NI-9512

Getting Started with NI SoftMotion™ for SolidWorks

This tutorial demonstrates how to set up and design motion simulations using NI SoftMotion for SolidWorks. You will use the LabVIEW Project to connect to a preconfigured SolidWorks motion study, create and configure NI SoftMotion axes for the motors in the SolidWorks assembly, and use NI SoftMotion Express VIs to create a trajectory for the SolidWorks simulation.

Tip If you encounter any problems, refer to the *Tips and Troubleshooting* section for assistance.

This document covers how to use NI SoftMotion Express VIs with your existing SolidWorks assemblies to create and evaluate motion profiles for your system. For information about using SolidWorks refer to the SolidWorks documentation.

Contents

NATIONAL INSTRUMENTS™

Required Components

This section lists the software used in the tutorial. This section also lists documents you may find helpful while completing the tutorial.

Required Software

The following software is required for this tutorial:

- ☐ LabVIEW 2011 (32-bit) or later
- ☐ LabVIEW NI SoftMotion Module Standard 2011 or later
- ☐ SolidWorks 2009 Service Pack 2.1 or later and SolidWorks Motion Simulation with the SolidWorks Motion add-in enabled from the **Tools»Add-ins** menu in SolidWorks. This is included with SolidWorks Premium, Simulation Premium, or Simulation Professional.

> **Tip** When you enable the SolidWorks Motion add-in from the **Add-Ins** dialog box in SolidWorks, place a checkmark in both the left and right checkboxes. This automatically enables the SolidWorks Motion add-in when SolidWorks launches.

You can download a free trial of the required National Instruments software from `ni.com/labview/family`.

Optional Hardware and Software

The following additional hardware and software is required to complete the *Step 4: Deploying to Hardware (Optional)* section of this tutorial:

- ☐ Software
  - – LabVIEW Real-Time Module 2011 or later
  - – NI-RIO 4.0.0 or later
- ☐ Hardware
  - – NI real-time controller
    - • CompactRIO controller and chassis that support the RIO Scan Interface

> **Tip** To determine if your controller and chassis support the RIO Scan Interface go to `ni.com/info` and enter the Info Code `rdsoftwareversion`.

      or

    - • NI 9144 distributed chassis and compatible RT controller
  - – Two NI 9512 single-axis stepper drive interface modules
  - – Power supply for the controller
  - – A separate power supply for the modules
  - – Ethernet connection and cable

Tip Even if you do not have the hardware used in this tutorial, you can follow the steps and perform offline configuration to learn concepts about using CompactRIO with LabVIEW.

Related Documentation

The following documents contain information that you may find helpful as you read this tutorial:

- *Getting Started with NI 951x C Series Modules and LabVIEW*—Use this document to learn about using the NI 951x modules with LabVIEW, including information about the LabVIEW NI SoftMotion Module. To access this document, select **Start»All Programs» National Instruments»LabVIEW»LabVIEW Manuals»Getting_Started_NI_951x_ Modules_LabVIEW.pdf**.
- *LabVIEW NI SoftMotion Module Help*—Use this help file to learn about using NI SoftMotion in LabVIEW including information about NI SoftMotion VIs and functions and using NI SoftMotion with the LabVIEW Project. To access this help file from LabVIEW, select **Help»LabVIEW Help**, then expand the *NI SoftMotion Module* book on the **Contents** tab.
- *LabVIEW Help*—Use the *LabVIEW Help* to access information about LabVIEW programming concepts, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, tools, properties, methods, events, dialog boxes, and so on. The *LabVIEW Help* also lists the LabVIEW documentation resources available from National Instruments. Access the *LabVIEW Help* by selecting **Help»LabVIEW Help**.
- *Getting Started with LabVIEW*—Use this document as a tutorial to familiarize yourself with the LabVIEW graphical programming environment and the basic LabVIEW features you use to build data acquisition and instrument control applications. Access the *Getting Started with LabVIEW* PDF by selecting **Start»All Programs»National Instruments» LabVIEW»LabVIEW Manuals»LV_Getting_Started.pdf**.
- *SolidWorks Help*

Note Refer to the software documentation for installation information.

