Example: Model Editing

1.1 Introduction

In this example we will be modifying simple arm model with 2 degrees of freedom and 6 muscles. This simplified model is intended for demonstration purposes only and will help introduce you to the basic concepts of editing OpenSim models. Within this example we will add a bucket body for the right hand to hold and add an actuator to apply a torque between the hand and bucket.

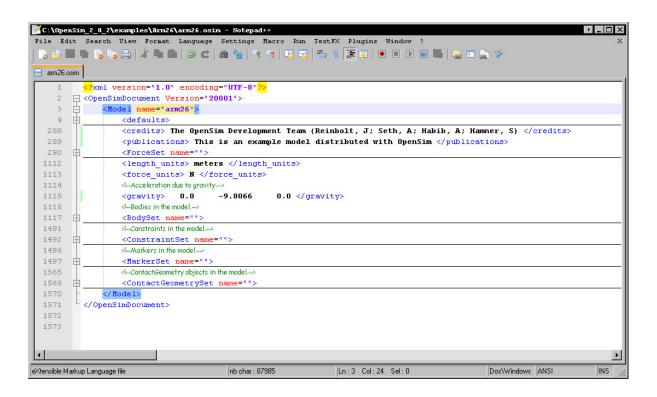
1.2 Setup

To get started, we'll copy some example files to a new working directory so we can prototype safely. Locate your OpenSim installation directory and navigate to the examples directory (e.g. C:\OpenSim\examples). Copy the Arm26 folder and paste it to a convenient working location like the Desktop. From within OpenSim, navigate to your new Arm26 directory and open arm26.osim. You should see a head and torso fixed to ground, one right arm consisting of a humerus and forearm, and six muscles.

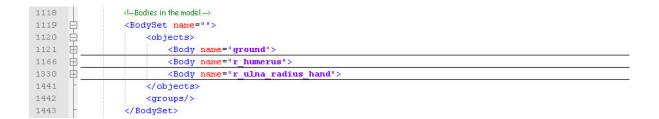
1.3 Connecting an Additional Segment to the Model

Open Model File in XML. Use an XML editor (e.g., Notepad++) to open the OpenSim model file (e.g., *arm26.osim*). When collapsed to the 3rd level (e.g., **Alt+3** in Notepad++), your model file should look like the figure below.

Explore the Model. The Model tag has five main sets named, ForceSet, BodySet, ConstraintSet, MarkerSet, and ContactGeometrySet.



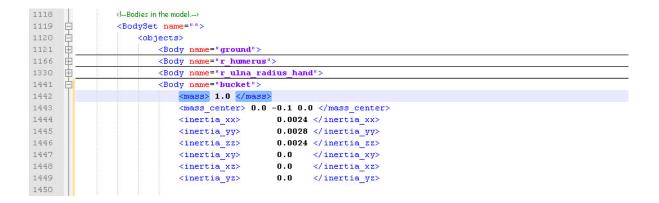
Explore the Body Set. The BodySet tag has three Body objects named ground, r_humerus, and r_ulna_radius_hand.



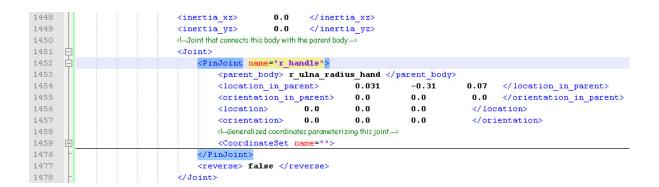
Add New Body. Add a new **Body** named **bucket** immediately below the **Body** named **r_ulna_radius_hand**.



