Robot-Era: Work Package 4

Domestic Robotic Platform

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Technical Aspects of Multimodal Systems

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Outline

1. Description of Activities
2. Robot Architecture Solutions
3. Robot Integration Solutions
4. Simulation
5. Schedule

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- preparing D4.1 *Report on specifications and middleware architecture of the domestic robotic platform* (within Workgroup 1)
  - technical communicating with robot arm suppliers
  - HW + SW integration design
- ROS tabletop segmentation + manipulation
- Pick and Place demo[1], which involves
  - (3D) obstacle avoidance
  - navigation + localization
  - (simple hierarchical) task planning (JSHOP2)
  - tabletop detection
  - tabletop segmentation (and object detection)

[1] http://youtu.be/RE7C2yyLXU8

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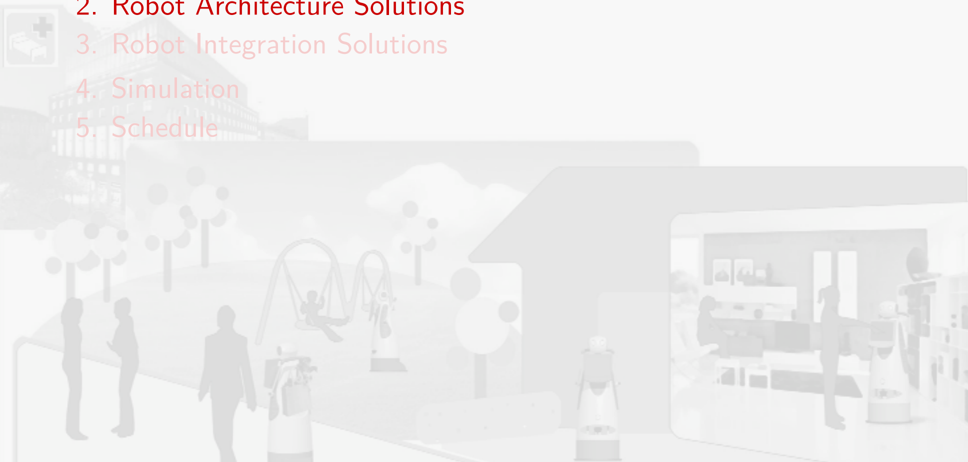
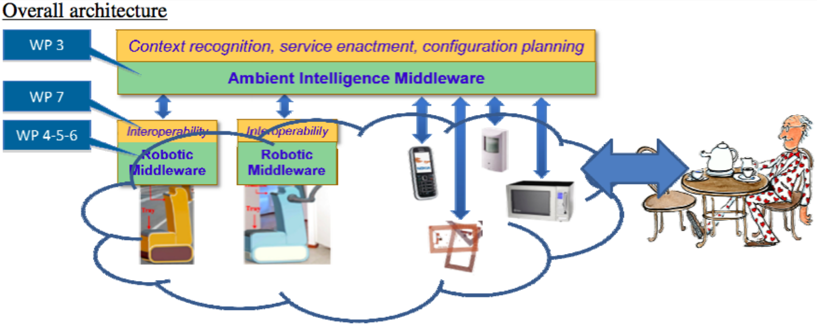
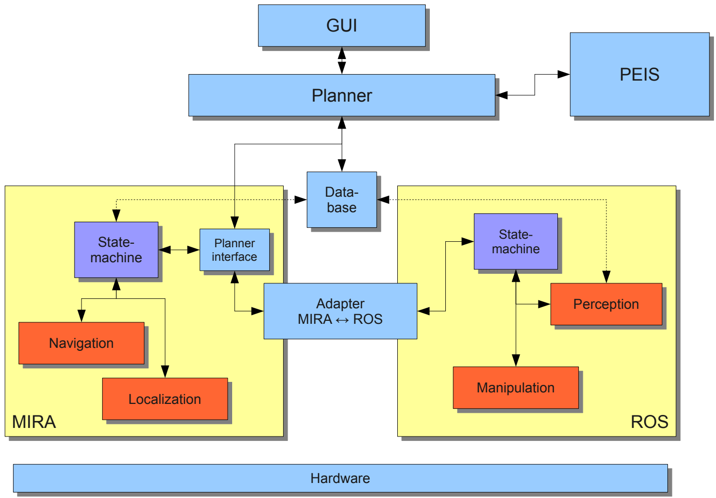


