YARP Plugins for Gazebo Simulator: development and application on the iCub and COMAN robots

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The WALK-MAN Project

WALK-MAN objectives and technologies to advance

- Soft robot design
- Agile whole-body locomotion
- Motion planning and control
- Perception and whole-body affordances
- Robust and powerful whole-body manipulation

High performance humanoid

Validation in realistic scenarios
- DARPA Robotics Challenge
- Own challenge demonstrators
- Real world exploitation scenario in collaboration with civil defense corps
other European projects directly working or contributing to the Gazebo and YARP ecosystem:
WALK-MAN SIMULATOR: Motivation

Module → Simulator → Module

DEVELOPING
TESTING
VALIDATION

Robot

TUNING
VALIDATION
Easy to use

Simulates sensors
- IMU, Cameras, RGB-D, ...

Expandable through plugins

Different Dynamics Engines
- ODE, Bullet, DART, SimBody

Open-Source

Large and active community
- OSRF, DARPA
gazebo_yarp_plugins

Interaction between YARP modules and Gazebo

- Interfaces: sensors, actuators...

Open-Source

- https://github.com/robotology/gazebo_yarp_plugins

gazebo_yarp_plugins
& robotInterface
gazebo_yarp_plugins & robotInterface

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Gazebo Plugin

- World, Model, Sensor and System

YARP Device Drivers

- Control Interfaces, Sensor Interfaces, ...
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Control Board Plugin
- position, velocity, torque...

Force/Torque sensor plugin

IMU plugin

Camera plugin

Apply External Wrench

Clock Synchronization Plugin
- Simulation clock vs wall clock – simulated real-time@1kHz (even on slow computers :P)
Clock Sync.

Module A

\( q_d \)

\( \tau_d \)

Simulator

\( t_{sim} \)

Module B

\( \dot{q} \)

\( dq \)

\( w \)
XACRO, URDF, SRDF & SDF

- **Visualization** – Status Monitoring (Forward Kinematics)
- **Control** (Inverse Kinematics/Inverse Dynamics)
- **Simulation** (Forward Dynamics)
- **Tool** (Automatic Conversion from CAD, output format of identification)
XACRO

...<xacro:if value="${GAZEBO_COMAN_USES_XTION}" />

<link name="Xtion_body">
  <inertial>
    <origin xyz="0.047 0 0.40" rpy="0 0 0"/>
    <mass value="0.39"/>
    <inertia ixx="0.01" ixy="3.34E-7" ixz="-2.66E-4" iyx="0.009"
       iyz="1.97E-6" izz="5.1E-4"/>
  </inertial>
  <visual>
    <origin xyz="-0.020281504 0.0 -0.68662053" rpy="0 0 -
       3.14159265359"/>
    <geometry name="Xtion_body_visual">
      <mesh
filename="package://coman_urdf/meshes/collada/Xtion/xtion_base.dae"
scale="0.03937 0.03937 0.03937"/>
    </geometry>
    <visual>
    <collision>
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       3.14159265359"/>
      <geometry name="Xtion_body_collision">
      <mesh
filename="package://coman_urdf/meshes/collada/simple/Xtion/xtion_base.stl"
scale="0.03937 0.03937 0.03937"/>
      </geometry>
    </collision>
    </link>

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Universal Robotic Description Format

- **coman.xacro**
- **coman.urdf**
- **coman.srdf**
- **coman.sdf**
XACRO, URDF, SRDF & SDF

Semantic Robot Description Format

- coman.xacro
- coman.urdf
- coman.srdf
- coman.sdf

- base_link
  - l_arm
    - LPitchSh
    - LRollSh
    - LYawSh
    - LPitchElb
    - ...
  - r_arm
    - RPitchSh
    - RRollSh
    - RYawSh
    - RPitchElb
    - ...
  - ...

- Link Collisions
- Homing Configurations
- ...

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Simulation Description Format

- Loaded Plugins
- Sensors
- …
Simulation Description Format (SDF)

```xml
<plugin filename="libgazebo_yarp_controlboard.so" name="coman_yarp_gazebo_plugin_torso">
  <yarpConfigurationFile>
    model://coman.urdf/conf/coman/coman_gazebo_torso.ini
  </yarpConfigurationFile>
  <initialConfiguration>
    0.0 0.0 0.0
  </initialConfiguration>
</plugin>

<plugin filename="libgazebo_yarp_jointsensors.so" name="coman_yarp_gazebo_plugin_torso_speed">
  <yarpConfigurationFile>
    model://coman.urdf/conf/coman/coman_gazebo_torso_speed.ini
  </yarpConfigurationFile>
</plugin>
```

COMAN & iCub Models

- https://github.com/EnricoMingo/iit-coman-ros-pkg
- https://github.com/robotology-playground/icub_gazebo

Robotology Superbuild

- https://github.com/robotology-playground/robotology-superbuild
YARP controllers in Gazebo: from simulation to execution
YARP controllers in Gazebo: from simulation to execution
Thanks for your attention!