Proseminar Roboter und Aktivmedien

Mobile Service Robot "TASER"

Lecturer

Houxiang Zhang

TAMS, Department of Informatics
University of Hamburg, Germany

@Tams

Outline of today's lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Control PC
  - Actuators
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Outline of today's lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Control PC
  - Actuators
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Our TAMS group

Outline of today's lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Control PC
  - Actuators
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Outline of today's lecture

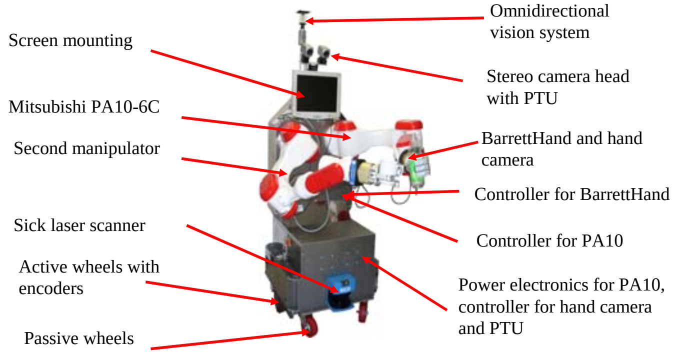
- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Control PC
  - Actuators
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Review of TASER platform

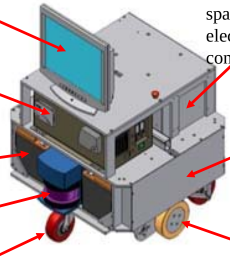
- Taser
  - Service-robot of the University of Hamburg
  - Mobile platform with differential drive
  - Two Mitsubishi PA10-6C manipulators
  - Two 3-finger robotic hands
  - Stereovision camera head
  - Omni-directional vision system
  - Two SICK laser range finders
  - Pentium 4 control PC
  - Wireless LAN communication

@TAMS

Hardware devices

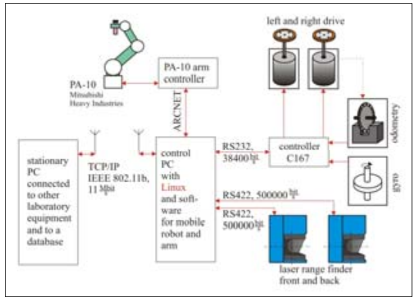


Mobile Base



@Neobotix – GPS GmbH Stuttgart

Research prototypes – old platform



Outline of today’s lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Actuators
  - Control PC
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Upper Body

- Structure for two robot arms
- MHI - PA10-6C
- BarettHand with hand camera
- Camera head with PTU
- Omnidirectional vision system

Mitsubishi PA10

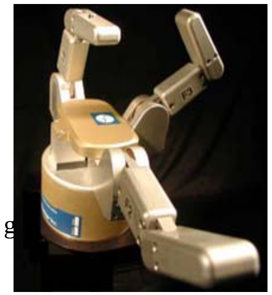
- Mitsubishi Heavy Industry
- 6 degrees of freedom, individually controllable
- Maximum range about 137cm
- Payload about 6 kg
- Controlled via ARCnet
  - Modified PCI-board
  - Control loop 2ms possible

PA10(2)

- Control software RCCL bzw. RCCL++
  - Supports control loop 10ms (RCI)
- Current work:
  - Adapt to RCCL to control two manipulators
  - Problems:
    - Collision avoidance
    - Interaction/collaboration
    - Timing

BarrettHand BH-262

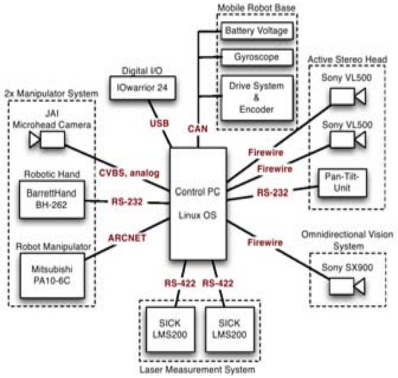
- Controlled by serial RS-232
- 4 degrees of freedom:
  - Open/close each finger individually
  - Spread angle between finger 1 and 3
- Force sensors in each finger (strain g



Outline of today’s lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Actuators
  - Control PC
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

System architecture



Control PC

- Pentium 4 2,4 Ghz, industrial PC
  - 1 GB RAM
  - 54 Mbit WLAN
- SuSE 9.0 Linux (Kernel 2.4.21-166)
  - Kernel patched for Real-Time
  - Driver-Modules for:
    - CAN-Bus
    - Arcnet
    - Videograbber
    - MOXA serial board (obsolet)

Control PC (2)