Architecture



Architecture cont'd



Architecture cont'd

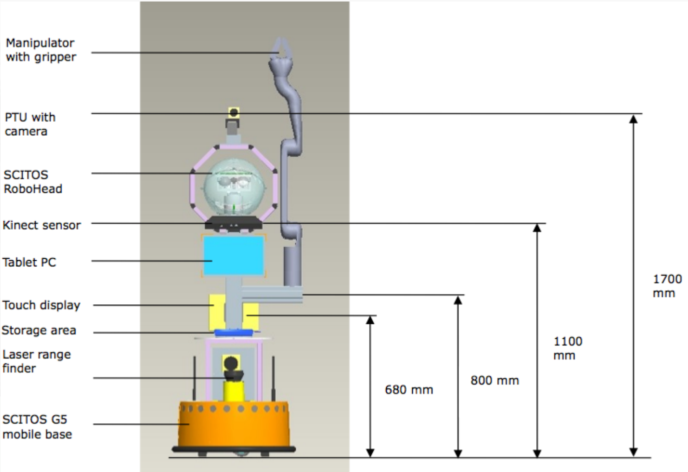
- *GUI* for supervision, debugging, test controlling
- *PEIS* is the the interface to the PEIS Ecology
- *Planner* subsumes tasks into subtasks and re-plans if something fails (included in PEIS?)
- *Database* holds information about objects in order to recognize them (interfaced by the ROS tabletop stack)
- *State machine* (ROS) will be realized by the SMACH (ROS python) library

Architecture cont'd

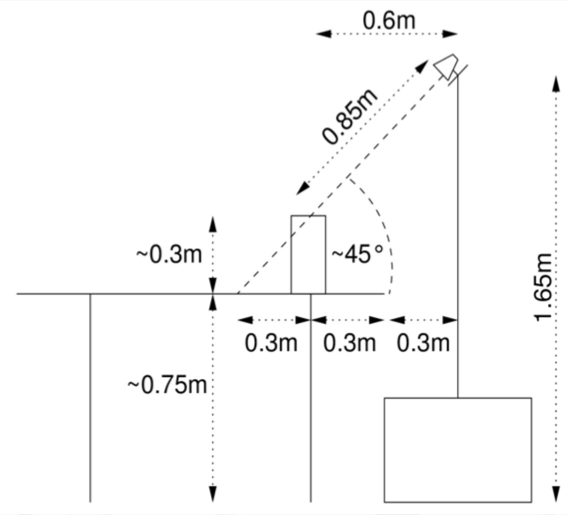
- *Perception* (ROS) includes ROS tabletop recognition and table detection and is available
  - sensory data will be retrieved by the (front) Kinect
- *Manipulation* (ROS) is available in the ROS manipulation stack
  - the Jaco Arm model has to be integrated
- *Adapter* provides transparent communication between ROS and MIRA
  - translates between Services (RPC), Actions (Callbacks) and Messages

Outline

Kinect Integration



Kinect Integration cont'd



Robot Arm Kinova Jaco

- payload 1.5 kg, weight 5.7 kg
- (horizontal) range of 0.9 m
- fixed 3 finger gripper
- USB (CAN) interface
- fall-back joystick control possible
- arm loses its position when powered-off, nevertheless several park positions available

Robot Arm Kino Jaco cont'd

- ROS API available for Ubuntu (11.04) and ROS Electric
- basically a ROS wrapper for the (Windows) proprietary kinematic controller libraries
  - uses the Linux Mono project
- provides a 3D model for visualization in RViz
- controllable by setting each interpolation point's velocity
- official release of the ROS driver is planned for autumn (Sep-Dec?) 2012
- driver development is done at a German university and direct developer contact is possible