Overview of NI SoftMotion for SolidWorks

Using NI SoftMotion with SolidWorks to simulate your system with actual motion profiles allows you to simulate mechanical dynamics, including mass and friction effects, cycle times, and individual component performance before specifying a single physical part and connecting it to an actual control algorithm. Digital prototyping offers the ability to visualize and optimize the design and evaluate different design concepts before incurring the cost of physical prototypes.

Integrating motion simulation with CAD simplifies design because the simulation uses information that already exists in the CAD model, such as assembly mates, couplings, and material mass properties. The NI SoftMotion Module provides easy to use APIs for programming the motion control system for users with little or no motion control programming experience.

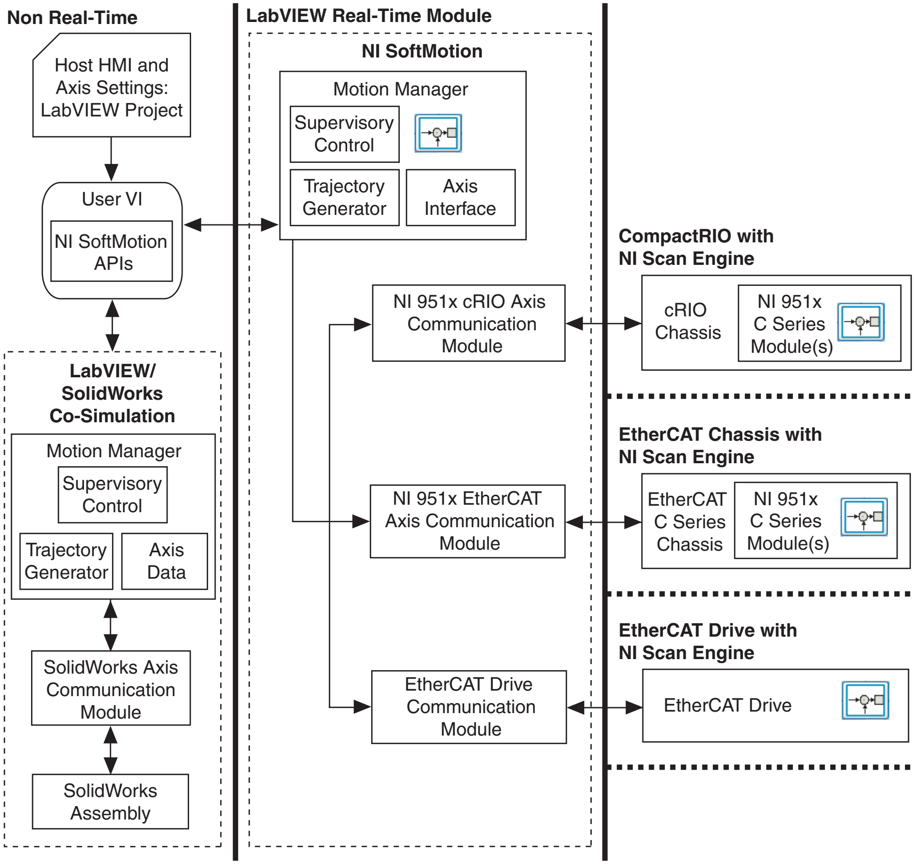
Typical applications for the LabVIEW NI SoftMotion Module with NI SoftMotion for SolidWorks include the following:

- **Motion trajectory design**—You can build complex motion profiles containing a series of sequential or concurrent move operations composed of multi-axis straight-line moves, contoured moves, arc moves, and even complex moves using electronic gearing and camming.
- **Visualization**—By animating your 3D SolidWorks assembly using the motion control profiles and timing/sequencing logic you have designed in LabVIEW, you can quickly evaluate the feasibility of the overall conceptual design for your machine.

