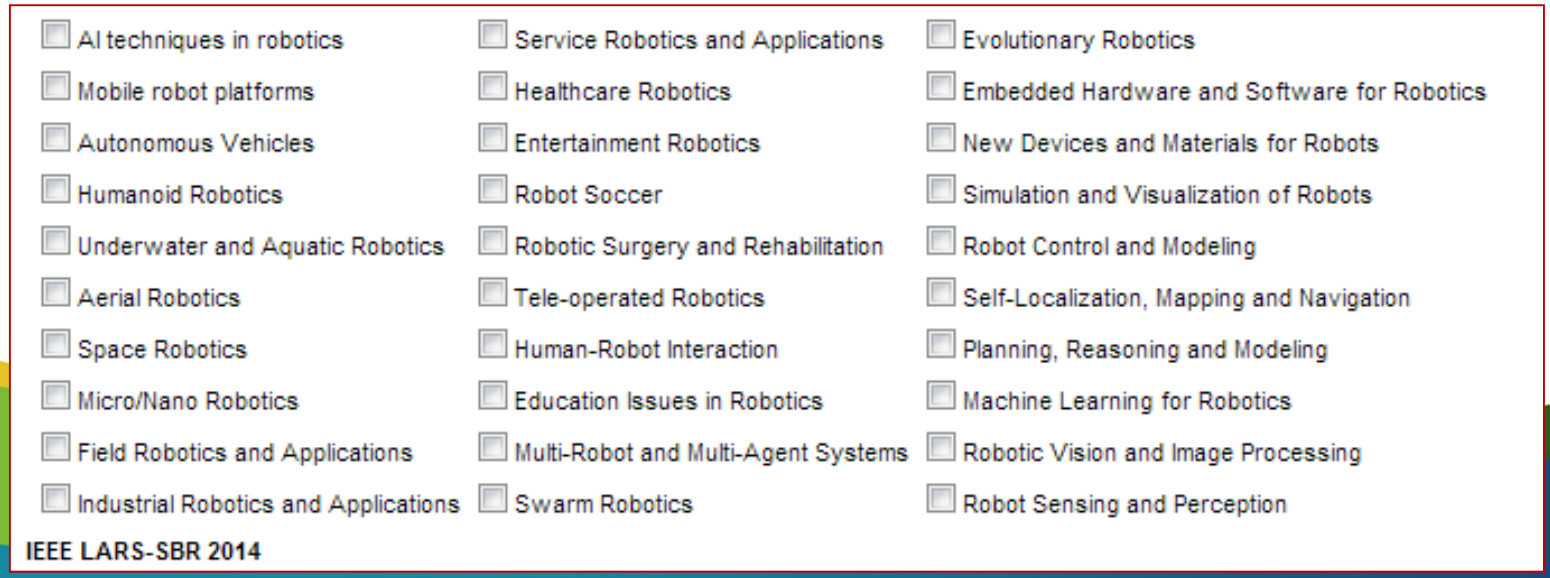
Aplicações da Robótica Móvel

Fernando Santos Osório

Rafael Alceste Berri

Aplicações: Robôs Móveis e Articulados

- Robótica Industrial
- Robótica de Serviço
- Robótica de Campo
- Robótica para o Entretenimento
- Robótica Educacional
- Robótica aplicada a Medicina
- Telepresença Robótica
- ....



- AI techniques in robotics
- Mobile robot platforms
- Autonomous Vehicles
- Humanoid Robotics
- Underwater and Aquatic Robotics
- Aerial Robotics
- Space Robotics
- Micro/Nano Robotics
- Field Robotics and Applications
- Industrial Robotics and Applications
- Service Robotics and Applications
- Healthcare Robotics
- Entertainment Robotics
- Robot Soccer
- Robotic Surgery and Rehabilitation
- Tele-operated Robotics
- Human-Robot Interaction
- Education Issues in Robotics
- Multi-Robot and Multi-Agent Systems
- Swarm Robotics
- Evolutionary Robotics
- Embedded Hardware and Software for Robotics
- New Devices and Materials for Robots
- Simulation and Visualization of Robots
- Robot Control and Modeling
- Self-Localization, Mapping and Navigation
- Planning, Reasoning and Modeling
- Machine Learning for Robotics
- Robotic Vision and Image Processing
- Robot Sensing and Perception

IEEE LARS-SBR 2014

- **Research & Development of Service Robots: Growing Market …**

"The market for personal and service robots is about $3 billion now but is expected to reach $15 billion by 2015, according to the Japan Robotics Association and market analysts like ABI Research. In 10 years or so, experts predict, sales of personal robots could surpass sales of industrial robots, now about $4.6 billion a year."
[NewsWeek August 09, 2008 by Katie Baker]

- **Applications of this technology *:**

:: Cleaning & Housekeeping	:: Edutainment	:: Humanoids
:: Humanitarian Demining	:: Rehabilitation	:: Inspection
:: Agriculture & Harvesting	:: Lawn Mowers	:: Surveillance
:: Medical Applications	:: Mining	:: Construction
:: Automatic Refilling	:: Guides & Office	:: Fire Fighters
:: Picking & Palletising	:: Food Industry	:: Search & Rescue

*IEEE Technical Committee on Service Robots

• Research & Development of Service Robots: Growing Market …

"The market for personal and service robots ~~is about $3 billion now but is expected to reach $15 billion by 2015, according to the Japan Robotics Association and mar ABI Research. In 10 years or so, experts predict, sales of pers ld surpass sales of industrial robots, now about $4.6 billion a year.~~"
[NewsWeek August 09, 2008 by Katie aker]

UPDATED

*CGAR: Compound Annual Growth Rate

The global service robotics market in 2011 was worth $18.39 billion.
This market is valued at $20.73 billion in 2012 and
expected to reach $46.18 billion by 2017
at an estimated CAGR* of 17.4% from 2012 to 2017.

