



Instituto Nacional de Ciência e Tecnologia
em **Sistemas Embarcados Críticos**

Instituto Nacional de Ciência e Tecnologia em Sistemas Embarcados Críticos

INCT-SEC

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ICMC/USP



Instituto Nacional de Ciência e Tecnologia
em **Sistemas Embarcados Críticos**

LRM – Laboratório de Robótica Móvel

- Principais Projetos: GT1, GT2 e GT3

GT 1 - Robôs Táticos para Ambientes Internos

GT 2 - Veículos Terrestres Autônomos

GT 3 - Sistemas Aéreos não Tripulados



GT1:
Robôs Pioneer, Erratic, SR1



GT3:
VANT
Arara

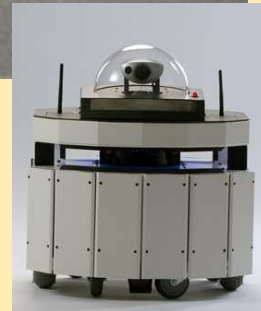
GT2:
Veículo Elétrico Club Car



Instituto Nacional de Ciência e Tecnologia
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Service and Tactical Robots



Service and Tactical 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 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



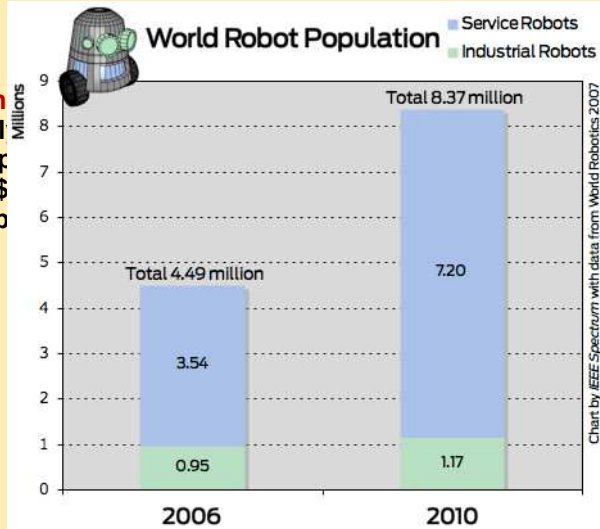
WG1 – Indoors Tactical Robots

• Research & Development of Service Robots: Growing Market ...

“The market for personal and expected to reach **\$15 billion** Association and market anal experts predict, sales of p industrial robots, now about \$ [NewsWeek August 09, 2008 b

• Applications of this

- :: Cleaning & Housekeeping
- :: Humanitarian Demining
- :: Agriculture & Harvesting
- :: Medical Applications
- :: Automatic Refilling
- :: Picking & Palletising



IEEE Spectrum March 2008 by Erico Guizzo



WG1 – Indoors Tactical Robots

- The WG1 deals with the creation of systems, tools and methods to allow for the individual or collaborative work of mobile robots.

• These robots should:

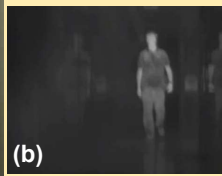
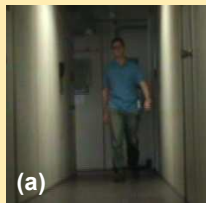
- * Be used in sensitive security operations involving fire, dangerous chemical material, harm situations, etc;
- * As a squadron, to be able to act in a coordinated way;
- * Execute their mission in a pre-defined and precise way required by **critical missions**

INCT_{SEC} WG1 – Indoors Tactical Robots

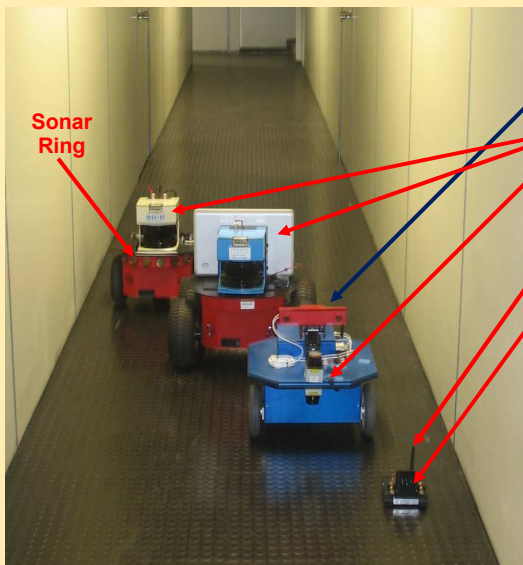
- One of our main research focus is on service robots used to execute tasks into indoor environments based on **tele-operation and autonomous navigation** for environment monitoring and incident detection, notification and response.



