From CAD to URDF: the detailed work flow for exoskeleton model

August 25, 2017

The first part of the process consists of generating link geometries. This is done by grouping together parts that move together into single geometries.
For references see [1].

1 From CAD to SimMechanics

1.1 Simple Representation

Use Simple Representation (Simp Rep) to group parts, pay attention to include ALL parts that are needed (possibly including screws). When doing this include and exclude components at the highest possible level.

1. open the CAD exoskeleton model ("C:\$Users\mlazzaroni\Desktop\Creo\robo_mate_$2017\$asm_robomate_sencillo.asm$) with Creo Parametric;
2. in "View" → "Manage Views" → "View Manager" → "Simp Rep" create a new simple representation. Include all the interested parts at the highest possible level. At the end of this process you have three simple representation: $sim\_leftleg$, $sim\_rightleg$ and sim_torso.

1.2 Save the grouped parts as shrinkwrap

This operation allows to shrink the grouped parts to one part.

1. in "File" → "Save as" save each simple representation as Shrinkwrap type. Name the file as the interested link, possibly with the "sim_" prefix.

2. in the dialog panel select:

   (a) Select Creation method → Faceted Solid;

   (b) Select a quality level as high as possible. Increase the quality gradually until computation time remains below 1 minute;

   (c) Uncheck the "Fill holes" check box;

   (d) Check the "Ignore skeletons" and "Ignore quilts" check boxes;

   (e) Check the "Assign mass properties" check box

   (f) In Datum references select additional datums reference joint axes (and eventually points ?) to assemble the robot mechanism afterwards;

   (g) In Mass Properties panel select Assign for the assembly;

   (h) Uncheck the "Use default template" and choose an empty template.

   Three files are generated: $sim\_leftleg.prt$, $sim\_rightleg.prt$ and $sim\_torso.prt$.

3. Open the .prt files generated and in "Model" → "Point" create a new point for the attachment of the exoskeleton with the human body. Save the coordinates for each point;

4. Check in "Analysis" → "Mass Properties" → the mass properties assigned. For change the measurements unit select "File" → "Prepare" → "Model Properties" and change in millimetre Kilogram Sec (mmKs) selecting interpret dimensions.

1.3 Assemble the robot using the shrunk parts

Create a new simulation mechanism and assemble the robot using the shrunk parts. Pay attention to assemble it as the original one.

1. Open Creo Parametric "New" → "Assembly" → sub-type "Design";

2. In "Model" → "Assemble" → "Assemble" → insert the first .prt file sim_torso;

3. In the "Component Placement" panel select "Default" constraint;

4. In "Model" → "Assemble" → "Assemble" → insert the second and the third .prt files $sim\_leftleg$ and $sim\_rightleg$:

   (a) For rotational joint choose the pin connection;

(b) In "Placement" select for axis alignment one axes of the new added part and one axes of the father part sim_torso and make then coincident;

(c) Select for translation one surface of the new added part and one surface of the father part sim_torso and make then coincident.

1.4 Convert from CAD files to SimMechanics

Convert from CAD files to SimMechanics using the tool SimMechanics Link, licensed by MathWorks (link is available on MathWorks website).

◇ Input: CAD assembly files (Creo or SolidWorks files)

◇ Output: XML model description file and .stl mesh files (you can visualize the meshes with MeshLab or Blender)

1. In Creo Parametric "Tools" → "Auxiliary Applications" start Simscape Multibody Link;
2. In "Tools" → "Tools" → "Simscape Multibody Link" → "Export" first generation. Before doing that check that the measurements units are the ones that you need (millimetre Kilogram Sec (mmKs) for our model).
3. Select the directory where to save the XML model description file $ExoskeletonXMLmodel$ and the mesh files for each part of the assembly $sim\_leftleg\_prt$, $sim\_rightleg\_prt$ and sim_torso_prt.

2 From SimMechanics to URDF

2.1 Convert from SimMechanics Link XML to URDF

To convert from SimMechanics Link XML to URDF the tool to be used is the one available on GitHub https://github.com/robotology/simmechanics-to-urdf, authored by Silvio Traversaro.

◇ Input: XML model description file from SimMechanics Link.

◇ Optional inputs: .csv file with joint and actuator specifications, yaml configuration file

◇ Output: XML model description (URDF)

the command line is:

$\$simmechanics-to-urdf XMLname --yalmYALMname --csv-jointCSVname --outputxml$

References

[1] Creo mechanism to urdfe, last update 12 May 2017. Available on line $http://wiki.icub.org/wiki/Creo\_Mechanism\_to\_URD$.