Service Robotics Market (Personal & Professional)
Global Forecast & Assessment by Applications & Geography (2012 – 2017)
By: marketsandmarkets.com - Publishing Date: July 2012 - Report Code: SE 1146

*IEEE Technical Committee on Service Robots

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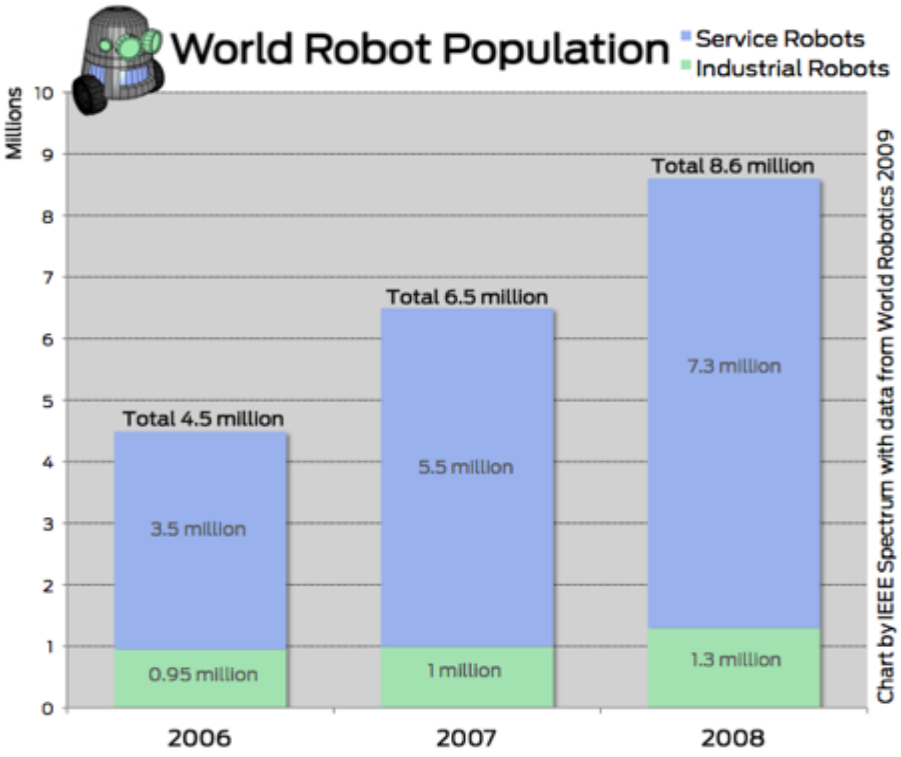
AUTOMATON The future of robots

BLOGS // AUTOMATON

World Robot Population Reaches 8.6 Million

POSTED BY: ERICO GUIZZO / QUA, ABRIL 14, 2010



The world's robot population has reached 8.6 million. That's ~~more than one~~

TOP SELLER:

iRobot Roomba® 780

Vacuum Cleaning Robot

Intelligent Robots: Industry, Jobs, Companies & Opportunities!

7.5 Million home robots!

About Our Robots

iRobot has made some of the world's most important robots.

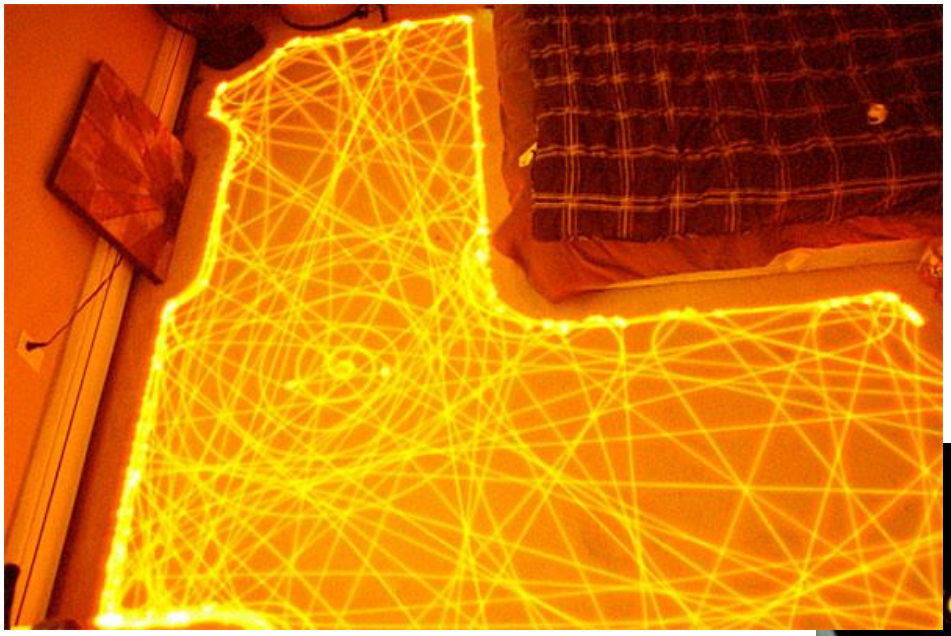
iRobot Home Robots: The smarter way to get it done

iRobot's home robots are revolutionizing the way people clean – inside and out. More than 7.5 million home robots have been sold worldwide. The award-winning iRobot® Roomba® vacuum cleaning robot is leading the charge. Roomba made practical robots a reality for the first time and showed the world that robots are here to stay. iRobot's acclaimed line of home robots also includes the iRobot Scooba® floor washing robot, the iRobot Verro® pool cleaning robot and the iRobot Looj® gutter cleaning robot.

