Modular OpenRobot Simulation Engine
The ROS-middleware for MORSE
Michael Karg
Intelligent Autonomous Systems Group
Department of Computer Science
Technische Universität München

euRobotics Forum 2011 / Västerås
Outline

1. The IAS TUM group and the Adapto project
2. The MORSE simulator
3. MORSE and ROS
4. Application scenarios
1. The IAS TUM group and the Adapto project

2. The MORSE simulator

3. MORSE and ROS

4. Application scenarios
Who we are

- Part of the TUM - Intelligent Autonomous Systems group of Prof. Beetz
- Adapto project under the supervision of Dr. Alexandra Kirsch
- Plan based control mechanisms for human-robot interaction in domestic environments
- Reactive, opportunistic and adaptive planning
- Failure recognition and avoidance using expectation models
- Continual adaptation by learning prediction models
- Human aware navigation
Outline

1. The IAS TUM group and the Adapto project
2. The MORSE simulator
3. MORSE and ROS
4. Application scenarios
Why simulation?

- Simulation allows experiments on specific parts of a robotic system, (e.g. task planning)
- Real robot behavior is often hard to repeat (due to sensing, battery charge, ...)
- Many diverse environments are possible and different robot platforms are available at low cost
Why MORSE for our simulation?

- Modularity allows to regulate level of detail according to our needs (e.g. task planning)
- Human model is already available
- Human robot interaction scenarios can easily be generated in a computer-game like way
Outline

1. The IAS TUM group and the Adapto project

2. The MORSE simulator

3. MORSE and ROS
   - ROS
     - The Morse - ROS middleware
     - The Python 3 - situation

4. Application scenarios
ROS

- Operating system for robotics by Willow Garage
- Open source, BSD licensed
- Big, active community
- Documentation, tutorials, tech support

More information:
http://www.ros.org
ROS uses so called nodes and topics for communication with one master node.

The ROS-middleware in MORSE creates a MORSE-rosnode and one topic for every sensor and actuator according to the following scheme: [robot name]/[sensor or actuator name].

Communication with roscore using standard ROS messages to assure compatibility with standard ROS components.
Python 2 VS Python 3

- Blender uses Python 3
- ROS uses Python 2.6
- Python 3 is NOT downwardly compatible
- Porting of ROS-messaging parts to work on Python 2 AND 3
- Can safely be used with ROS overlays without affecting your Python2-ROS-installation
- Easy installation by executing one rosinstall-file

Installation instructions:

http://www.openrobots.org/wiki/morse
Outline

1. The IAS TUM group and the Adapto project

2. The MORSE simulator

3. MORSE and ROS

4. Application scenarios
   - TF - transformations
   - Mapping
   - ROS Navigation stack in MORSE
   - Human friendly navigation
   - Arm control using JointState-messages
   - Outlook: CRAM bindings for MORSE
Transform between multiple coordinate frames

- ROS TF builds a tree of all coordinate frames and provides means of conversion between them
- Create map and odometry coordinate frames based on the origin of the blender map and the robot truepose
- Create coordinate-frames of the robot using a robot-URDF and ROS robot state publisher
- Robot can easily exchanged if you have a URDF-file of it
Using ROS Gmapping

- Easy way to create maps of Blender scenarios
- Works out of the box
- Needs robot pose (Truepose or Localization), TF-tree and data of lasercanner
- Collision bounds define collision with laser scan
Video: Gmapping in MORSE (1)
Video: Gmapping in MORSE (2)
Video: Gmapping in MORSE (3)
Video: Gmapping in MORSE (3)
Using the ROS navigation stack in MORSE

- 2D navigation
- Takes information from odometry, sensor streams and a goal-pose and outputs safe velocity commands that can be used by a MORSE motion-actuator
- Uses TF-tree and map
- Comes with obstacle avoidance based on local and global costmaps
- Global and local planner can be replaced using ROS-Pluginlib
- Works with real PR2-robot
Video: ROS Navigation stack in MORSE
Human friendly navigation

- Replaces global planner of navigation stack
- Integrates human into robot path-planning
- Based on Move3D by LAAS CNRS
- Collision-free motion planning
- Social cost-function around the human pose
Video: Human friendly navigation
Controlling the Kuka-arm

- Send ROS-Jointstate-message to control every joint of the arm
Outlook: CRAM bindings for MORSE

- Cognitive Robot Abstract Machine
- Plan-based control of autonomous robots
- Based on CommonLISP
- Complex failure handling
- Task synchronization, parallel execution, resource management
- Goal: Perform complex activities in a human household

CRAM-PL ROS-package:
http://www.ros.org/wiki/cram_pl
Outlook: CRAM bindings for MORSE

