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ASS4HR

An Artificial Somatosensory System for a Humanoid Robot
The ROS package.

USER MANUAL

Istituto di Calcolo
e Reti ad Alte Prestazioni

1 General Information

General Information section explains in general terms the system and the purpose for which it is intended. This software as distributed as-is under Apache License 2.0[1]

1.1. System Overview

ASS4HR are a ROS[2] modules to emulate a human somatosensors system on a humanoid robot. The design takes inspiration from the biological model but has been adapted to the robot's characteristics. The implementation, based on the use of the soft sensors paradigm, was done in Python[3] and uses the development tool for robots produced by SoftBank Robotics, NAOqi[4].

1.2. Organization of the Manual

The user's manual consists of four sections: General Information, System Summary, Getting Started, and Using The System.
General Information section explains in general terms the system and the purpose for which it is intended.
System Summary section provides a general overview of the system. The summary outlines the uses of the system's hardware and software requirements, system's configuration, user access levels and system's behavior in case of any contingencies.
Getting Started section explains how to get ASS4HR and install it.
Using The System section provides a detailed description of system functions.

[1] ASL 2.0 -`http://www.apache.org/licenses/LICENSE-2.0`
[2] Robot Operating System - `http://www.ros.org`
[3] Python - `https://www.python.org/`
[4] NAOqi - `http://doc.aldebaran.com/`

2

System Summary

This section presents the implementations of the ROS nodes that constitute the system architecture.

2.1. ROS Nodes

The software defines five nodes that make up the implementation of sensors, both real and virtual, referred to the humanoid robotic platform.

In particular, we have the modules *CurrentStimulus* and *TemperatureStimulus* which refer to real quantities related to the actuators. Instead the modules *AnxietyStimulus, ExertionStimulus,* and *ForcefulnessStimulus* have been defined referring to virtual sensors obtained by a particular combination of real sensors.

CurrentStimulus.py
TemperatureStimulus.py
AnxietyStimulus.py
ExertionStimulus.py
ForcefulnessStimulus.py

Finally, we have a module *Roboception* that combines the results published by the sensor nodes to obtain a particular behaviour (character) of the robot.

Roboception.py

2.2. System Configuration

The system has been developed and tested with Ubuntu 18.04 64-bit LTS. Therefore all configurations refer to this distribution.

It is assumed that the following software is already installed and working:

- Python 2.7 [1]
- ROS Melodic Morenia[2] (apt install ros-melodic-desktop)
- NAOqi Python SDK (≥2.5.5)[3]
- git (≥2.10.1)[4]

IMPORTANT: Set the environment variable PYTHONPATH to */path/to/python-sdk*/lib/python2.7/site-packages

[1] Python 2.7 - `https://www.python.org/download/releases/2.7/`
[2] ROS Melodic Morenia - `http://wiki.ros.org/melodic/Installation/Ubuntu`
[3] NAOqi 2.5 - `http://doc.aldebaran.com/2-5/dev/python/install_guide.html`
[4] GIT - `https://git-scm.com/`

3

Getting Started

3.1. Installation

To use the code it is necessary to define a ROS workspace, we suggest to carry out the following operations:

$ mkdir -p ~/Nao/src && cd ~/Nao/src && catkin_init_workspace

$ cd .. && catkin_make

Next step is to configure git global environment:

$ git config –global user.name "Name Surname"

$ git config –global user.email "email@email.org"

And then, clone in local the ASS4HR project:

$ cd ~/Nao/src

Download the ASS4HR project from the GitHub repository with the following instruction:

$ git clone https://github.com/crss-lab/ASS4HR somatosensory_system

$ catkin_create_pkg somatosensory_system

Finally, configure the shell environmental variables:

$ source ~/Nao/devel/setup.bash

Some *roslaunch* arguments can define both the IP address of the robot, the robot name, and many other parameters (see <*file*>.*launch* arg elements). Important, the *robot_name* parameter will identify the prefix of the ROS topic and node name:

- robot_ip:=<*ip or name of robot*>
- robot_name:=<*robot name*>

4

Using The System

4.1. Robot Characterization

To set the behavior of a robot, a general configuration file in xml is used. The file is structured to define the real sensors related to the actuators present and their possible combination, through two parameters *mod* and *inibh*. The first allows modulating the amplitude of the signal read by the sensor, the second allows activation or inhibition of the reading itself.