http://www.irobot.com/filelibrary/ppt/corp/cool_stuff_ppt/cool_stuff_ppt.html

http://spectrum.ieee.org/automaton/robotics/industrial-robots/041410-world-robot-population

Aspirador de pó Roomba

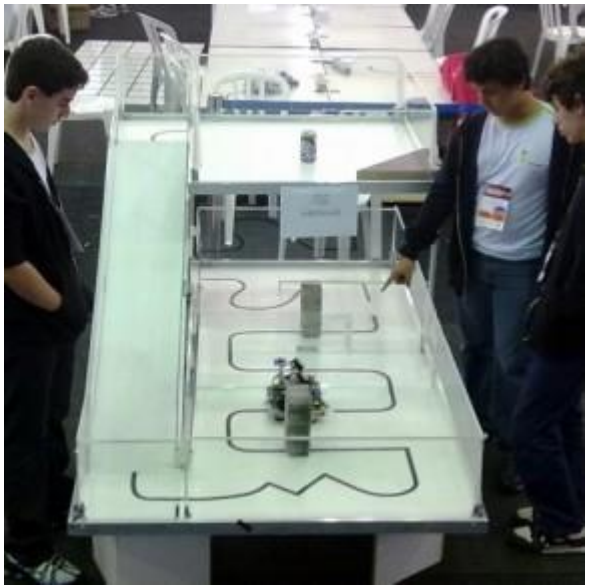


Percepção Simples
Wander Behavior + Avoid Obtacles

Comportamento
Reativo Simples

Seguidor de Linhas

Percepção Simples
Line Following



Comportamento
Reativo Simples

Amazon / Kiva Systems

BLOGS // AUTOMATON

Amazon Acquires Kiva Systems for $775 Million

POSTED BY: ERICO GUIZZO / SEG, MARÇO 19, 2012

Photo: Joel Eden Photography/Kiva Systems

Looks like Amazon is getting some robots. LOTS of robots.

The giant online retailer announced today that it is acquiring Kiva Systems, a North Reading, Mass.-based company that invented a revolutionary way of managing vast warehouses by using fleets of mobile robots to sort, organize, and transport inventory.

Amazon agreed to acquire all of the outstanding shares of Kiva for approximately US $775 million in cash. The companies expect to close the acquisition in the second quarter of 2012.

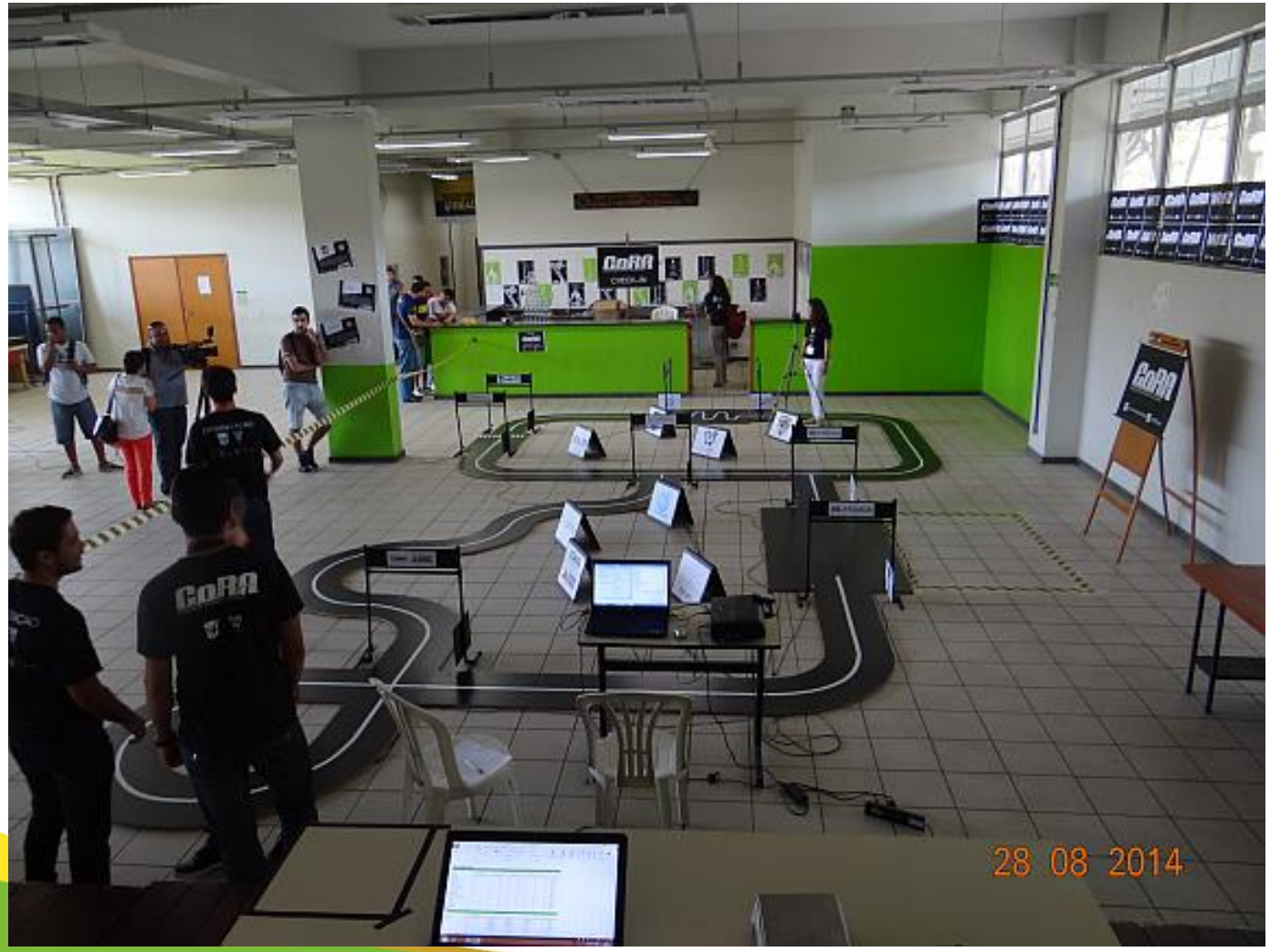
Intelligent Robotics:
Industry
Jobs and Companies

