Altair

HyperWorks

Altair MotionView 2019 Tutorials

MV-1080: Creating an Analysis using MDL

altairhyperworks.com

MV-1080: Creating an Analysis using MDL

In this tutorial, you will learn how to create an analysis definition and instantiate it in an MDL file.

An analysis is a collection of loads, motions, output requests, and entities (bodies, joints, etc.) describing a particular event applied to a model. For example, an analysis to determine the kinematics of a four-bar mechanism can be described in one analysis, while another analysis can be used to study a dynamic behavior. In both cases, while the overall model is the same, the analysis container may contain different entities that form the event. The kinematic analysis can contain motion and related outputs, while the dynamic analysis may contain forces and its corresponding outputs.

- An analysis definition is similar to a system definition in syntax and usage, except:
    - Analysis definitions use `*DefineAnalysis()`, while system definitions use `*DefineSystem()`.
    - Analysis can be instantiated under the top level Model only.
    - Only one analysis can be active in the model at a given instance.
- A analysis definition block begins with `*DefineAnalysis()` and ends with `*EndDefine()`. All entities defined within this block are considered to be part of the analysis definition.

  The syntax of `*DefineAnalysis()` is as follows:

  ```
  *DefineAnalysis(ana_def_name,  arg_1,arg_2, ..., arg_n)
  ```

  Where;

  – `ana_def_name` is the variable name of the analysis definition and will be used while instantiating the analysis.

  – `arg_1,arg_2..arg_n` are a list of arguments passed to the analysis definition as attachments.
- The following table illustrates an analysis definition and its subsequent instantiation within an MDL file. Two files, an analysis definition file and the model file, work together when instantiating a particular analysis under study. Some of the terms in the example below are in bold to highlight a few key relationships between the files.

Reference Numbers	System Instantiation with Definition

1	`// Model : Body.mdl`
	`*BeginMDL(base_model, "Base Model")`

2	`//Instantiate the analysis definition ana_def`
	`*Analysis``(ana1, "Analysis 1", `**`ana_def`**`, j_rev)`

3	`//Begin Analysis Defintion Block`
	`*DefineAnalysis(ana_def,j_joint_att)`

Reference Numbers	System Instantiation with Definition

4	`//Declare a joint attachment to the analysis`
	`*Attachment(j__joint_att,` `"Joint Attachment",` **`Joint,`** `"Add an joint external to this analysis to apply motion/force")`

5	`//Entities within the analysis`
	`*Point(p_1, "Point in the analysis")`
	`*Body(b_1, "Body in the analysis")`

6	`//Define a joint with the body b_sys and the body attachment b_att`
	`*Motion(mot, "Joint Motion", JOINT,` **`j_joint_att,`** `ROT)`

7	**`*EndDefine()`** `//End Definition Block`
8	`*EndMDL()`

- The following table details the relationships between the analysis definition and its instantiation in the MDL Model file.

Variable	Relationship
`j_joint_att`	The varname of the attachment, declared in the `*Attachment()` statement (line 4) in the analysis definition file, appears as an argument in the `*DefineAnalysis()` statement (line 3). A motion is applied on this joint using the `*Motion()` statement (line 6).
`ana_def`	The varname of the analysis definition is specified in the `*DefineAnalysis()` statement (line 3). The analysis definition is used by `ana1` in the `*Analysis()` statement (line 2).

Defining relationships between the analysis definition and MDL model files

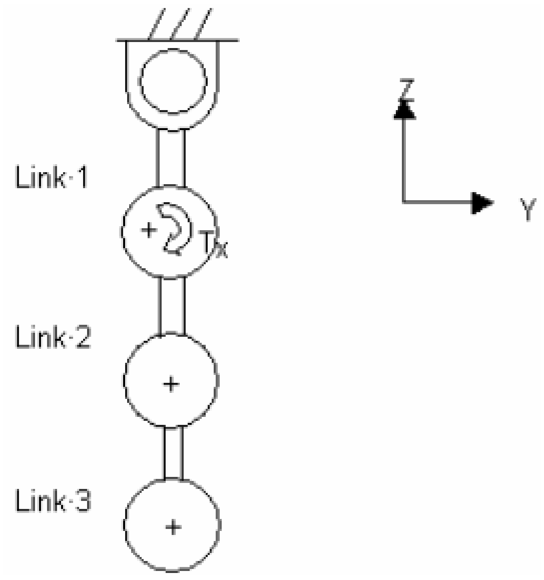
Exercise: Creating an Analysis Definition

An experimental technique for estimating the natural frequencies of structures is to measure the response to an impulsive force or torque, then look at the response in the frequency domain via a Fourier Transform. The peaks in the frequency response indicate the natural frequencies. In this tutorial, we will create an analysis to simulate this test procedure. The analysis applies an impulsive torque to the system and measures the response.