The file *~/Nao/somatosensory_system/config/xml/character.xml* defines some characters for two robots: naored (<robot name="naored">) and naogrey (<robot name="naogrey">).
The default (<character name="default">), emotive (<character name="emotive">), and sensitive to pain (<character name="sensitive_to_pain">) characters are defined for both robots.

~/Nao/somatosensory_system/config/xml/character.xml

```
<?xml version="1.0" ?>
<somatosensory_system>
    <robot name="naored">
        <characters>
            <character name="default">
                <roboception name="current_pain" topicname="current_stimulus">
                    <sensor name="HeadPitch" mod="0.5" inibh="1" />
                    <sensor name="LAnklePitch" mod="0.5" inibh="1" />
                    <sensor name="LAnkleRoll" mod="0.5" inibh="1" />
                    <sensor name="LElbowRoll" mod="0.5" inibh="1" />
                    <sensor name="LElbowYaw" mod="0.5" inibh="1" />
                    <sensor name="LHand" mod="0.5" inibh="1" />
                    <sensor name="LHipPitch" mod="0.5" inibh="1" />
                    <sensor name="LHipRoll" mod="0.5" inibh="1" />
                    <sensor name="LHipYawPitch" mod="0.5" inibh="1" />
                    <sensor name="LKneePitch" mod="0.5" inibh="1" />
                    <sensor name="LShoulderPitch" mod="0.5" inibh="1" />
                    <sensor name="LShoulderRoll" mod="0.5" inibh="1" />
                    <sensor name="LWristYaw" mod="0.5" inibh="1" />
                    <sensor name="RAnklePitch" mod="0.5" inibh="1" />
                    <sensor name="RAnkleRoll" mod="0.5" inibh="1" />
                    <sensor name="RElbowRoll" mod="0.5" inibh="1" />
                    <sensor name="RElbowYaw" mod="0.5" inibh="1" />
                    <sensor name="RHand" mod="0.5" inibh="1" />
                    <sensor name="RHipPitch" mod="0.5" inibh="1" />
                    <sensor name="RHipRoll" mod="0.5" inibh="1" />
                    <sensor name="RHipYawPitch" mod="0.5" inibh="1" />
                    <sensor name="RKneePitch" mod="0.5" inibh="1" />
                    <sensor name="RShoulderPitch" mod="0.5" inibh="1" />
                    <sensor name="RShoulderRoll" mod="0.5" inibh="1" />
                </roboception>
                <roboception name="temperature_pain" topicname="temperature_stimulus">
                    <sensor name="HeadPitch" mod="0.5" inibh="1" />
```

```
            <sensor name="LAnklePitch" mod="0.5" inibh="1" />
            <sensor name="LAnkleRoll" mod="0.5" inibh="1" />
            <sensor name="LElbowRoll" mod="0.5" inibh="1" />
            <sensor name="LElbowYaw" mod="0.5" inibh="1" />
            <sensor name="LHand" mod="0.5" inibh="1" />
            <sensor name="LHipPitch" mod="0.5" inibh="1" />
            <sensor name="LHipRoll" mod="0.5" inibh="1" />
            <sensor name="LHipYawPitch" mod="0.5" inibh="1" />
            <sensor name="LKneePitch" mod="0.5" inibh="1" />
            <sensor name="LShoulderPitch" mod="0.5" inibh="1" />
            <sensor name="LShoulderRoll" mod="0.5" inibh="1" />
            <sensor name="LWristYaw" mod="0.5" inibh="1" />
            <sensor name="RAnklePitch" mod="0.5" inibh="1" />
            <sensor name="RAnkleRoll" mod="0.5" inibh="1" />
            <sensor name="RElbowRoll" mod="0.5" inibh="1" />
            <sensor name="RElbowYaw" mod="0.5" inibh="1" />
            <sensor name="RHand" mod="0.5" inibh="1" />
            <sensor name="RHipPitch" mod="0.5" inibh="1" />
            <sensor name="RHipRoll" mod="0.5" inibh="1" />
            <sensor name="RHipYawPitch" mod="0.5" inibh="1" />
            <sensor name="RKneePitch" mod="0.5" inibh="1" />
            <sensor name="RShoulderPitch" mod="0.5" inibh="1" />