Percepção Simples
Line Following + Avoid Collision

Comportamento
Reativo Simples

Amazon Acquires Kiva Systems for $775 Million - IEEE Spectrum

Autonomous Driving: Challenges!



Line follower

CoRA Autonomous Robots Competition [UFMG] [FAPEMIG]

Autonomous Driving: Challenges!

COMPETITIONS:

- **DARPA Grand Challenge 2004 (Desert / *No winners*)**
- **DARPA Grand Challenge 2005 (Desert)**
  Winner: Stanley - Stanford Racing Team (S.Thrun)
- **DARPA Urban Challenge 2007 (Urbano)**
  Winner: Boss - CMU (Tartan Racing / Carnegie Mellon University)
- **ELROB – The European Robot Trial**
  M-ELROB: Military (2006, 2008, 2010, 2012)
  C-ELROB: Civilian (2007, 2009, 2011, 2013)
- **AUVSI Competition (IGVC - Intelligent Ground Vehicle Competition)**
- **DARPA Robotics Challenge (DRC) 2013/14 – Humanoid Robot Driving a Car**

Autonomous Driving: Challenges!

Darpa Grand Challenge

Autonomous Driving: Challenges!

Darpa Grand Challenge
Waypoint – GPS Coordinates

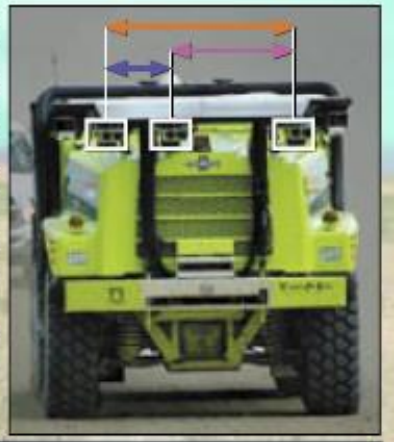
Intelligent Vehicles

DARPA Grand Challenge

VISION LINKED TO SPEED

Smart speed switch, which helped Stanley win the 2005 Grand Challenge, combines laser and video sensors in a four-step process. First, the robot filters its laser data to identify a section of terrain ahead that is smooth and relatively flat (*green*). Second, a program finds the corresponding patch of road in the video frame sent by the onboard camera (*blue outlines*). Next, the system highlights all other areas in the same video frame that match that pattern, which it equates with good, drivable road (*pink areas*). Finally, the software checks whether the matching area completely fills the robot's intended path for the next 130 feet (*orange*). If it does, then the system concludes that a long stretch of open road lies ahead, and it informs the onboard planning computer that it is safe to step on the gas.

Trinocular Terramax (*right*) can build a 3-D stereo view of the world from any of three pairs (*arrows*) of color video cameras. The closest cameras (*purple*), used at slow speeds, can detect obstacles up to 50 feet away. At fast speeds the robot selects its widest pair (*orange*), which can pick up objects 65 to 165 feet ahead. The third pair (*pink*) offers a happy medium.



Laser scan lines

Camera and five laser scanners

Terramax might first detect the pillars of an underpass with its long-range stereo cameras (*orange zone above*). As the vehicle slows, it will switch to medium- and then short-range camera pairs to make certain it notices all the obstacles in its video scene (*inset*).

Where is safe?