- Planned Progression:
  - Upgrade to Kernel 2.6 (Driver for USB-Framegrabber)
  - integration of second 2nd manipulator in software
  - improved documentation of software modules

Drive system/CAN-Bus

- Individually controllable drive wheels
- Getting data of wheel encoders
- Getting data of battery voltage
- Getting data of gyroscope
- Getting joystick commands

Outline of today's lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Actuators
  - Control PC
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Sensors onboard

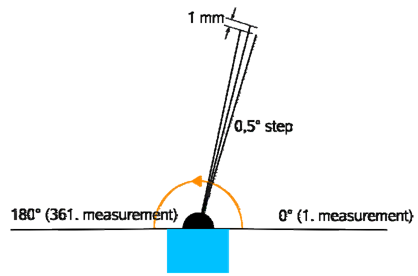
- Gyroscope
- Wheel encoders
- Force sensor on the hand
- Stereovision on the shoulder
- Omni-directional camera on the top
- Two laser range finders in the front and at the back

SICK-Laser Range Finders

- Robot is equipped with 2 LRF's
- Serial communication at 500 kBaud
- Distance measurement, fan-shaped
- Used for
  - Collision avoidance
  - Navigation
  - Person-tracking

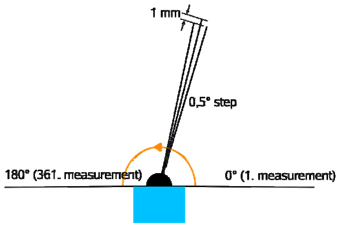
LRF-measurement principle

- Rotary mirror
- Resolution: 1 mm
- 0,5° angular resolution

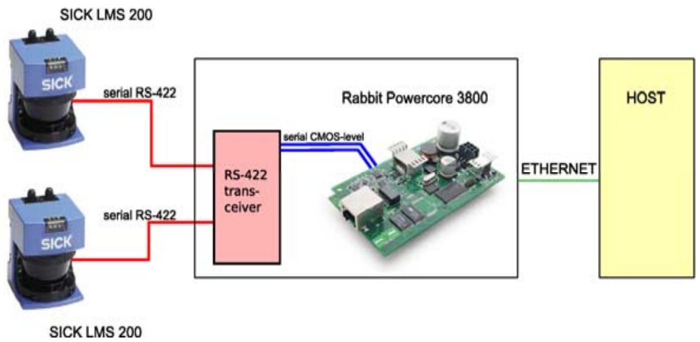


SICK LMS 200 - integration

- Modified serial High-Speed-board from MOXA:
  - Quarth replaced to reach 500 kBd instead of 460 kBd
  - Linux-Kernel-module modified to this adjustment
  - Connection of 2 LRF's possible
- Problems:
  - high system load due to IRQ
  - loss of dataResolution: 1 mm



SMART-Interface for LMS-200



Vision Systems

- Stereo camera head:
  - Two IEEE1394-cameras (640x480 pixel, 30 fps)
  - PTU serially controlled
- Omnidirectional Vision System:
  - IEEE1394-camera (1280x960 Pixel, 7.5 fps)
  - Hyperbolic mirror
- Hand-camera:
  - Analogue micro-camera with external electronics
  - Digitalized with USB-Grabber

Stereo-Head

- 3D – Image information by correlation of two images
- Depth information about the scene
- Visual serving

Omni-directional camera system

- Parabolic mirror
- 360° view
- Transformation to perspective image possible
- Used for coarse overview of the scene

Omni-directional camera system (2)

Hand-Camera

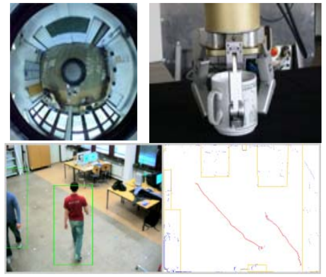
- Jai Microhead Camera
- Analogue, digitalize by USB-Framegrabber
- Controls approach to objects
- Fine-positioning

Outline of today's lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Actuators
  - Control PC
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Research prototypes – TASER

- Taser
  - Mobile manipulation
  - Grasping
  - Mobile robot navigation
  - People tracking
  - 3D image processing
  - Man-machine interaction



@TAMS

Research Projects

- People Tracking
- Monocular 3D image reconstruction
- Navigation
- Learning by demonstration
- Grasping
- SMART-Camera-Systems

People Tracking

- Motion of people are recorded by cameras and laser range finders
- Detection of walking direction and speed
- Boost of Reliability due to multimodality
  - vision and laser range measurements
- Foreword looking path planning

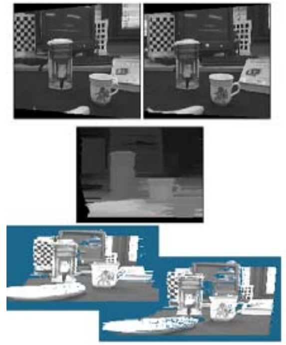
People Tracking(2)