            <sensor name="RShoulderRoll" mod="0.5" inibh="1" />
        </roboception>
        <roboception name="anxiety" topicname="anxiety_stimulus">
            <sensor name="sonar" mod="0.5" inibh="1" />
        </roboception>
        <roboception name="exertion" topicname="exertion_stimulus">
                <sensor name="bodily" mod="0.5" inibh="1" />
                        </roboception>
        <roboception name="forcefulness" topicname="forcefulness_stimulus">
                <sensor name="energy" mod="0.5" inibh="1" />
        </roboception>
    </character>

    <character name="emotive">
        <roboception name="anxiety" topicname="anxiety_stimulus">
            <sensor name="sonar" mod="1.0" inibh="1" />
        </roboception>
    </character>

    <character name="sensitive_to_pain">
        <roboception name="current_pain" topicname="current_stimulus">
            <sensor name="HeadPitch" mod="1.0" inibh="1" />
            <sensor name="LAnklePitch" mod="1.0" inibh="1" />
            <sensor name="LAnkleRoll" mod="1.0" inibh="1" />
            <sensor name="LElbowRoll" mod="1.0" inibh="1" />
            <sensor name="LElbowYaw" mod="1.0" inibh="1" />
            <sensor name="LHand" mod="1.0" inibh="1" />
            <sensor name="LHipPitch" mod="1.0" inibh="1" />
            <sensor name="LHipRoll" mod="1.0" inibh="1" />
            <sensor name="LHipYawPitch" mod="1.0" inibh="1" />
            <sensor name="LKneePitch" mod="1.0" inibh="1" />
            <sensor name="LShoulderPitch" mod="1.0" inibh="1" />
            <sensor name="LShoulderRoll" mod="1.0" inibh="1" />
            <sensor name="LWristYaw" mod="1.0" inibh="1" />
            <sensor name="RAnklePitch" mod="1.0" inibh="1" />
            <sensor name="RAnkleRoll" mod="1.0" inibh="1" />
            <sensor name="RElbowRoll" mod="1.0" inibh="1" />
            <sensor name="RElbowYaw" mod="1.0" inibh="1" />
            <sensor name="RHand" mod="1.0" inibh="1" />
            <sensor name="RHipPitch" mod="1.0" inibh="1" />
            <sensor name="RHipRoll" mod="1.0" inibh="1" />
            <sensor name="RHipYawPitch" mod="1.0" inibh="1" />
            <sensor name="RKneePitch" mod="1.0" inibh="1" />
            <sensor name="RShoulderPitch" mod="1.0" inibh="1" />
            <sensor name="RShoulderRoll" mod="1.0" inibh="1" />
        </roboception>
        <roboception name="temperature_pain" topicname="temperature_stimulus">
            <sensor name="HeadPitch" mod="1.0" inibh="1" />
            <sensor name="LAnklePitch" mod="1.0" inibh="1" />
```

```
                <sensor name="LAnkleRoll" mod="1.0" inibh="1" />
                <sensor name="LElbowRoll" mod="1.0" inibh="1" />
                <sensor name="LElbowYaw" mod="1.0" inibh="1" />
                <sensor name="LHand" mod="1.0" inibh="1" />
                <sensor name="LHipPitch" mod="1.0" inibh="1" />
                <sensor name="LHipRoll" mod="1.0" inibh="1" />
                <sensor name="LHipYawPitch" mod="1.0" inibh="1" />
                <sensor name="LKneePitch" mod="1.0" inibh="1" />
                <sensor name="LShoulderPitch" mod="1.0" inibh="1" />
                <sensor name="LShoulderRoll" mod="1.0" inibh="1" />
                <sensor name="LWristYaw" mod="1.0" inibh="1" />
                <sensor name="RAnklePitch" mod="1.0" inibh="1" />
                <sensor name="RAnkleRoll" mod="1.0" inibh="1" />
                <sensor name="RElbowRoll" mod="1.0" inibh="1" />
                <sensor name="RElbowYaw" mod="1.0" inibh="1" />
                <sensor name="RHand" mod="1.0" inibh="1" />
                <sensor name="RHipPitch" mod="1.0" inibh="1" />
                <sensor name="RHipRoll" mod="1.0" inibh="1" />
                <sensor name="RHipYawPitch" mod="1.0" inibh="1" />