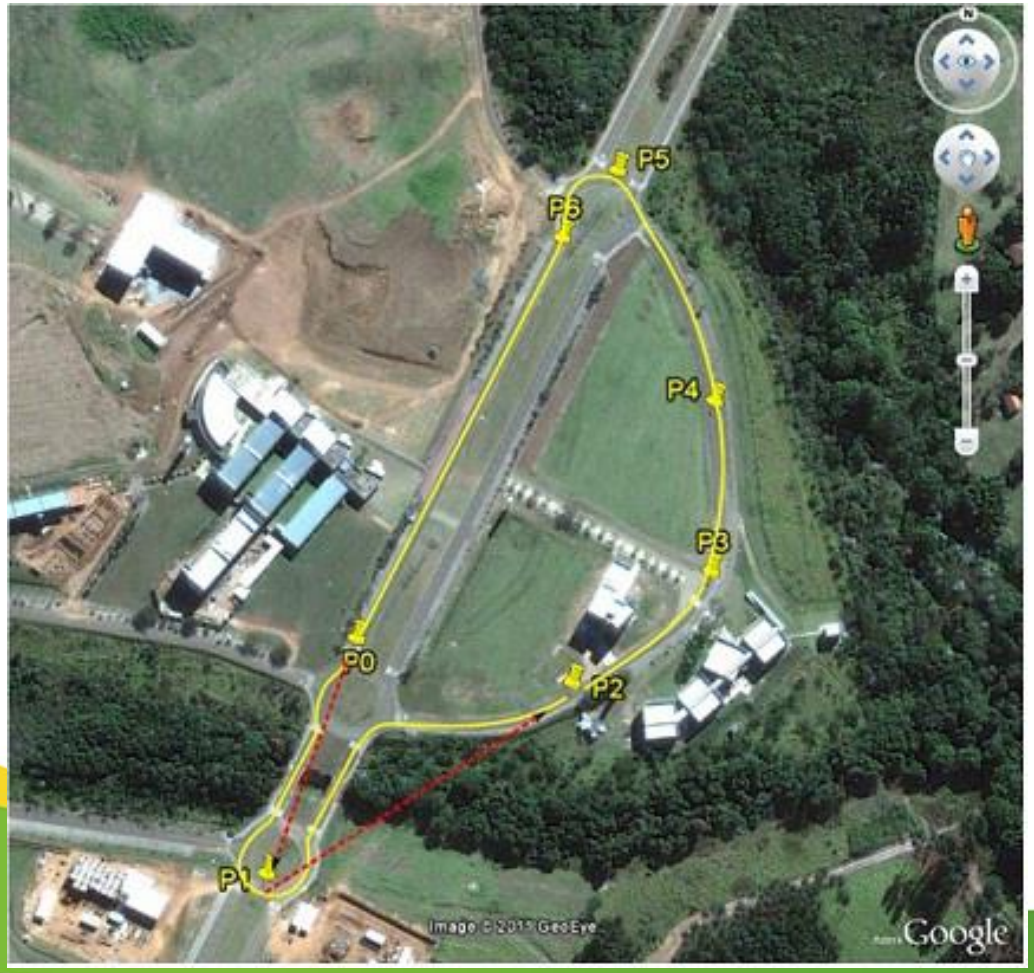
Computational Vision

Where is safe?

Computational Vision

Project CaRINA I : R&D

Autonomous Navigation



October 2011:

Total path: 1,08 km

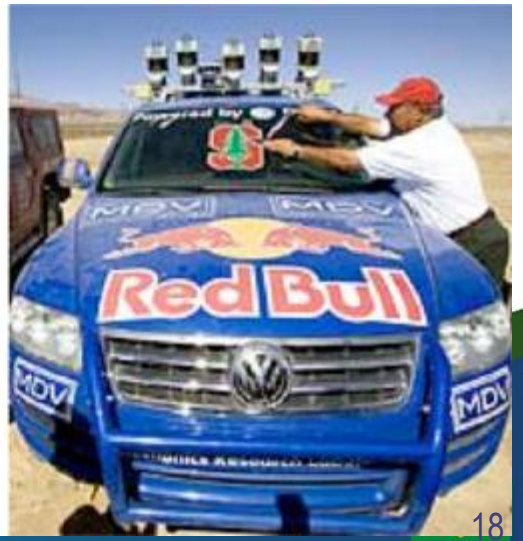
Autonomous Control Mode

Intelligent Vehicles

DARPA Grand Challenge

Winner – Stanley / Stanford University

Sebastian Thrun, Mike Montemerlo, Hendrik Dahlkamp, David Stavens, Andrei Aron, James Diebel, Philip Fong, John Gale, Morgan Halpenny, Gabriel Hoffmann, Kenny Lau, Celia Oakley, Mark Palatucci, Vaughan Pratt, and Pascal Stang, Sven Strohband, Cedric Dupont, **Stanford Artificial Intelligence Laboratory-** Stanford University - Stanford, California 94305, Lars-Erik Jendrossek, Christian Koelen, Charles Markey, Carlo Rummel, Joe van Niekerk, Eric Jensen, and Philippe Alessandrini **Volkswagen of America**, Inc. - Electronics Research Laboratory - Palo Alto, C Gary Bradski, Bob Davies, Scott Ettinger, Adrian Kaehler, and Ara Nefian **Intel Research** - 2200 Mission College Boulevard, Santa Clara, California 95052, Pamela Mahoney ...