Monocular 3D image reconstruction

- Acquisition of two images with one camera
- Hand-camera is used
- Manipulator is moved between shots
- Calculation of depth information
- Control of grasps

Technical Aspects of Multimodal System
Dept. Informatics, Faculty of Mathematics, Informatics and Natural Sciences
University of Hamburg

Monocular 3D image reconstruction



Technical Aspects of Multimodal System
Dept. Informatics, Faculty of Mathematics, Informatics and Natural Sciences
University of Hamburg

Navigation

- Recognition of reflector marks with laser range finders
- Comparison with a map of all known reflector marks
- Calculation of robots' position
- Path planning

Technical Aspects of Multimodal System
Dept. Informatics, Faculty of Mathematics, Informatics and Natural Sciences
University of Hamburg

Learning by Demonstration

- 3D-recognition of human hand
- Use of Stereovision Camera Head
- Tracking of features
- Recognition of grasp types
- Transfer of grasps to manipulator

Grasping

- Development of a Reinforcement-Learning agent to calculate grasping strategies
- Shape of objects must be known
- Try- and Error-Learning, but actions that have lead to stable grasp are chosen more likely



SMART-Camera

- Camera-systems with integrated computing capabilities
- Connection via Ethernet
- Image (pre-)processing directly on the camera
- Image-information instead of raw image data
- Increase of image processing power/unload control PC of the service Robot

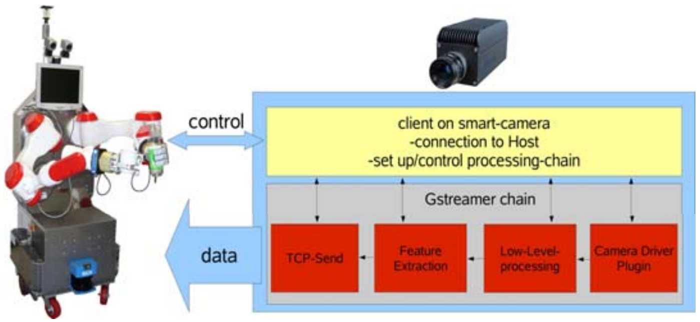
Specifications of the SMART-Camera

- Basler eXcite exA-1390
- Embedded Linux OS (2.6 Kernel)
- 1 Ghz MIPS processor
- 128 MB RAM, 128 MB ROM
- Gigabit Ethernet
- 1388 x 1038 resolution, 12 bit per pixel
- Bayer 8 colour-pattern

Plugin-based processing architecture

- Each processing step is done by a plug-in
- Processing functions are run consecutively on image-data
- Configuration at runtime
- Simple integration of new functions
- Reuse of code in different context
- Architecture uses Gstreamer Framework (Open Source)
  - Comparable with Direct Show (MS Windows)
  - Many existing plug-in (resizing, format conversion, network transfer)
  - Expandable

Example of a processing strategy



Outline of today's lecture

- Introduction to TAMS
- Review of TASER platform
  - Mobile platform
  - Actuators
  - Control PC
  - Sensors
- Research Project
  - Localization of mobile robot
  - Grasping
  - Learning
- Conclusions

Demonstration

Conclusions

- A mobile prototype with colourful devices
- Control system supports different onboard sensors to make the system full-functions
- Different high-level research implemented on this prototype
- Some open problems
  - Two arms integration
  - Hardware recourse limited
  - RCCL is not functional and easy-to-use.

Lecture material

- ***Development of a Smart Laser Range Finder for an Autonomous Service Robot***, Hannes Bistry, Stephan Pöhlsen, Daniel Westhoff, Jianwei Zhang "", Proceedings of the 2007 IEEE International Conference on Integration Technology (ICIT), Shenzhen, China, March 20-24, 2007
- ***Three-Dimensional Monocular Scene Reconstruction for Service-Robots: An Application,*** Sascha Jockel, Tim Baier-Löwenstein, Jianwei Zhang , In Proceedings of VISAPP 2007 - Second International Conference on Computer Vision Theory and Applications, Vol. Special Sessions, Barcelona, Spain, 2007 March 8-11, INSTICC Press, pp. 41-46.
- ***Proactive Multimodal Perception for Feature Based Anchoring of Complex Objects,*** Martin Weser, Jianwei Zhang, Proceedings of the 2007 IEEE International Conference on Robotics and Biomimetics (ROBIO), Sanya, China, December 15-18, 2007
- Many other publications on the webpage:
  - http://tams-www.informatik.uni-hamburg.de/publications/

Thanks for your attention!

Any questions?