                <sensor name="RKneePitch" mod="1.0" inibh="1" />
                <sensor name="RShoulderPitch" mod="1.0" inibh="1" />
                <sensor name="RShoulderRoll" mod="1.0" inibh="1" />
            </roboception>
        </character>
    </characters>
 </robot>

<robot name="naogrey">
    <characters>
        <character name="default">
            <roboception name="current_pain" topicname="current_stimulus">
                <sensor name="HeadPitch" mod="0.5" inibh="1" />
                <sensor name="LAnklePitch" mod="0.5" inibh="1" />
                <sensor name="LAnkleRoll" mod="0.5" inibh="1" />
                <sensor name="LElbowRoll" mod="0.5" inibh="1" />
                <sensor name="LElbowYaw" mod="0.5" inibh="1" />
                <sensor name="LHand" mod="0.5" inibh="1" />
                <sensor name="LHipPitch" mod="0.5" inibh="1" />
                <sensor name="LHipRoll" mod="0.5" inibh="1" />
                <sensor name="LHipYawPitch" mod="0.5" inibh="1" />
                <sensor name="LKneePitch" mod="0.5" inibh="1" />
                <sensor name="LShoulderPitch" mod="0.5" inibh="1" />
                <sensor name="LShoulderRoll" mod="0.5" inibh="1" />
                <sensor name="LWristYaw" mod="0.5" inibh="1" />
                <sensor name="RAnklePitch" mod="0.5" inibh="1" />
                <sensor name="RAnkleRoll" mod="0.5" inibh="1" />
                <sensor name="RElbowRoll" mod="0.5" inibh="1" />
                <sensor name="RElbowYaw" mod="0.5" inibh="1" />
                <sensor name="RHand" mod="0.5" inibh="1" />
                <sensor name="RHipPitch" mod="0.5" inibh="1" />
                <sensor name="RHipRoll" mod="0.5" inibh="1" />
                <sensor name="RHipYawPitch" mod="0.5" inibh="1" />
                <sensor name="RKneePitch" mod="0.5" inibh="1" />
                <sensor name="RShoulderPitch" mod="0.5" inibh="1" />
                <sensor name="RShoulderRoll" mod="0.5" inibh="1" />
            </roboception>
            <roboception name="temperature_pain" topicname="temperature_stimulus">
                <sensor name="HeadPitch" mod="0.5" inibh="1" />
                <sensor name="LAnklePitch" mod="0.5" inibh="1" />
                <sensor name="LAnkleRoll" mod="0.5" inibh="1" />
                <sensor name="LElbowRoll" mod="0.5" inibh="1" />
                <sensor name="LElbowYaw" mod="0.5" inibh="1" />
                <sensor name="LHand" mod="0.5" inibh="1" />
                <sensor name="LHipPitch" mod="0.5" inibh="1" />
                <sensor name="LHipRoll" mod="0.5" inibh="1" />
                <sensor name="LHipYawPitch" mod="0.5" inibh="1" />
                <sensor name="LKneePitch" mod="0.5" inibh="1" />
                <sensor name="LShoulderPitch" mod="0.5" inibh="1" />
                <sensor name="LShoulderRoll" mod="0.5" inibh="1" />
                <sensor name="LWristYaw" mod="0.5" inibh="1" />
                <sensor name="RAnklePitch" mod="0.5" inibh="1" />
```

```
            <sensor name="RAnkleRoll" mod="0.5" inibh="1" />
            <sensor name="RElbowRoll" mod="0.5" inibh="1" />
            <sensor name="RElbowYaw" mod="0.5" inibh="1" />
            <sensor name="RHand" mod="0.5" inibh="1" />
            <sensor name="RHipPitch" mod="0.5" inibh="1" />
            <sensor name="RHipRoll" mod="0.5" inibh="1" />
            <sensor name="RHipYawPitch" mod="0.5" inibh="1" />
            <sensor name="RKneePitch" mod="0.5" inibh="1" />
            <sensor name="RShoulderPitch" mod="0.5" inibh="1" />
            <sensor name="RShoulderRoll" mod="0.5" inibh="1" />
        </roboception>
        <roboception name="anxiety" topicname="anxiety_stimulus">
            <sensor name="sonar" mod="0.5" inibh="1" />
        </roboception>
        <roboception name="exertion" topicname="exertion_stimulus">