Autonomous Vehicles – Urban Spaces

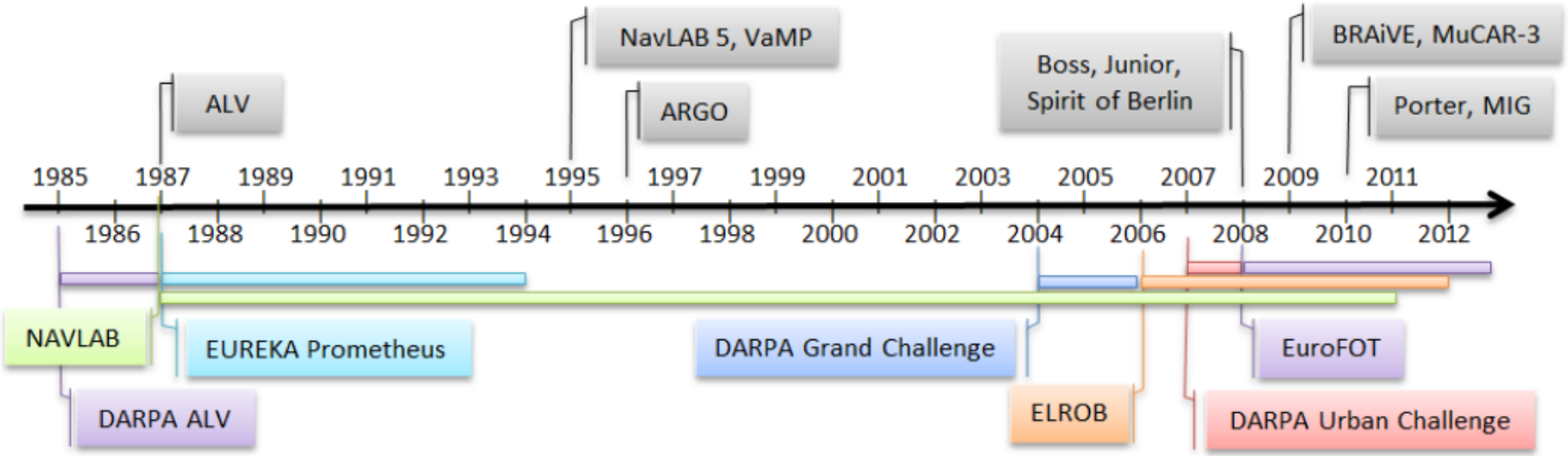
DARPA Urban Challenge

Boss, the autonomous Chevy Tahoe that won the 2007 DARPA Urban Challenge

Tartan Racing – CMU Carnegie Mellon University

Pittsburgh, Pennsylvania

The quest for Autonomous Vehicles



LRM Laboratory :)

2009: INCT-SEC was created and start its activities

2010: April / Acquisition of our 1st vehicle (Electric Car) Club Car CarryAll **CaRINA 1**

2010: October / Autonomous Driving on Campus 2 using CaRINA 1

2011: July / Acquisition of our 2nd vehicle - Fiat Palio Adventure - **CaRINA 2**

2012: September / CaRINA 2 at USP/SC Campus 2 - Fully autonomous!

State of the Art

- Reference Challenges:
  - DARPA Urban Challenge
  - Elrob
- Projects:
  - Boss, Junior e Spirit of Berlin
  - MIG e MuCAR-3
  - BRAiVE e Porter
  - Google Autonomous Car

State of the Art

State of the Art

Intelligent Vehicles
Brazilian Initiatives

Automated Vehicles: Assisted conduction, Drive-by-wire

- **GPVA** – Grupo de Pesquisa em Veículos Autônomos / RS
  Automated Baja Buggy, drive-by-wire e sist. de visão - 2002/2008
- **USP SC** – EESC/ICMC - Projeto SENA (Fiat Stilo instrumented w/sensors)
  Sistema Embarcados para Navegação Autônoma 2008/2011
- **UNIFEI /MG** - Grupo de Automação e Tecnologia da Informação / UFJF
  Projeto Driving4u - Chevrolet Zafira 2008/2011

Autonomous Vehicles: Perception e Actuation

- **UFMG DEE** – R&D Group: Veículos Autônomos (PDVA) - GM Astra
  CADU Carro Autônomo Desenvolvido na UFMG – final 2007/2012
- **CTI** CenPRA - DRVC Divisão de Robótica e Visão Computacional - "Freedom"
  Projeto VERO - Veículo Robótico Terrestre de Exterior – 2008/2012
- **USP SC** – ICMC / LRM – Projeto CaRINA I e II - Club Car, Palio Adventure
  Carro Robótico Inteligente para Navegação Autônoma – 2010/2012
- **UFES**: LCAD carro adquirido em Setembro/2012- TorcRobotics Bywire-XGV

Brazilian Initiatives

Autonomous Vehicles:

- **GPVA** –Baja Buggy - 2002/2008
- **USP SC**- SENA – Fiat Stilo - 2008/2011
- **UNIFEI /MG** - Projeto Driving4u
  Chevrolet Zafira 2008/2011

Brazilian Initiatives

Autonomous Vehicles:

- **UFMG DEE** - GM Astra - CADU 2007/2012
- **CTI** CenPRA - DRVC - Freedom Elétrico
  VERO - 2008/2012
- **USP SC** – ICMC / LRM – Club Car CarryAll
  CaRINA I - 2010/2012