  Visualizing the working machine as a virtual prototype helps to validate the overall conceptual design for the machine very early in the development. This fosters better communication with customers and between design team members and helps to close the loop on the design requirements, must-have features, and engineering trade-offs.
- **Collision detection**—The collision detection feature in SolidWorks enables you to validate your motion profile designs using your actual 3D CAD model. You can check for interferences, evaluate the need for interlock control logic to prevent collisions, optimize your motion profiles to minimize unnecessary dead time, quickly evaluate what-if scenarios, and safely test new control system logic without the risk of damaging your physical machine. After your machine has been designed, prototyped and deployed to the field, collision detection can also be used to validate new motion profiles before downloading them to machines operating at your customer site, reducing the risk of unplanned downtime due to programming mistakes.
- **Throughput time studies**—By validating your motion system design using a simulation that includes the actual motion profile constraints and the mechanical dynamics of your machine such as mass and friction, you can accurately calculate an estimate for the cycle time throughput of your machine.
- **Motor, drive, and transmission sizing**—Motor torque and velocity requirements depend on the acceleration characteristics of your motion profile and the mechanical dynamics of the payload and transmission components such as lead screws. Using NI SoftMotion, you can calculate the required motor torque and velocity charts for your motion profiles.

Figure 1 shows how the NI SoftMotion Module works with your SolidWorks assembly, and how you can use the same APIs after simulation to deploy to hardware.

Figure 1. NI SoftMotion Module with SolidWorks and Hardware



Step 1: Setting Up the LabVIEW Project

Before you can start designing motion profiles for your SolidWorks simulation, you need to import the information from your SolidWorks assembly into the LabVIEW Project and create NI SoftMotion axes for the simulated motors included in your assembly.

Tip Refer to the *Working with SolidWorks Assemblies* topic in the *NI SoftMotion Module* book of the *LabVIEW Help* for a list of caveats and recommendations to consider when creating and using SolidWorks assemblies with the NI SoftMotion Module.

Creating the LabVIEW Project File

Complete the following steps to create the LabVIEW Project. Depending on which version of LabVIEW you are using the steps are slightly different.

Creating a Project in LabVIEW 2012

1. Launch LabVIEW.
2. Select **File»Create Project** or **Project»Create Project** to display the **Create Project** dialog box. You can also click the **Create Project** button on the Getting Started window. The **Create Project** dialog box includes a list of templates and sample projects you can use to ensure that the project you create uses reliable designs and programming practices.
3. Select **Blank Project** from the list of templates.
4. Click **Finish**.
5. Select **Help** and make sure that **Show Context Help** is checked. You can refer to the context help throughout the tutorial for information about items on the block diagram.

Creating a Project in LabVIEW 2011 SP1 or Earlier

1. Launch LabVIEW.
2. Select **File»New Project** or **Project»New Project** to display the **Create Project** dialog box. You can also click the **Empty Project** link on the Getting Started window.
3. Select **Help** and make sure that **Show Context Help** is checked. You can refer to the context help throughout the tutorial for information about items on the block diagram.

Adding the SolidWorks Assembly to the Project

Complete the following steps to add the SolidWorks assembly to the LabVIEW Project:

1. Launch SolidWorks and open the Sorting Machine.SLDASM file from the <labview>\examples\motion\SolidWorks\SolidWorks Files directory. This model simulates an assembly that takes test tubes from one location and moves them to another.

   Note Verify that the SolidWorks Motion add-in available from the **Tools»Add-ins** menu in SolidWorks contains a checkmark in both the left and right checkboxes. This automatically enables the SolidWorks Motion add-in when SolidWorks launches.

   This tutorial focuses on using an arc move to transport the test tubes to a rotary table. At this point, the assembly and motion study must be ready to simulate with all the constraints and motors properly configured. Refer to the *SolidWorks Help* for more information about setting up a SolidWorks assembly.

