

# 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 3<sup>rd</sup> 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**.

```

1      <?xml version="1.0" encoding="UTF-8" ?>
2      <OpenSimDocument Version="20001">
3          <Model name="arm26">
4              <defaults>
288             <credits> The OpenSim Development Team (Reinbolt, J; Seth, A; Habib, A; Hammer, S) </credits>
289             <publications> This is an example model distributed with OpenSim </publications>
290             <ForceSet name="">
1112            <length_units> meters </length_units>
1113            <force_units> N </force_units>
1114            <!--Acceleration due to gravity-->
1115            <gravity> 0.0 -9.8066 0.0 </gravity>
1116            <!--Bodies in the model-->
1117            <BodySet name="">
1491            <!--Constraints in the model-->
1492            <ConstraintSet name="">
1496            <!--Markers in the model-->
1497            <MarkerSet name="">
1565            <!--ContactGeometry objects in the model-->
1566            <ContactGeometrySet name="">
1570            </Model>
1571        </OpenSimDocument>
1572
1573
    
```

**Explore the Body Set.** The **BodySet** tag has three **Body** objects named **ground**, **r\_humerus**, and **r\_ulna\_radius\_hand**.

```

1118            <!--Bodies in the model-->
1119            <BodySet name="">
1120                <objects>
1121                    <Body name="ground">
1166                    <Body name="r_humerus">
1330                    <Body name="r_ulna radius hand">
1441                </objects>
1442            </groups/>
1443            </BodySet>
    
```

**Add New Body.** Add a new **Body** named **bucket** immediately below the **Body** named **r\_ulna\_radius\_hand**.

```

1118 | <!--Bodies in the model-->
1119 | <BodySet name="" >
1120 |   <objects>
1121 |     <Body name="ground">
1166 |     <Body name="r humerus">
1330 |     <Body name="r ulna radius hand">
1441 |     <Body name="bucket" >
1443 |   </objects>
1444 | </groups/>
1445 | </BodySet>

```

**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:

```

1118 | <!--Bodies in the model-->
1119 | <BodySet name="" >
1120 |   <objects>
1121 |     <Body name="ground">
1166 |     <Body name="r humerus">
1330 |     <Body name="r ulna radius hand">
1441 |     <Body name="bucket">
1442 |       <mass> 1.0 </mass>
1443 |       <mass_center> 0.0 -0.1 0.0 </mass_center>
1444 |       <inertia_xx> 0.0024 </inertia_xx>
1445 |       <inertia_yy> 0.0028 </inertia_yy>
1446 |       <inertia_zz> 0.0024 </inertia_zz>
1447 |       <inertia_xy> 0.0 </inertia_xy>
1448 |       <inertia_xz> 0.0 </inertia_xz>
1449 |       <inertia_yz> 0.0 </inertia_yz>
1450 |

```

**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:

```

1448 | <inertia_xz> 0.0 </inertia_xz>
1449 | <inertia_yz> 0.0 </inertia_yz>
1450 | <!--Joint that connects this body with the parent body-->
1451 | <Joint>
1452 |   <PinJoint name="r_handle">
1453 |     <parent_body> r_ulna_radius_hand </parent_body>
1454 |     <location_in_parent> 0.031 -0.31 0.07 </location_in_parent>
1455 |     <orientation_in_parent> 0.0 0.0 0.0 </orientation_in_parent>
1456 |     <location> 0.0 0.0 0.0 </location>
1457 |     <orientation> 0.0 0.0 0.0 </orientation>
1458 |     <!--Generalized coordinates parameterizing this joint-->
1459 |     <CoordinateSet name="" >
1476 |   </PinJoint>
1477 |   <reverse> false </reverse>
1478 | </Joint>

```

**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:

```

1456 <location> 0.0 0.0 0.0 </location>
1457 <orientation> 0.0 0.0 0.0 </orientation>
1458 <!--Generalized coordinates parameterizing this joint.-->
1459 <CoordinateSet name="" >
1460 <objects>
1461 <Coordinate name="r_handle_rot">
1462 <!--Coordinate can describe rotational, translational, or coupled values.
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>
1467 <initial_value> 0.0 </initial_value>
1468 <range> -3.14159265 3.14159265 </range>
1469 <clamped> false </clamped>
1470 <locked> false </locked>
1471 <prescribed_function/>
1472 </Coordinate>
1473 </objects>
1474 <groups/>
1475 </CoordinateSet>
1476 </PinJoint>
1477 <reverse> false </reverse>
1478 </Joint>

```

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

```

1476 </PinJoint>
1477 <reverse> false </reverse>
1478 </Joint>
1479 <VisibleObject name="" >
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>
1488 </VisibleObject>
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 **TRllong**, **TRlLat**, **TRlmed**, **BIClong**, **BICshort**, and **BRA**.

```
290 | <ForceSet name="">
291 |   <objects>
292 |     <Thelen2003Muscle name="TRllong">
433 |     <Thelen2003Muscle name="TRlLat">
564 |     <Thelen2003Muscle name="TRlmed">
695 |     <Thelen2003Muscle name="BIClong">
882 |     <Thelen2003Muscle name="BICshort">
1021 |     <Thelen2003Muscle name="BRA">
1110 |   </objects>
1111 | </ForceSet>
```

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="TRllong">
505 |     <Thelen2003Muscle name="TRlLat">
685 |     <Thelen2003Muscle name="TRlmed">
865 |     <Thelen2003Muscle name="BIClong">
1133 |     <Thelen2003Muscle name="BICshort">
1329 |     <Thelen2003Muscle name="BRA">
1443 |     <CoordinateActuator name="r_handle_rot_force">
1444 |       <coordinate> r_handle_rot </coordinate>
1445 |       <optimal_force> 1000.00000000 </optimal_force>
1446 |     </CoordinateActuator>
1447 |   </objects>
1448 | </groups/>
1449 | </ForceSet>
```

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?