Intelligent Vehicles

Brazilian Initiative @ USP São Carlos

Laboratório de Robótica Móvel
ICMC/USP - São Carlos

CARINA
Carro Robótico Inteligente para Navegação Autônoma

Autonomia

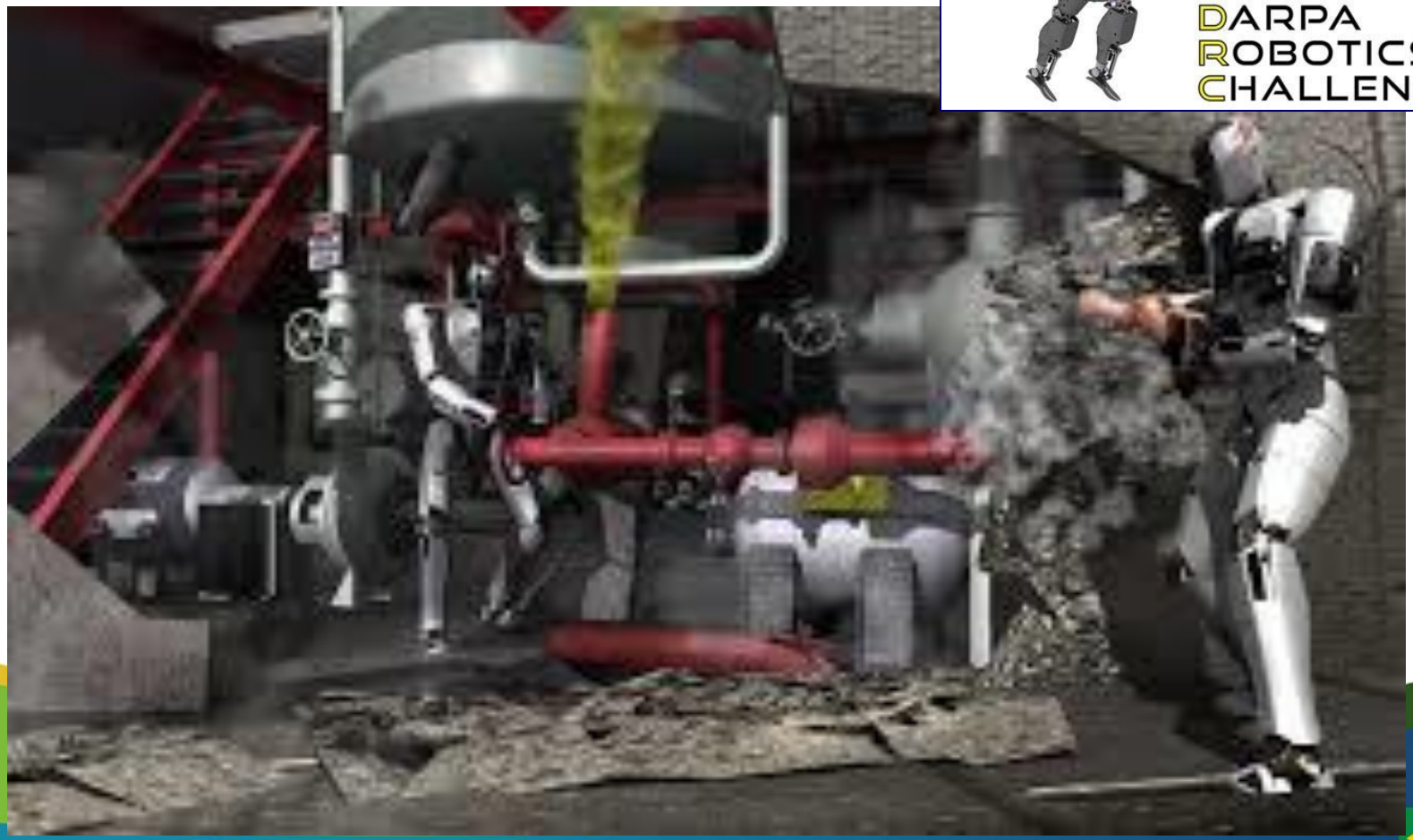
- Executar tarefas sem a intervenção humana

Projeto CaRINA 2 - LRM

DRC Darpa Robotics Challenge

DRC – Darpa Robotics Challenge

2013-2015 / US$ 2M Prize



DRC Darpa Robotics Challenge

DRC – Darpa Robotics Challenge TASKs

- Drive a utility vehicle at the site.
- Move/Walk across ruins/debris.
- Remove debris blocking an entryway.
- Open a door and enter a building.
- Climb an industrial ladder and traverse an industrial walkway.
- Use a tool to break through a concrete panel.
- Locate and close a valve near a leaking pipe.
- Connect a fire hose to a standpipe and turn on a valve.

http://en.wikipedia.org/wiki/DARPA_Robotics_Challenge

http://www.theroboticschallenge.org/overview

How to Win?

1. First:

   Finish the Tasks

2. Second:

   Time to Finish the Task

3. Third:

   Amount of Data Required to Finish the Task

   (bits uplinked + bits downlinked)

How to Win?