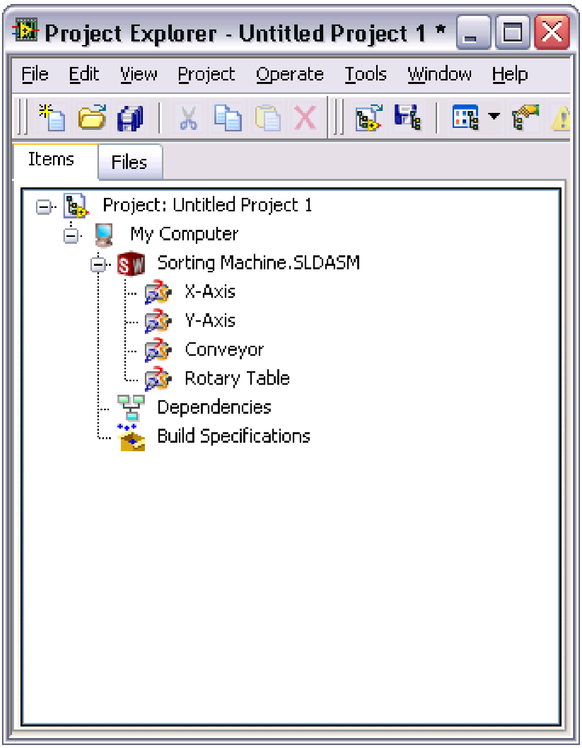
   Tip Use the NI Example Finder, available in LabVIEW at **Help»Find Examples** to find additional examples using NI SoftMotion for SolidWorks.

2. Right-click **My Computer** in the **Project Explorer** window and select **New»SolidWorks Assembly** from the shortcut menu to open the **Import SolidWorks Motors from Assembly File** dialog box.
3. Select the SolidWorks assembly to add to the LabVIEW project. If a SolidWorks assembly is currently open, the **Import SolidWorks Motors from Assembly File** dialog box contains the path of this assembly. Click **Browse** to select a different assembly file if necessary.
4. Click **OK**. The selected SolidWorks assembly is added to the **Project Explorer** window, including all motors contained in the SolidWorks motion study.

Note If the SolidWorks assembly contains multiple motion studies, choose the motion study to add to the project using the **Select Motion Study** dialog box. To change the motion study used in the project after adding the assembly, right-click the SolidWorks assembly item in the project tree and select **Change Motion Study** from the shortcut menu.

The following figure shows the **Project Explorer** window with a SolidWorks assembly added.

Figure 2. SolidWorks Assembly in the LabVIEW Project



5. Right-click the SolidWorks assembly in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Assembly Properties** dialog box. In the **Data Logging Properties** section, specify a name for the log file and place a checkmark in the **Log Data** checkbox. This will log position, velocity, acceleration, and torque data for the simulation to the specified file name in LabVIEW Measurement (`.lvm`) format.

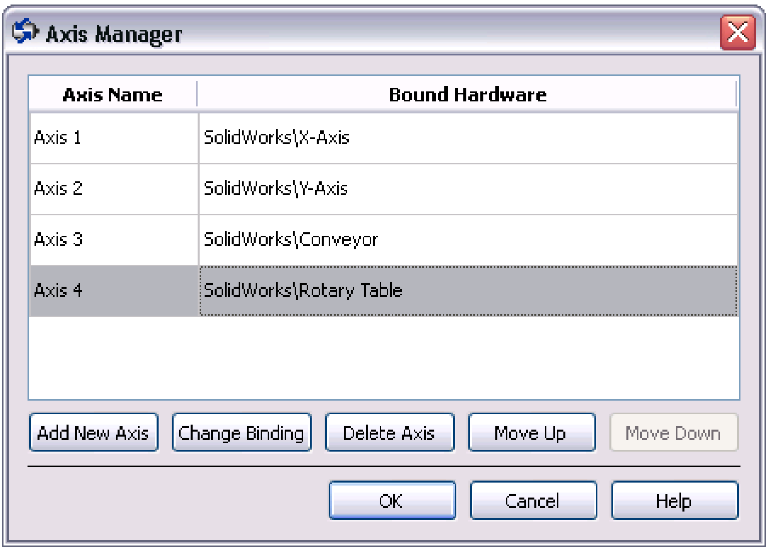
Note Each simulation overwrites the selected log file. To create a new log file for the next simulation you must change the file name before starting the simulation.

Adding Axes to the Project

To simulate using the SolidWorks motors included in the model, you need to associate the motors with NI SoftMotion axes. The NI SoftMotion axes are used when creating motion profiles using NI SoftMotion VIs and functions. Complete the following steps to add NI SoftMotion axes to the project:

1. Right-click **My Computer** in the **Project Explorer** window and select **New» NI SoftMotion Axis** from the shortcut menu to open the **Axis Manager** dialog box, shown in Figure 3.