                <sensor name="bodily" mod="0.5" inibh="1" />
                    </roboception>
        <roboception name="forcefulness" topicname="forcefulness_stimulus">
                <sensor name="energy" mod="0.5" inibh="1" />
        </roboception>
    </character>

    <character name="emotive">
        <roboception name="anxiety" topicname="anxiety_stimulus">
            <sensor name="sonar" mod="1.0" inibh="1" />
        </roboception>
    </character>

    <character name="sensitive_to_pain">
        <roboception name="current_pain" topicname="current_stimulus">
            <sensor name="HeadPitch" mod="1.0" inibh="1" />
            <sensor name="LAnklePitch" mod="1.0" inibh="1" />
            <sensor name="LAnkleRoll" mod="1.0" inibh="1" />
            <sensor name="LElbowRoll" mod="1.0" inibh="1" />
            <sensor name="LElbowYaw" mod="1.0" inibh="1" />
            <sensor name="LHand" mod="1.0" inibh="1" />
            <sensor name="LHipPitch" mod="1.0" inibh="1" />
            <sensor name="LHipRoll" mod="1.0" inibh="1" />
            <sensor name="LHipYawPitch" mod="1.0" inibh="1" />
            <sensor name="LKneePitch" mod="1.0" inibh="1" />
            <sensor name="LShoulderPitch" mod="1.0" inibh="1" />
            <sensor name="LShoulderRoll" mod="1.0" inibh="1" />
            <sensor name="LWristYaw" mod="1.0" inibh="1" />
            <sensor name="RAnklePitch" mod="1.0" inibh="1" />
            <sensor name="RAnkleRoll" mod="1.0" inibh="1" />
            <sensor name="RElbowRoll" mod="1.0" inibh="1" />
            <sensor name="RElbowYaw" mod="1.0" inibh="1" />
            <sensor name="RHand" mod="1.0" inibh="1" />
            <sensor name="RHipPitch" mod="1.0" inibh="1" />
            <sensor name="RHipRoll" mod="1.0" inibh="1" />
            <sensor name="RHipYawPitch" mod="1.0" inibh="1" />
            <sensor name="RKneePitch" mod="1.0" inibh="1" />
            <sensor name="RShoulderPitch" mod="1.0" inibh="1" />
            <sensor name="RShoulderRoll" mod="1.0" inibh="1" />
        </roboception>
        <roboception name="temperature_pain" topicname="temperature_stimulus">
            <sensor name="HeadPitch" mod="1.0" inibh="1" />
            <sensor name="LAnklePitch" mod="1.0" inibh="1" />
            <sensor name="LAnkleRoll" mod="1.0" inibh="1" />
            <sensor name="LElbowRoll" mod="1.0" inibh="1" />
            <sensor name="LElbowYaw" mod="1.0" inibh="1" />
            <sensor name="LHand" mod="1.0" inibh="1" />
            <sensor name="LHipPitch" mod="1.0" inibh="1" />
            <sensor name="LHipRoll" mod="1.0" inibh="1" />
            <sensor name="LHipYawPitch" mod="1.0" inibh="1" />
            <sensor name="LKneePitch" mod="1.0" inibh="1" />
            <sensor name="LShoulderPitch" mod="1.0" inibh="1" />
            <sensor name="LShoulderRoll" mod="1.0" inibh="1" />
            <sensor name="LWristYaw" mod="1.0" inibh="1" />
            <sensor name="RAnklePitch" mod="1.0" inibh="1" />
            <sensor name="RAnkleRoll" mod="1.0" inibh="1" />
```

```
                    <sensor name="RElbowRoll" mod="1.0" inibh="1" />
                    <sensor name="RElbowYaw" mod="1.0" inibh="1" />
                    <sensor name="RHand" mod="1.0" inibh="1" />
                    <sensor name="RHipPitch" mod="1.0" inibh="1" />
                    <sensor name="RHipRoll" mod="1.0" inibh="1" />
                    <sensor name="RHipYawPitch" mod="1.0" inibh="1" />
                    <sensor name="RKneePitch" mod="1.0" inibh="1" />
                    <sensor name="RShoulderPitch" mod="1.0" inibh="1" />
                    <sensor name="RShoulderRoll" mod="1.0" inibh="1" />
                </roboception>
            </character>
        </characters>
    </robot>
</somatosensory_system>
```