Touch Interface

related to T4.4 'Design of interfaces for Human Robot Interaction'

- using a ROS node to send commands to the robot
- node receives command via the network from the tablet
- UHAM made some experiments with using an iPad to control a humanoid 5-finger hand
  - can be extended by a Robot-Era (domestic) centric GUI

Issues

- 3D collision avoidance (without tilting laser)
- PEIS-ROS bridge needed
- Kinect height of 1.1 m and thus ca. 0.4 m above table plane might be not sufficient to segment (high) objects on top of the table (better place it on top of the robot at 1.6 to 1.7 m)
- Arm height of ca. 1.1 m might reduce collision free position when manipulation on the tabletop
- establish close Kinova Jaco developer contact

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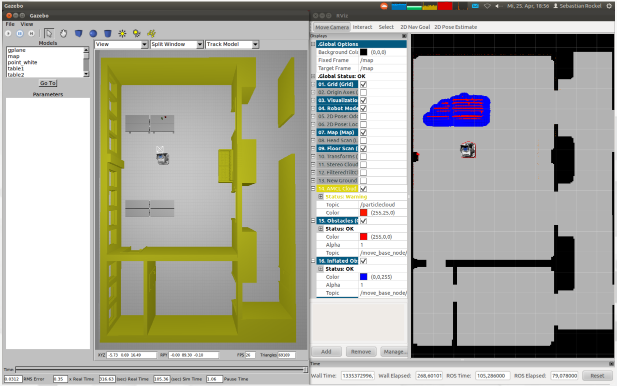
ROS Gazebo Simulation

- will there be the test environment available as Gazebo world? (ORU, SSSA?)



Outline

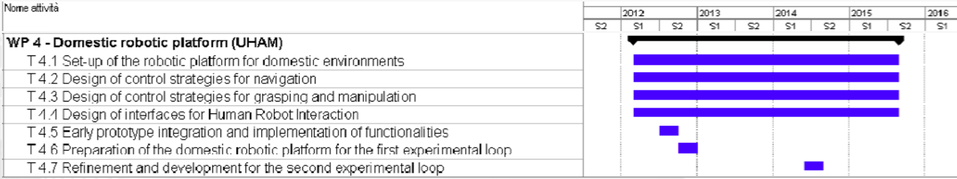
Deliverables

Deliverable Number [61]	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature [62]	Dissemination level [63]	Delivery date [64]
D4.1	Report on specifications and middleware architecture of the domestic robotic platform	7	8.00	R	CO	5
D4.2	First domestic robotic platform prototype for the first experimental loop	5	42.00	P	PU	15
D4.3	Final domestic robotic platform prototype for the second experimental loop	5	38.00	P	PU	32
D4.4	Report on the final domestic robotic platform and documentation about usage	5	4.00	R	PU	44
		Total	92.00			

Milestones

Milestone number [59]	Milestone name	Lead beneficiary number	Delivery date from Annex I [60]	Comments
MS2	Delivery of robotic platforms and AmI infrastructure prototype for the first experimental loop	1	15	
MS5	Delivery of robotic platforms and AmI infrastructure prototype for the second experimental loop	1	35	

Tasks


Nome attività
2012
2013
2014
2015
2016
S2
S1
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S1
S2
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S1
WP 4 - Domestic robotic platform (UHAM)
T 4.1 Set-up of the robotic platform for domestic environments
T 4.2 Design of control strategies for navigation
T 4.3 Design of control strategies for grasping and manipulation
T 4.4 Design of interfaces for Human Robot Interaction
T 4.5 Early prototype integration and implementation of functionalities
T 4.6 Preparation of the domestic robotic platform for the first experimental loop
T 4.7 Refinement and development for the second experimental loop

