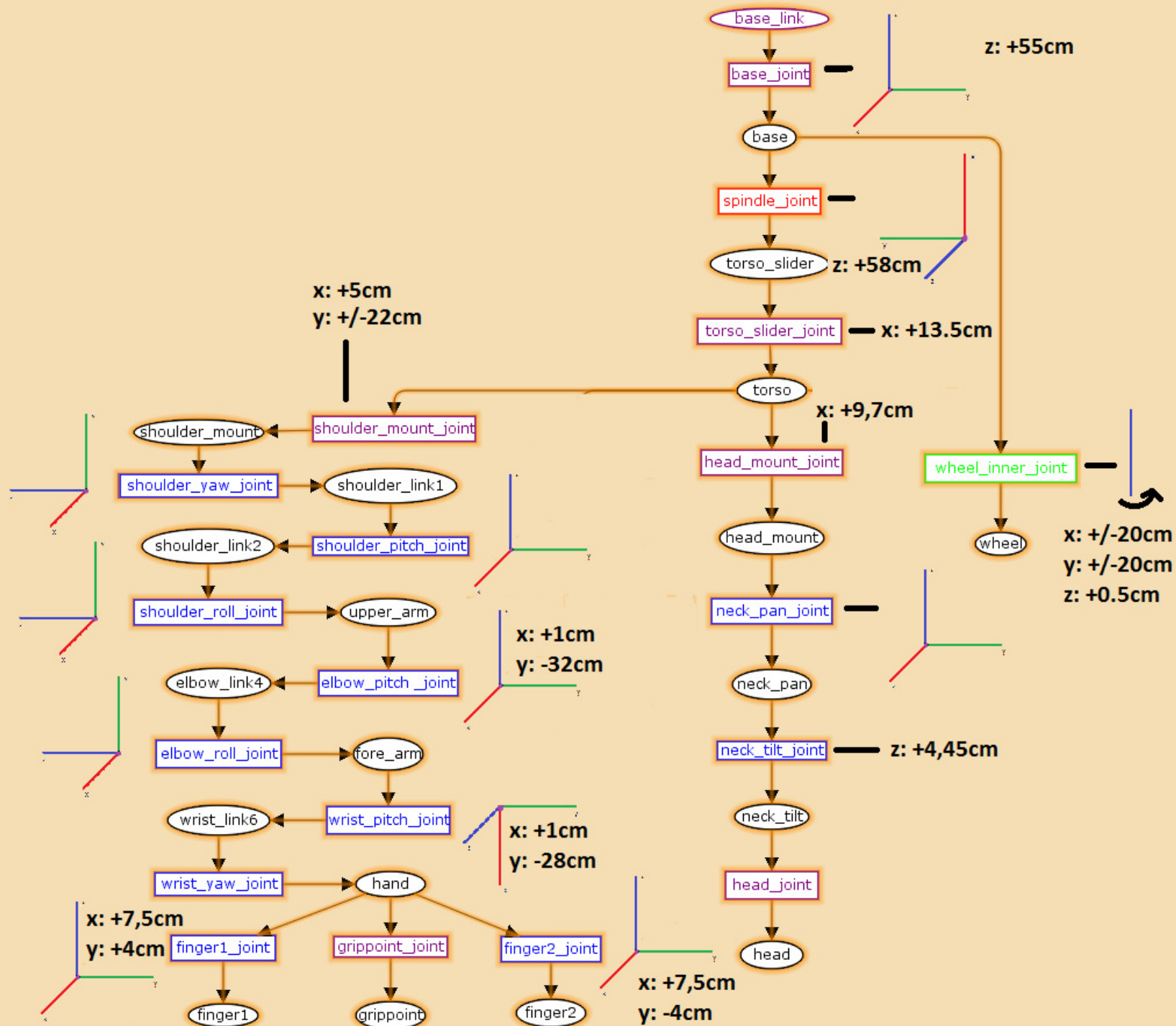


## Tf-tree

On the following page is an overview of the transformation tree, in short tf-tree. This tree shows the joints that are actuated and their links in between. A purple joint is fixed, a blue joint is revolute, a red joint is prismatic and a green joint is continuous. If the orientation of the joints changes this is indicated by a picture of the new coordinate system. The offsets between the joints are indicated as well, these changes apply after rotating the coordinate system.

The four wheels each have a different orientation, the joints describe a circle where the y-axis is always tangent to this circle, and the x-axis is always pointing out of, or away from, the circle. The z-axis in these orientations is always pointing up. The offset is unique for each of the four wheels, for example the left rear wheel has a positive y offset and a negative x offset.

Similarly the left shoulder\_mount\_joint has a negative y offset (y is pointing in the opposite direction here) and the right shoulder\_mount\_joint a positive y offset.



