Robot Model Specifications [Preliminary]

This is a preliminary document, next major update will be published on March 29th. The section describing the Robot Model specifications are expected to be exhaustive. In case you feel that your team requires elements which are not described in this document (e.g. specific contact properties between the robot feet and the ground). Contact the TC as soon as possible and we will examine your request. The guidelines with respect to writing and reviewing models are still expected to receive major updates.

Introduction

This document aims at providing teams clear specifications on what is allowed for robot models but also advices on how to write their models and review the one provided by other teams.

The robot models for the competition will have to be written in the PROTO format. This format generally allows for a wider variety of sensors than what can be used for the humanoid league, therefore we will present additional constraints in this document.

The main concerns of those rules and the reasons for these restrictions are the following:

- From a **research** point of view, this competition aims at providing an environment for transfer learning through sim2real experiments.
- In order to achieve **realism**, the characteristics and design of the robots should be close to regular competitions and robots that teams could use.
- To ensure a **fair** competition, teams who try to model their robots accurately by taking into account noise models and flaws of their hardware should not be penalized with respect to others.
- Using an **automatic referee** implies a few additional constraints on the robot models
- Since the **resources** available for the simulation are limited, restrictions on the architecture of robots or on the accuracy of meshes might be required.

Model constraints

All the sensor and actuator nodes that are not explicitly mentioned in this section are forbidden during the competition.

Sensors

For several sensors, a LUT is used to specifiy the response of the sensor. This information is also used to specify the limits (min and max) for each sensor and the noise profile. This table should always be set according to the sensor used.

The following list of sensors is allowed with the restrictions mentioned here:

- Position sensors
  - The resolution of sensors should match hardware specifications
- Accelerometer
  - LUT should be specified
- Gyro
  - LUT should be specified
- Touch Sensor
  - The 3 different options are allowed `Bumper`, `Force`, `Force-3d`.
  - Noise should be used for `Force` and `Force-3d`
    - LUT should be specifed
  - Support for 6-axis sensors is under investigation
- Cameras
  - The maximal 'bandwidth' authorized is 100MB/s *per team* (based on raw RGB images). This requirements ensures that we are able to run the simulation at a reasonable speed. An example of valid configuration with 4 robots is the use of 640*480 images at 27 FPS.

Actuators

Active joints can be implemented in two different ways:

- Hinge Joint for angular articulations, with the following child:
  - A rotational motor with the field `maxTorque` set to a value matching the hardware specifications.
- SliderJoint for linear articulations, with the following child
  - A linear motor with the field `maxForce` set to a value matching the hardware specifications.

Both types of joints need to have the following children as well:

- A brake such as the maximal speed for the joint obtained by combining `maxTorque` or `maxForce` and the damping constant that match the hardware specification.
- A position sensor matching the constraints expressed in the previous section

Structure of the robot

Teams should provide in a dedicated file the configurations to be used:

- For upright posture (with fully extended knee)
- Longest extension posture

The robot should need to comport body parts with the following annotations:

- `[foot]`: for all the body parts that can be in contact with the ground when walking
- `[arm]`: for all body parts between shoulder and hand. Those parts are not allowed to touch the ball.
- `[shoulder]`: for the first arm joint

- `[hip]`: for the first leg joint with an axis lying parallel to the ground plane.

Model inspections

Semi-automated validation

The following properties of the robot are extracted automatically:

- `Htop`: In upright posture, the amplitude along the z component
- `Hleg`: In upright posture, z component between `[hip]` and the minimal value of the robot along z axis
- `Hhead`: In upright posture, z component between `[shoulder]` and the maximum value along z axis.
- `M`: the total mass of the robot
- `Hcom`: In upright posture, the height of center of mass.
- `BMI = M/Htop^2`
- `Width`: In upright posture, the diameter of the smallest cylinder in which the robot can fit
- `FootWidth, FootLength`: The size along y (resp x) axis of the bounding box for one foot.
- `MaxLength`: The maximal distance between two points of the robot in longest extension posture.

The following constraints are checked automatically

- `5 <= BMI <= 30`
- `(FootWidth*FootHeight) <= (2.2*Hcom)^2/32`
- `1.2 <= max(FootWidth,FootHeight)/min(FootWidth, FootHeight) <= 3.5`
- `Width <= 0.55 Htop`
- `0.35 Htop <= Hleg <= 0.7 Htop`
- `0.1 Htop <= Hhead <= 0.3 Htop`
- Check that only allowed sensors/actuators are used
  - All required fields should also be set (e.g LUT)

A document containing the following information is generated from the robot model:

- List of all the joints with their maximal torque and speed.
- List of the properties extracted automatically
- TO BE COMPLETED

Peer-reviewed validation

The points that should be validated during the review process are the following:

- Are specifications for custom actuators/sensors valid
- Visual check of annotations: `[foot]`, `[hand]`, `[shoulder]`, `[hip]`
- TO BE COMPLETED

Guidelines for writing your models

- Use the `DEF/USE` mechanism from `PROTO` files to keep the file simple and make the job of the reviewers easier.
- TO BE COMPLETED