New characters or new configurations can be validated via *~/Nao/somatosensory_system/config/xml/character.xsd* file.

~/Nao/somatosensory_system/config/xml/character.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
    <xs:element name="somatosensory_system">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" ref="robot"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="robot">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="characters"/>
            </xs:sequence>
            <xs:attribute name="name" use="required" type="xs:NCName"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="characters">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" ref="character"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="character">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" ref="roboception"/>
            </xs:sequence>
            <xs:attribute name="name" use="required" type="xs:NCName"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="roboception">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" ref="sensor"/>
            </xs:sequence>
            <xs:attribute name="name" use="required" type="xs:NCName"/>
            <xs:attribute name="topicname" use="required" type="xs:NCName"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="sensor">
        <xs:complexType>
            <xs:attribute name="inibh" use="required" type="xs:integer"/>
            <xs:attribute name="mod" use="required" type="xs:decimal"/>
            <xs:attribute name="name" use="required" type="xs:NCName"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="mod" >
        <xs:simpleType>
```

```
          <xs:restriction base="xs:decimal">
             <xs:minInclusive value="0.0" />
             <xs:maxInclusive value="1.0" />
          </xs:restriction>
        </xs:simpleType>
    </xs:element>
    <xs:element name="inibh" >
        <xs:simpleType>
          <xs:restriction base="xs:integer">
              <xs:enumeration value="0"/>
              <xs:enumeration value="1"/>
          </xs:restriction>
        </xs:simpleType>
    </xs:element>
</xs:schema>
```

4.2. Runtime Testing

In this section presents examples to start the specific ROS nodes. In all the ROS launch files there are the *robot_ip*, *robot_port,* and *robot_name* args. Respectively, they represent the robot IP address, the NAOqi Broker connection port, and the name of the robot that defines the prefix of both the topic and the name of the ROS node.

4.2.1. AnxietyStimulus

ROS node *AnxietyStimulus* startup example:

$ roslaunch somatosensory_system AnxietyStimulus.launch intimateZone:=0.8 robot_ip:=172.20.0.103 \ robot_name:=naored

Use ROS startup script:

~/Nao/src/somatosensory_system/launch/AnxietyStimulus.launch

```
<launch>
        <arg name="robot_ip" default="naored" />
        <arg name="robot_port" default="$(optenv␣NAO_PORT␣9559)" />
        <arg name="robot_name" default="naored" />
        <arg name="personalZone" default="1.2" />
        <arg name="intimateZone" default="0.7" />

        <param name="robot_ip" type="string" value="$(arg␣robot_ip)" />
        <param name="robot_port" type="string" value="$(arg␣robot_port)" />
        <param name="robot_name" type="string" value="$(arg␣robot_name)" />
        <param name="personalZone" type="double" value="$(arg␣personalZone)" />
        <param name="intimateZone" type="double" value="$(arg␣intimateZone)" />
        <param name="config_file" type="string" value="$(find␣somatosensory_system)/
            config/xml/character.xml" />