# Files

## **arm\_extra\_visuals**

In here all visual links and corresponding joints in the arms that cannot be mapped to the tf-tree are found. So it contains the black cylinders that seal the arms, the elbow links and wrist links.

## **arms\_DH**

All links and joints of the arms that are in the tf-tree above can be found here.

## **body**

All links and joints of the spindle, torso and bottomcovers that are in the tf-tree can be found here. The bottomcovers have a deviating bounding box because a normal one would be too inaccurate. Therefore separate bounding boxes are added for the batteries and computers on amigo. Also, in base\_link all values are 0 because this link only serves as a root to the tf-tree. The link for the spindle is called 'torso\_slider'.

## **body\_extra\_visuals**

Contains all visual links and corresponding joints of the body that cannot be mapped to the tf-tree. This means it contains the links for the metal sliders next to and behind the spindle, the objects that seal the body and the clavicles.

## **head**

In here are all links and joints for the head of amigo.

## **kinect**

The joints and links that represent the Kinect camera are in here.

## **laser**

The links and joints for the laser and tue-logo can be found here.

## **media**

Contains all the textures and corresponding scripts.

## **wheels**

All links and joints for the wheels are found here.

## **robot.urdf.xacro**

The main file that calls all other urdf.xacro files.

## **materials.urdf**

Contains the definitions of colors and textures for rviz.

## **definitions.urdf**

Contains the definitions for the my\_link and my\_joint macro's.

## Method

I was supplied with step files to use as meshes; the problem was these files were way too detailed. Step files can be edited in Inventor Fusion (Autodesk). What I did in this program is modify the step files such that they are less complex, i.e. I removed things like screw holes and straightened invisible curves. This can be done by removing faces; Inventor Fusion will calculate what the model should (most likely) be without this face. Please note that this means it can make a difference in which order you remove faces.

When I was done I converted these step files to stl files with CAD Exchanger and imported them in 3ds Max. In 3ds Max I first reduced the number of polygons in the model even further by using the modifier ProOptimizer, this is done as follows:

- Select the model
- Select modify in the menu on the right
- Choose ProOptimizer from the drop-down menu
- Click on calculate
- Set the optimization level to whatever percentage or vertex count you want

Then I textured the models using the Unwrap UVW modifier, the procedure is as follows:

- Select the model
- Select modify in the menu on the right
- Choose Unwrap UVW from the drop-down menu
- Click on the plus next to the modifier and select face
- Select all faces (ctrl+a)
- Choose the best fitting map parameter (box, cylinder, sphere etc.)
- Click on fit under map parameters
- Click on edit under parameters

A menu will pop up with the model unwrapped and contained in a square. For complex/reduced models this will probably look like a mess.

- Therefore click on flatten mapping under mapping
- Set the face angle threshold. The smaller the angle the more the pieces the model will be divided in. For the bottomcovers I used an angle of 100 degrees.
- Click on OK
- Now click on Render UVW Template under tools
- The standard settings should be good, so click Render UV Template.
- Save this image.
- Use this image, for example as a background in photoshop, to create a texture.
- Now back in the UVW menu, select remove texture from the dropdown menu to remove the standard checker pattern.
- Now click pick texture from this same dropdown menu
- Choose bitmap from the popup menu and click on OK
- Browse to your own texture

The model is now textured, however 3ds Max doesn't display it yet. To make it visible in 3ds Max, you have to add the texture as the material of the model as well. To do this:

- Press m (with the model selected)
- Click on the small square next to diffuse
- Choose bitmap and browse to your texture again
- Click on Assign Material to Selection in the material window
- Click on Show Standard Map in Viewport

You can now export the model as .dae file. There seems to be a bug in 3ds Max 2010 that doesn't allow for .dae files to be imported, so save your model normally (as .3ds file) as well so you can edit it later.

To make sure the texture is also displayed correctly in rviz, it is necessary the path in the .dae file that points to the texture is correct. So if you move your model or texture after creating it, modify the .dae file so the path is correct.

## Modifying urdf files

Things to remember when modifying urdf.xacro files:

- All links except the root of an object needs a parent
- The offset in a joint is always with respect to the previous joint, not the inertial/visual/collision origin.
- The offset of inertial/visual/collision origin is applied to the joint that precedes the link.
- Translation always precedes rotation in offset declaration.
- A color/texture needs to be defined both for rviz and gazebo.
- There are only three primitive shapes: boxes, cylinders and spheres. Want something else? Use meshes.
- It is recommended but not required to give every link a mass and inertia.
- If you want to add links that are not in the tf-tree, use fixed joints and don't make them a parent of anything in the tf-tree.
- Links can be made invisible by setting their size to 0.
- If you use custom materials (i.e. a Media folder in your package) don't forget to put '`<export> <gazebo gazebo_media_path="`${prefix}`"/> </export>`' in the manifest of your package.