- Cognitive Robot Abstract Machine
- Plan-based control of autonomous robots
- Based on CommonLISP
- Complex failure handling
- Task synchronization, parallel execution, resource management
- Goal: Perform complex activities in a human household

CRAM-PL ROS-package:
http://www.ros.org/wiki/cram_pl
Outlook: CRAM bindings for MORSE

(LET ((INNER-CONTACTS NIL))
  (WITH-FAILURE-HANDLING FAILURE ((CARRY-TRIES-COUNT CARRY-TRIES) (GRIP-TRIES-COUNT GRIP-TRIES) (FAIL :CLASS ENTITY-LOST-FAILURE))
    (RECOVER ((TYPEP FAILURE 'ENTITY-LOST-FAILURE)
      (LET ((SIDE (ENTITY-GRIPPING SIDE ENTITY NIL)))
        (HANDLE-PLAN-FAILURE GRIP-TRIES-COUNT :ENTITY ENTITY :DO-RETRY ((RECOVER ARM-POS SIDE))
          (T (HANDLE-PLAN-FAILURE 0 :ENTITY ENTITY))))
      (FAIL :CLASS NO-ROUTINE-FOUND-FAILURE)
      (HANDLE-PLAN-FAILURE GRIP-TRIES-COUNT :ENTITY ENTITY :DO-RETRY ((RECOVER ARM-POS SIDE))
        (T (HANDLE-PLAN-FAILURE 0 :ENTITY ENTITY))))
    (FAIL :CLASS NO-ROUTINE-FOUND-FAILURE)
    (HANDLE-PLAN-FAILURE GRIP-TRIES-COUNT :ENTITY ENTITY :DO-RETRY ((RECOVER ARM-POS SIDE))
      (T (HANDLE-PLAN-FAILURE 0 :ENTITY ENTITY))))

(MONITOR)
(PERFORM
 (:TAG FIND-ENTITY
 (SETF ENTITY
 (EXPANDED-GOAL (:PERCEIVE ENTITY) :PERCEIVE ((DESIGNATOR TR-RULE-NAME SK
 (LET* ((#:GOAL1359 (MAKE-INSTANCE 'ENTITY-FOUND :DESIGNATOR DESIGNATOR)
     #:ROUTINE1360 (ARBITRATION #:GOAL1359 (COGITO::FILTER-SETTINGS
     #:ROUTINE-RES1361 NIL))
     (SETGV :GOAL-TASK (TYPE-OF #:GOAL1359) #:TAG-GOAL1363)
     (PULSE (GETGV :GOAL-START-FLUENT (TYPE-OF #:GOAL1359)))
     (:TAG #:TAG-GOAL1363
     (IF (NULL #:ROUTINE1360)
       (FAIL :CLASS NO-ROUTINE-FOUND-FAILURE :GOAL-CLASS (TYPE-OF #:GOAL1359))
       (EVAP-AND-FAIL-PROTECT
        (SEQ (WHEN (TYPEP #:ROUTINE1360 'EXTERNAL-LOW-LEVEL-ROUTINE) (ADD
        (COGITO::ADD-GOAL #:GOAL1359)
        (LET ((#:TIMEMODEL1364 (COGITO::GET-MODEL #:ROUTINE1360 :TIME))))))
      )))))

(LET ((#:ROUTINE-RES1496 NIL))
 (#:ROUTINE-RES1506 NIL))
 (#:ROUTINE-RES1633 NIL))
 (#:ROUTINE1370 (ARBITRATION #:GOAL1369 (COGITO::FILTER-SETTINGS (LIST)) NIL))
 (#:ROUTINE1380 (ARBITRATION #:GOAL1379 (COGITO::FILTER-SETTINGS (LIST)) NIL))
 (LET ((#:GOAL-TIMEOUT1365)
    (SEQ (WHEN (TYPEP #:ROUTINE1360 'EXTERNAL-LOW-LEVEL-ROUTINE) (ADD
    (COGITO::ADD-GOAL #:GOAL1359)
    (LET ((#:TIMEMODEL1364 (COGITO::GET-MODEL #:ROUTINE1360 :TIME))))))
  )))

(euRobotics Forum 2011)

The MORSE - ROS middleware
Summary

- MORSE in combination with ROS offer modular simulation adapted to your level of detail with widely used components and a big community.

- Outlook:
  - Full Python3 support for ROS
  - High-level HRI scenarios using CRAM language
  - Intuitive Interface for human control
  - Human robot interaction (Cooperative kitchen scenarios)

Summary:
Start using MORSE and ROS today!
Any questions?