Thermal Camera:
 (a) Color Image
 (b) Thermal Image
 (c) Intrusion Detection



INCT_{SEC} WG1 – Indoors Tactical Robots



Sensors

Sonar Ring

Stereo Camera

Laser Sensors

Wi-Fi Connection

Color Camera



Thermal Camera
 FLIR PathFindIR:
 320x240 / 720x480
 256 levels (gray levels)



Laser
 Hokuyo
 4 meters
 270 degrees

Laser SICK LMS 200
 Distance: Up to 80 meters
 75 Hz / 180 degrees scan



WG1 – Indoors Tactical Robots



Mobile Robots



Sensors





CARRO DO FUTURO



WG1 – Indoors Tactical Robots

INCT-SEC Tele-Operation

Remote and Autonomously Controlled Mobile Robot at USP ICMC - São Carlos
Control System running at PUC-RS - Porto Alegre (1.300Km far away from USP)









Player/Viewer localhost:6665
File View Devices



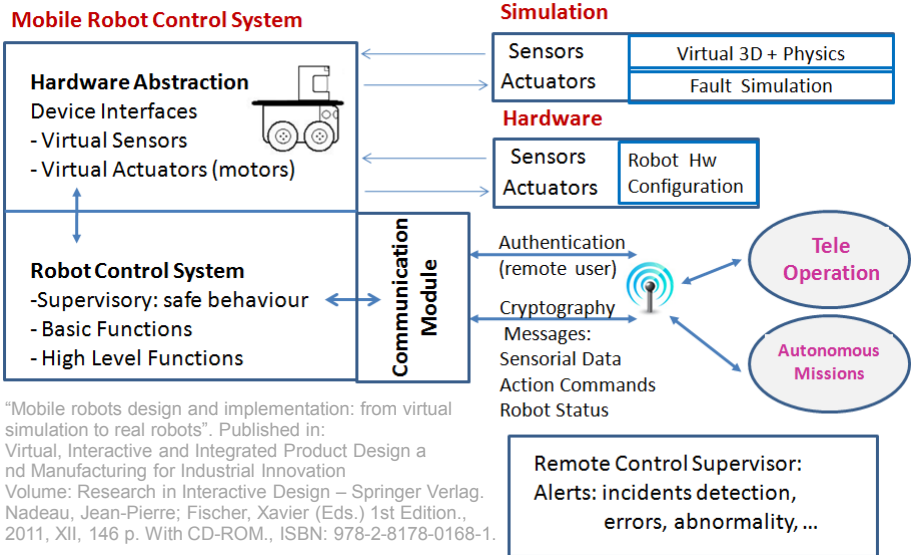




Laser sensor

INCT^{SEC} WG1 – Indoors Tactical Robots

INCT-SEC Semi and Autonomous Robot Control Architecture



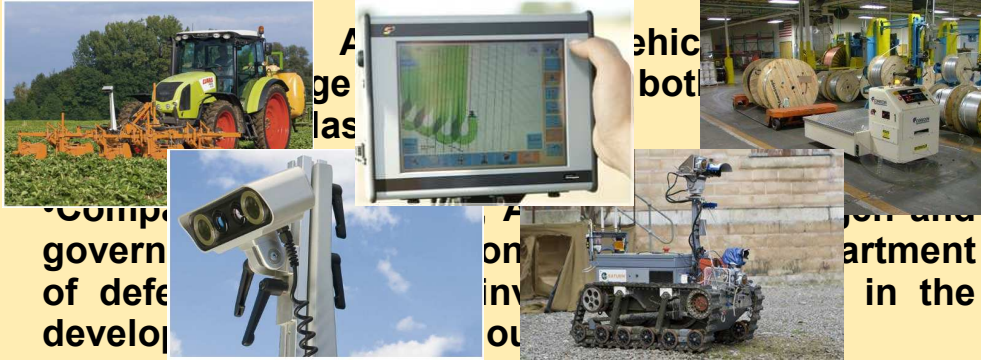
INCT^{SEC} WG1 – Indoors Tactical Robots