Specify Mass Properties. Add tags and enter values for the mass, mass_center, inertia_xx, inertia_yy, inertia_zz, interia_xy, inertia_xz, and inertia_yz for the bucket as seen below:



Specify Joint. Add tags and names for the **PinJoint** and **parent_body**, and tags and values for **location_in_parent**, **location**, and **orientation** as seen below:



Specify Generalized Coordinate. Add a tag and name for the **Coordinate**, and add tags and values for **motion type**, **default_value**, **default_speed_value**, **initial_value**, **range**, **clamped**, and **locked** as seen below:

```
1457
                                                          0.0
                                                                      0.0
                                                                                  0.0
                                                                                                </orientation>
                                        <orientation>
                                        <!--Generalized coordinates parameterizing this joint.-->
1458
1459
                                         <CoordinateSet name="">
1460
                                             <objects>
1461
                                                  <Coordinate name="r handle rot">
1462
                                                     <!--Cooridnate can describe rotational, translational, or coupled values.</p>
1463
                                                      Defaults to rotational.-->
1464
                                                      <motion_type> rotational </motion_type>
1465
                                                      <default value> 0.0 </default value>
1466
                                                      <default_speed_value> 0.0 </default_speed_value>
                                                      <initial_value> 0.0 </initial_value>
1467
1468
                                                      <range> -3.14159265 3.14159265 </range>
1469
                                                      <clamped> false </clamped>
1470
                                                     <locked> false </locked>
1471
                                                     cribed_function/>
1472
1473
                                             </objects>
1474
                                            <arouns/>
1475
                                        </CoordinateSet>
1476
                                    </PinJoint>
1477
                                    <reverse> false </reverse>
                               </Joint>
1478
```

Specify Geometry File. Add a tag for VisibleObject and add the appropriate tags for **geometry_files**, and **VisibleProperties** as seen below:

```
</PinJoint>
1476
1477
                                <reverse> false </reverse>
1478
1479
1480
                                 <geometry files> bucket.vtp </geometry files>
1481
                                 <VisibleProperties name="">
1482
                                     <display_preference> 4 </display_preference>
1483
                                     <show_normals> false </show_normals>
1484
                                    <show axes> false </show axes>
1485
                                     <material_name> DEFAULT </material_name>
1486
                                 </VisibleProperties>
1487
                                 <scale factors>
                                                      1.0
                                                               1.0
                                                                           1.0 </scale factors>
                             </VisibleObject>
1488
1489
                         </Body>
```

Save Model File. From the XML editor, save the OpenSim model file (e.g., $arm26_with_bucket.osim$). Now open your new model in OpenSim to see the bucket!

1.4 Adding an Additional Actuator

1. Explore the ForceSet. The ForceSet tag has six Thelen2003Muscle objects named TRIlong, TRIlat, TRImed, BIClong, BICshort, and BRA.

```
290
                <ForceSet name="">
291
                     <objects>
292
                         <Thelen2003Muscle name="TRILong">
433
                         <Thelen2003Muscle name="TRILat"</pre>
564
                         <Thelen2003Muscle name="TRImed">
695
                         <Thelen2003Muscle name="BIClong">
882
                         <Thelen2003Muscle name="BICshort";</pre>
                         <Thelen2003Muscle name="BRA">
                     </objects>
```

2. Add New Actuator. Add a CoordinateActuator object named r_handle_rot_force immediately below the Thelen2003Muscle named BRA. Associate this CoordinateActuator with the r_handle_rot coordinate and specify an optimal_force of 1000.

```
313
                <ForceSet name="
314
                     <objects>
315
                        <Thelen2003Muscle name="TRIlong">
505
                         <Thelen2003Muscle name="TRIlat">
685
                         <Thelen2003Muscle name="TRImed">
                        <Thelen2003Muscle name="BIClong">
865
133
                         <Thelen2003Muscle name="BICshort">
                         <Thelen2003Muscle name="BRA">
329
443
                         <CoordinateActuator name="r_handle_rot_force">
444
                            <coordinate> r handle rot </coordinate>
445
                             <optimal_force>
                                              1000.00000000 </optimal_force>
446
                        </CoordinateActuator>
447
                     </objects>
448
                     <groups/>
                </ForceSet>
1449
```

3. **Save Model File.** From the XML editor, save the OpenSim model file (e.g., $arm26_with_bucket.osim$).

1.5 Thinking Further:

What can we add to the model to attach the hand to ground?

What could we use to measure interaction forces between the hand and the ground?