T4.1 Set-up of the robotic platform for domestic environments

UHAM, SSSA, MLAB, UOP, STM, M3-44

- integrate mobile platform, robotic arms and end-effectors (payload etc. according to WP2 criteria)
- integrate communication module (for connectivity with *AmI*)
- integrate additional sensors (stereo cameras, infra-red?)
- integrate HRI (touch screen, microphone, speakers, LED (see T4.4)
- integrate additional HW (handle, case, tray?)
- integrate security mechanisms (security buttons, bumpers)
- implement friendly, acceptable cover (see WP2)
- define middleware architecture

T4.2 Design of control strategies for navigation

MLAB, RT, SSSA, M3-44

- measure and integrate robot characteristics (shape, dynamics) into the navigation stack *(CogniDrive)*
- design people tracking and following
  - face tracking (OpenCV?)
  - motion tracking
- object trajectory prediction

T4.3 Design of control strategies for grasping and manipulation

UHAM, UOP, M3-44

- object detection via stereo-vision (Kinect), SIFT-feature, 3D laser ranger
- learning manipulation strategies (object ontology), handle unknown objects
- use results of hierarchical task network (HTN) planning algorithm
- image processing and detecting offline-trained common objects
- apply offline-learned grasps (later also online)
- integrate online learning manipulation and linguistic architecture (*UOP*)

T4.4 Design of interfaces for Human Robot Interaction

UOP, RT, M3-44

- investigate sophisticated HRI (via screen, e.g. emotional state, language)
  - wireless tablet with suited GUI?
  - control typical tasks, e.g. call robot, get out the trash bin, initiate plastic bag catching from shop etc.
  - provide information about the (ambient) sensor system to the user
- investigate natural language interaction
- explore Julius speech recognition system

T4.5 Early prototype integration and implementation of functionalities

UHAM, SSSA, UOP, MLAB, RT, M7-9

- integrate outcomes of previous tasks into robotic platform (navigation, manipulation, interaction, learning)
  - SW and firmware integration for different parts
  - Control strategy (high-level)

T4.6 Preparation of the domestic robotic platform for the first experimental loop

UHAM, MLAB, UOP, M10-12

- prepare robotic platform for experiments in Italy and Sweden
- shipping
- testing

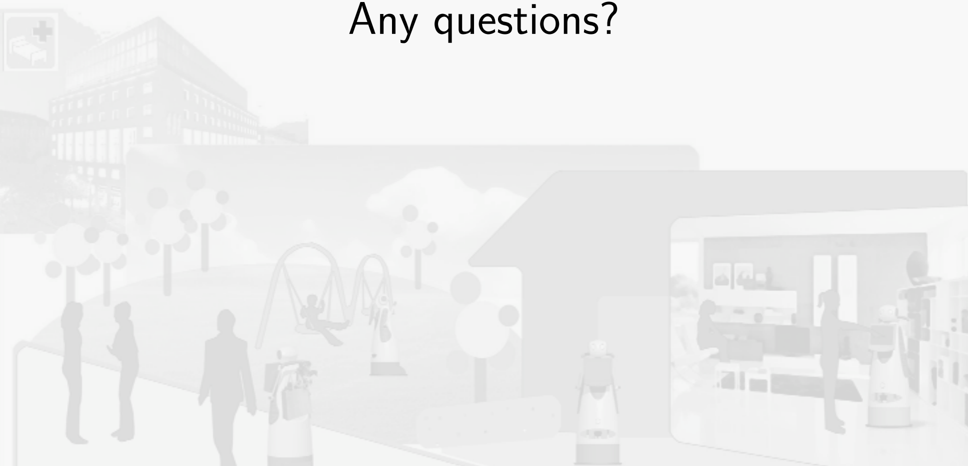
T4.7 Refinement and development for the second experimental loop

UHAM, UOP, M30-32

- integrate results of first experimental loop for improvements (T4.1-4.5)

Thank You!

Any questions?



Work Package Participation UHAM

Work Package	Person Month
1	1
2	2
3	2
4	44
5	2
6	2
7	6
8	6
9	2
10	5