INCT-SEC Indoor Navigation and Monitoring (videos)



Publications:
 Visual Navigation System
 IEEE LARS 2010
 Localization and Topological Navigation,
 Human Detection using Thermal Camera
 Submitted to CBSEC 2011

INCT SEC GT2 – Autonomous Vehicles




• Applications of this technology range from urban traffic safety , agriculture, factory work, and security and defense.


INCT SEC GT2 – Autonomous Vehicles

- The major challenge in obtaining intelligent autonomous vehicles is the development a intelligent computational system capable of make complex decisions in real time.
- In Brazil, few institutions have been working towards this goal and the INCT-SEC has been obtaining consistent advances in this field.





GT2 – Autonomous Vehicles



Sensors

- Camera
- GPS, IMU, and compass
- Laser Range Finders


Actuators

- DC Motor
- Encoder
- Motor Controller
- Acceleration Control

**INCT-SEC
Autonomous
Electric Vehicle**

Specifications


Engine: electric 48v
Autonomy: 8-10hs
Max speed: 32km/h
Payload: 363kg



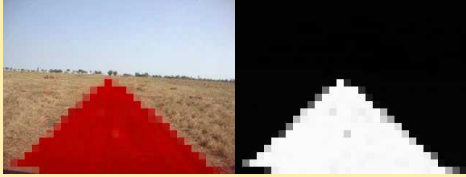
GT2 – Autonomous Vehicles

INCT-SEC Road Finding Algorithm*


Urban Environment



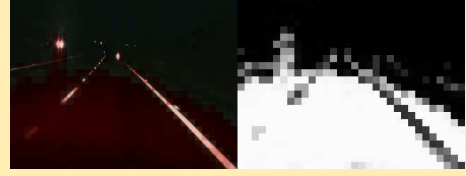
Rural Area



Rain



Night



* Shinzato, P. Y. ; Wolf, D. F. . A Road Following Approach Using Artificial Neural Networks Combinations, Journal of Intelligent & Robotic Systems, 2010

INCT SEC GT2 – Autonomous Vehicles

INCT-SEC Assisted Driving System

Vehicle Position

Laser information

Expected trajectory

Obstacles

Camera Image

Play-Laser: V.0.4
AngGPS: 270.600 - Ajusto AngGPS: 269.400

Zoom: 5.50 - RetanguloX 8.50 - RetanguloY: 26.50
FX: 2.20 - FY: 2.40 - DX: 830.00 - DY: 122.00
GPS Cnt: 55 - Tempo: 181237.800
GPS X: 814.4000 - Y: 814.4000

LASER Cnt: 53 - Tempo: 1246903970.804

CARRO INTELIGENTE

* FERNANDES, L. C. ; OSORIO, F. S. ; Wolf, D. F. ; DIAS, M. A. . A Driving Assistance System for Navigation in Urban Environments. In: Ibero-American Conference on Artificial Intelligence, 2010

INCT SEC GT2 – Autonomous Vehicles


INCT-SEC Partners

CTI – CENPRA
Automated Vehicle
Drive-by-Wire and
Sensors

Fiat Stylo / EESC – ICMC
SENA Project
Assisted Driving

INCT SEC GT2 – Autonomous Vehicles

Autonomous Navigation *



Vision-based obstacle avoidance



GPS-based Autonomous navigation

* J. Souza, D. Sales, P. Shinzato, F. Osório and D. Wolf, Template-based autonomous navigation in urban environments, In ACM Applied Computing Sysposium, 2011

INCT SEC GT2 – Autonomous Vehicles

Autonomous Navigation *



Vision-based obstacle avoidance



GPS-based Autonomous navigation

* J. Souza, D. Sales, P. Shinzato, F. Osório and D. Wolf, Template-based autonomous navigation in urban environments, In ACM Applied Computing Sysposium, 2011