1. Use the following function expression to create the impulse torque about the x axis.

```
Tx = step(TIME,.3, 0, .31, 10) + step(TIME, .31, 0, .32, -10)
```

2. Apply this torque to estimate the natural frequencies of the triple pendulum model shown in the image below:



Schematic representation of a triple pendulum in stable equilibrium

Your analysis applies to a pendulum with any number of links or to more general systems.

	Pivot Point			Center of Mass			Inertias						
	X	Y	Z	X	Y	Z	Mass	I_{XX}	I_{YY}	I_{ZZ}	I_{XY}	I_{YZ}	I_{ZX}
	(mm)			(mm)			(kg)	(kg mm^2)					
Link 1	0	0	0	0	0	-5	1	1	1	1	0	0	0
Link 2	0	0	-5	0	0	-10	2	2	2	2	0	0	0
Link 3	0	0	-10	0	0	-15	1	1	1	1	0	0	0

Properties table for the triple pendulum

The following MDL statements are used in this exercise:

```
*Attachment()

*ActionReactionForce()

*SetForce()

*Output()
```

Note Refer to the *MotionView Reference Guide* (located in the *HyperWorks Desktop Reference Guide*) for the syntax of the above MDL statements.

Step 1: Create the analysis definition file.

1. Open an empty file in a text editor.
2. Create the `*DefineAnalysis()` and `*EndDefine()` block. All other statements will be added between this block.
   - In the text editor, define an analysis with a variable name of `def_ana_0` and one argument `j_att` as an attachment.

   ```
   *DefineAnalysis(def_ana_0, j_att)
   ```
3. The torque may be applied between two bodies connected by a revolute joint, with the origin of the revolute joint taken as the point of application of the force. This allows you to have only one attachment; the revolute joint.
   - Create an `*Attachment()` statement which defines `j_att` as the attachment and `Joint` as the entity type. Make sure that the variable name used in the statement is the same as is used in the `*DefineAnalysis()` statement.

   ```
   *Attachment(j_att, "Joint Attachment", Joint, "Select joint to apply
   torque")
   ```
4. Use the `*ActionReactionForce()` statement to define an applied torque. Please note to reference the correct properties of the attachment joint to reach the bodies involved in the joint.

   Note Refer to the description of the dot separator in MDL. You can access properties of an entity by using the dot separator.

   For example, bodies attached to the revolute joint can be accessed as: `<joint variable name>.b1` and as `<joint variable name>.b2`.

   - Create an `*ActionReactionForce()` statement with the following:
     - Variable name of `force_1`.
     - Force type as `ROT` (rotational).
     - Body 1 as `j_att.b1` (attachment joint body 1).
     - Body 2 as `j_att.b2` (attachment joint body 2).
     - Force application point as `j_att_i.origin` (the attachment joint origin).
     - Reference frame as `Global_Frame` (global).

   ```
   *ActionReactionForce( force_1, "Torque", ROT, j_att.b1, j_att.b2,
   j_att.origin, Global_Frame )
   ```

5. Use the `*SetForce()` statement to set the value to the force defined in the previous step.
   - Create a `*SetForce()` statement with a variable name of `force_1` (the existing force) and the following torque values:

   ```
   TX = step(TIME,.3,0,.31,10) + step(TIME,.31,0,.32,-10),TY = 0,TZ = 0
   ```
6. Use an `*Output()` statement to output the applied force.
   - Define an `*Output()` statement with the following:
     - Variable name of `o_force`.
     - Output type as `FORCE`.
     - Entity type as `FORCE`.
     - Variable name of `force_1` (the action-reaction force created in Step 3 above).
     - Reference frame as `Global_Frame` (global).

   ```
   *Output( o_force, "Input Torque", FORCE, FORCE, force_1, Global_Frame)
   ```
7. Save the analysis definition as `analysis.mdl`.