        <!-- Launch Anxiety -->
        <node pkg="somatosensory_system" type="AnxietyStimulus.py" name="$(arg␣
            robot_name)_anxiety_stimulus" output="screen"/>
</launch>
```

The *personalZone* arg defines the distance (in meters) that represents the personal area of the robot. The *intimateZone* arg defines the distance (in meters) that represents the intimate area of the robot. IMPORTANT: *personalZone* must be greater than or equal to *intimateZone* distance.

4.2.2. Current Stimulus

ROS node *CurrentStimulus* startup example:

$ roslaunch somatosensory_system CurrentStimulus.launch robot_ip:=192.168.0.10 \ robot_name:=naored RC:=30

Use ROS startup script:

~/Nao/src/somatosensory_system/launch/CurrentStimulus.launch

```
<launch>
```

```
        <arg name="robot_ip" default="naored" />
        <arg name="robot_port" default="$(optenv␣NAO_PORT␣9559)" />
        <arg name="robot_name" default="naored" />
        <arg name="ts" default="0.0" />
        <arg name="td" default="100.0" />
        <arg name="RC" default="20" />

        <param name="robot_ip" type="string" value="$(arg␣robot_ip)" />
        <param name="robot_port" type="string" value="$(arg␣robot_port)" />
        <param name="robot_name" type="string" value="$(arg␣robot_name)" />
        <param name="ts" type="double" value="$(arg␣ts)" />
        <param name="td" type="double" value="$(arg␣td)" />
        <param name="RC" type="double" value="$(arg␣RC)" />
        <param name="config_file" type="string" value="$(find␣somatosensory_system)/
            config/xml/character.xml" />

        <!-- Launch Current Stimulus -->
        <node pkg="somatosensory_system" type="CurrentStimulus.py" name="$(arg␣
            robot_name)_current_stimulus" output="screen"/>
</launch>
```

The *ts* arg defines the initial time for the exponential function of the model applied to the specific sensation in the presence of the stimulus. The *td* arg defines the initial equivalent time for the exponential function of the model, applied to the specific sensation in the absence of the stimulus. Both *td* and *ts* are calculated, runtime, from the value of the sensation at the instant of variation of the stimulus. The *RC* arg defines a time constant (tau) of a model that represents an emulation of the somatosensory system.

4.2.3. Exertion Stimulus

ROS node *ExertionStimulus* startup example:

*$ roslaunch somatosensory_system ExertionStimulus.launch robot_ip:=192.168.0.10 *
robot_name:=naored

Use ROS startup script:

~/Nao/src/somatosensory_system/launch/ExertionStimulus.launch

```
<launch>
        <arg name="robot_ip" default="naored" />
        <arg name="robot_port" default="$(optenv␣NAO_PORT␣9559)" />
        <arg name="robot_name" default="naored" />
        <arg name="ts" default="0.0" />
        <arg name="td" default="100.0" />
        <arg name="RC" default="20.0" />

        <param name="robot_ip" type="string" value="$(arg␣robot_ip)" />
        <param name="robot_port" type="string" value="$(arg␣robot_port)" />
        <param name="robot_name" type="string" value="$(arg␣robot_name)" />
        <param name="ts" type="double" value="$(arg␣ts)" />
        <param name="td" type="double" value="$(arg␣td)" />
        <param name="RC" type="double" value="$(arg␣RC)" />
        <param name="config_file" type="string" value="$(find␣somatosensory_system)/
            config/xml/character.xml" />

        <!-- Launch Exertion Stimulus -->
        <node pkg="somatosensory_system" type="ExertionStimulus.py" name="$(arg␣
            robot_name)_exertion_stimulus" output="screen"/>
</launch>
```

The *ts* arg defines the initial time for the exponential function of the model applied to the specific sensation in the presence of the stimulus. The *td* arg defines the initial equivalent time for the exponential function of the model, applied to the specific sensation in the absence of the stimulus. Both *td* and *ts* are calculated, runtime, from the value of the sensation at the instant of variation of the stimulus. The *RC* arg defines a time constant (tau) of a model that represents an emulation of the somatosensory system.

4.2.4. Forcefulness Stimulus

ROS node *ForcefulnessStimulus* startup example:

*$ roslaunch somatosensory_system ForcefulnessStimulus.launch robot_ip:=192.168.0.10 *
robot_name:=naored tau:=70

Use ROS startup script:
~/Nao/src/somatosensory_system/launch/ForcefulnessStimulus.launch