1. First:

   Finish the Tasks

2. Second:

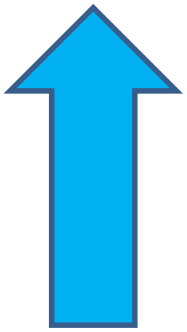
   Time to Finish the Task

3. Third:

   Amount of Data Required to Finish the Task

   (bits uplinked + bits downlinked)

Increase AUTONOMY



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Google Acquires Seven Robot Companies, Wants Big Role in Robotics

By Evan Ackerman
Posted 4 Dec 2013 | 14:52 GMT

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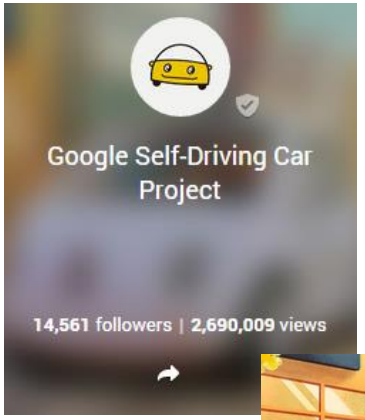
Here is the list of companies Google has acquired:

- Schaft Inc.
- Industrial Perception, Inc
- Redwood Robotics
- Meka Robotics
- Holomini
- Bot & Dolly
- Boston Dynamics
- DeepMind Technologies



http://en.wikipedia.org/wiki/List_of_mergers_and_acquisitions_by_Google

Pesquisa em Robótica

Sensores

Laser Hokuyo

Visão Estereo

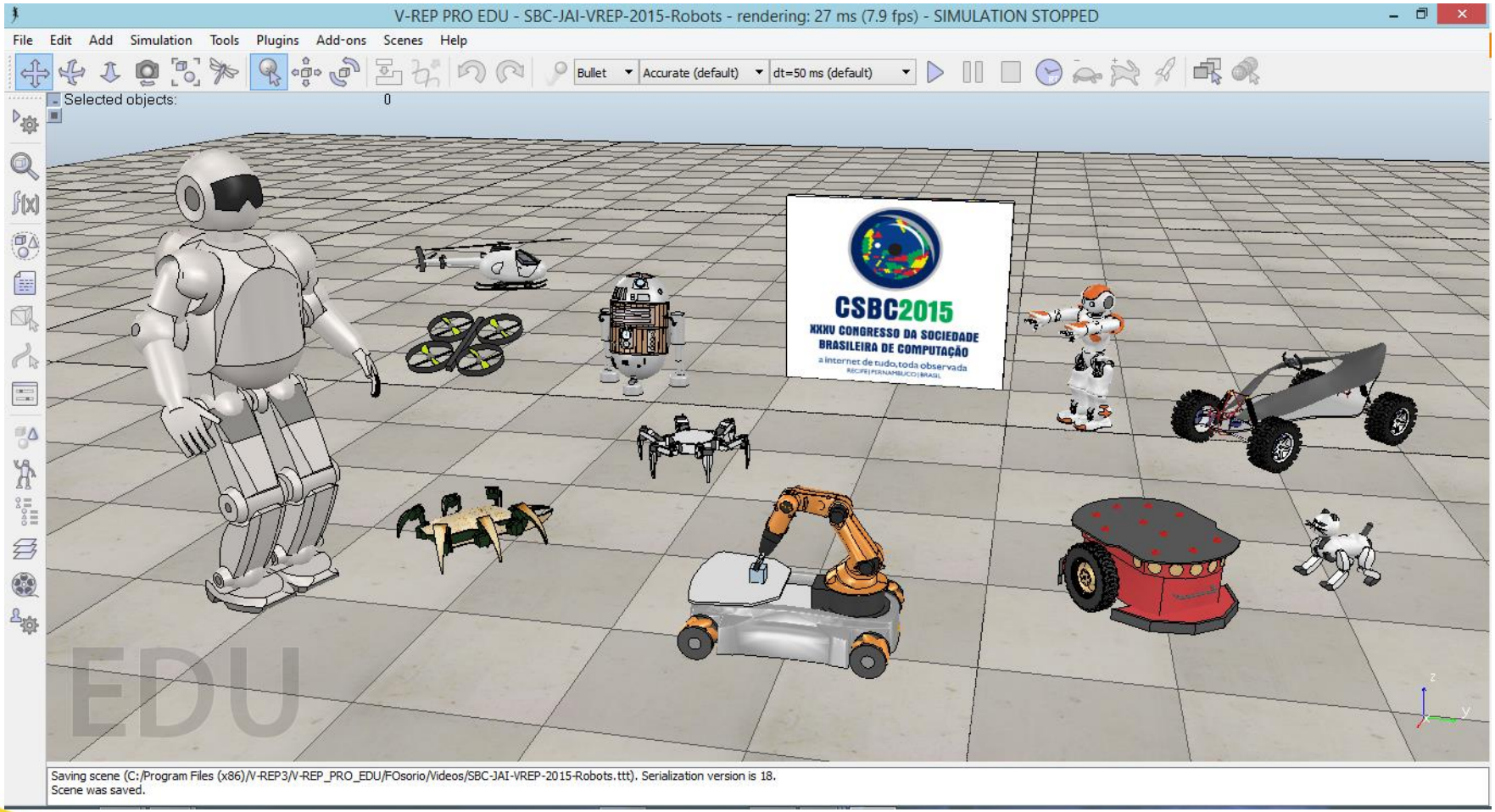
Kinect

Aplicações

Robôs de Segurança e Tele-Presença

Veículos Autônomos

Simulação!



VREP

A SEGUIR:

SIMULAÇÃO DE ROBÔS MÓVEIS E ARTICULADOS

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Prof. Denis Wolf
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E-mail: { fosorio, denis } @icmc.usp.br

Laboratório de Robótica Móvel – ICMC/USP

Site: http://www.lrm.icmc.usp.br/

Vídeos: http://youtube.com/lrmicmc

https://www.youtube.com/user/lrmicmc/videos