   The saved file `analysis.mdl` will look like this:

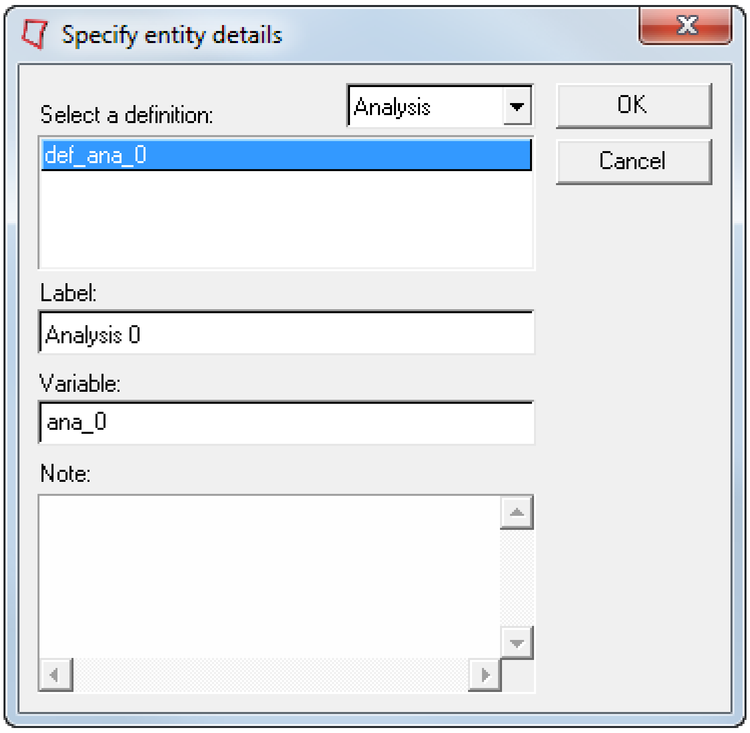
   ```
   *DefineAnalysis( def_ana_0,j_att )
    *Attachment(j_att, "Joint Attachment", Joint, "Select joint to apply
   torque")


    *ActionReactionForce( force_1, "Torque", ROT, j_att.b1, j_att.b2,
   j_att.origin,  Global_Frame )


   *SetForce( force_1, EXPR, `step(TIME,.3,0,.31,10) +
   step(TIME,.31,0,.32,-10)`)


   *Output( o_force, "Input Torque", FORCE, FORCE, force_1, Global_Frame)
   *EndDefine()
   ```

Step 2: Instantiate the analysis in a model.

1. Start MotionView and open the `triplependulum.mdl` file, located in the `mdl` folder.
2. From the **Project Browser**, click ***Model***.

   The **Systems/Assembly** panel is displayed.
3. Click the ***Import/Export*** tab.
4. Using the ***Select File:*** file browser, pick the analysis definition you just created, `analysis.mdl`.
5. Click ***Import***.

6. Make sure that the **Select a definition** drop-down menu is set to ***Analysis***.



Select a definition: Analysis

def_ana_0

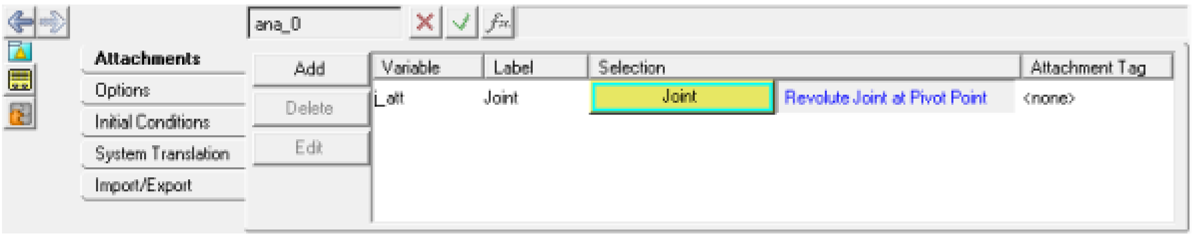
Label: Analysis 0

Variable: ana_0

7. Click ***OK***.
8. Select the newly added analysis by clicking on ***Analysis 0*** in the **Project Browser**, and resolve the joint attachment by selecting any one of the pivot joints of the triple pendulum:

   – From the **Attachments** tab, select the ***Joint Attachment***.

   – Select any pivot joint of the triple pendulum.



ana_0

Variable	Label	Selection		Attachment Tag
j_att	Joint	Joint	Revolute Joint at Pivot Point	<none>

9. Save your model as `new_triplependulum.mdl`.
10. Solve the model. From the **Main** tab of the **Run** panel, specify the **End time** as `1.0` and the **Print interval** as `0.01`.
11. View the animation .
12. Plot the output "`Input Torque`" using the `.abf` file from the solution.