```
<launch>
        <arg name="robot_ip" default="naored" />
        <arg name="robot_port" default="$(optenv␣NAO_PORT␣9559)" />
        <arg name="robot_name" default="naored" />
        <arg name="tau" default="100.0" />

        <param name="robot_ip" type="string" value="$(arg␣robot_ip)" />
        <param name="robot_port" type="string" value="$(arg␣robot_port)" />
        <param name="robot_name" type="string" value="$(arg␣robot_name)" />
        <param name="tau" type="double" value="$(arg␣tau)" />
        <param name="config_file" type="string" value="$(find␣somatosensory_system)/
            config/xml/character.xml" />

        <!-- Launch Forcefulness Stimulus -->
        <node pkg="somatosensory_system" type="ForcefulnessStimulus.py" name="$(arg␣
            robot_name)_forcefulness_stimulus" output="screen"/>
</launch>
```

The *tau* arg defines a time constant of a model that represents an emulation of the somatosensory system.

4.2.5. Temperature Stimulus

ROS node *TemperatureStimulus* startup example:
*$ roslaunch somatosensory_system TemperatureStimulus.launch robot_ip:=192.168.0.10 *
robot_name:=naored

Use ROS startup script:
~/Nao/src/somatosensory_system/launch/TemperatureStimulus.launch

```
<launch>
        <arg name="robot_ip" default="naored" />
        <arg name="robot_port" default="$(optenv␣NAO_PORT␣9559)" />
        <arg name="robot_name" default="naored" />
        <arg name="ts" default="0.0" />
        <arg name="td" default="100.0" />
        <arg name="RC" default="15.0" />

        <param name="robot_ip" type="string" value="$(arg␣robot_ip)" />
        <param name="robot_port" type="string" value="$(arg␣robot_port)" />
        <param name="robot_name" type="string" value="$(arg␣robot_name)" />
        <param name="ts" type="double" value="$(arg␣ts)" />
        <param name="td" type="double" value="$(arg␣td)" />
        <param name="RC" type="double" value="$(arg␣RC)" />
        <param name="config_file" type="string" value="$(find␣somatosensory_system)/
            config/xml/character.xml" />

        <!-- Launch Temperature Stimulus -->
        <node pkg="somatosensory_system" type="TemperatureStimulus.py" name="$(arg␣
            robot_name)_temperature_stimulus" output="screen"/>
</launch>
```

The *ts* arg defines the initial time for the exponential function of the model applied to the specific sensation in the presence of the stimulus. The *td* arg defines the initial equivalent time for the exponential function of the model, applied to the specific sensation in the absence of the stimulus. Both *td* and *ts* are calculated, runtime, from the value of the sensation at the instant of variation of the stimulus. The *RC* arg defines a time constant (tau) of a model that represents an emulation of the somatosensory system.

4.2.6. Roboception

ROS node *Roboception* startup example:
*$ roslaunch somatosensory_system Roboception.launch robot_ip:=192.168.0.10 *

robot_name:=naored character:=emotive

Use ROS startup script:

~/Nao/src/somatosensory_system/launch/Roboception.launch

```
<launch>
        <arg name="robot_ip" default="naored" />
        <arg name="robot_port" default="$(optenv␣NAO_PORT␣9559)" />
        <arg name="robot_name" default="naored" />
        <arg name="character" default="default" />

        <param name="robot_ip" type="string" value="$(arg␣robot_ip)" />
        <param name="robot_port" type="string" value="$(arg␣robot_port)" />
        <param name="robot_name" type="string" value="$(arg␣robot_name)" />
        <param name="character" type="string" value="$(arg␣character)" />
        <param name="config_file" type="string" value="$(find␣somatosensory_system)/
            config/xml/character.xml" />

        <!-- Launch Roboception -->
        <node pkg="somatosensory_system" type="Roboception.py" name="$(arg␣robot_name)_
            $(arg␣character)_roboception" output="screen"/>
</launch>
```

.