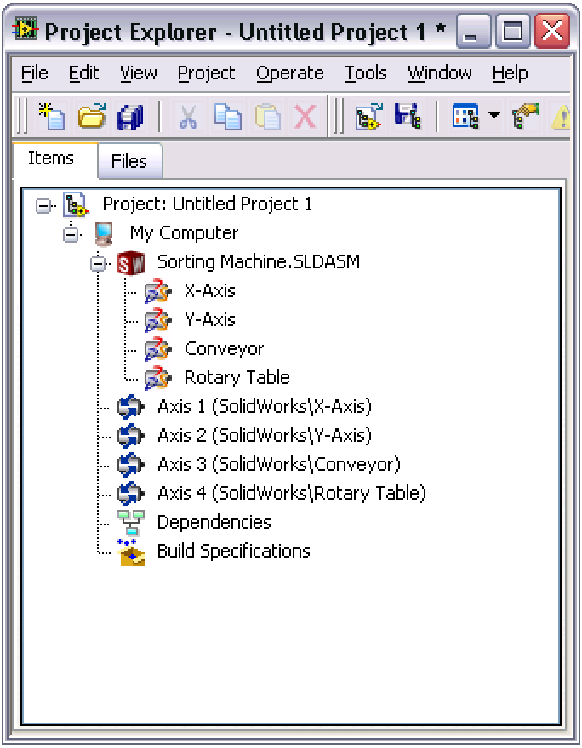
Figure 3. Axis Manager Dialog Box



2. Select **Add New Axis**. The new axis automatically binds to an available SolidWorks motor. Ensure that Axis 1 is associated with the X-Axis motor, and if it is not, double-click the name in the **Bound Hardware** column and select the correct motor.
3. Complete steps 1 through 2 for each additional axis. When you are finished, the **Axis Manager** dialog box will look similar to Figure 3.
4. (optional) Double-click the axis name to rename the axis and give it a descriptive name.

5. Click **OK**. All axes are added to the **Project Explorer** window as shown in the following figure.

Figure 4. Project Explorer Window with a SolidWorks Assembly and NI SoftMotion Axes

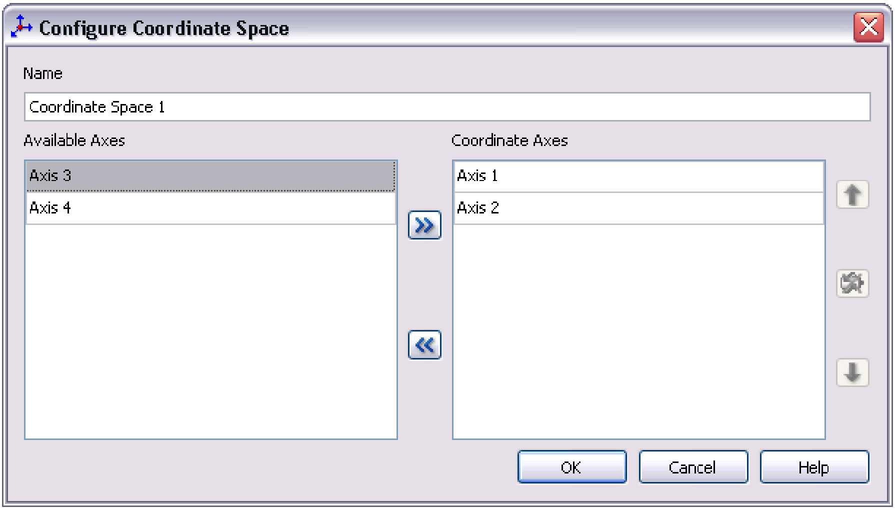


Adding Coordinates to the Project

NI SoftMotion axes can be grouped into coordinate spaces so that you can perform coordinated moves using multiple axes simultaneously. The coordinate spaces are used as inputs to your motion applications when performing coordinate moves. Complete the following steps to add a coordinate space to the project:

1. Right-click **My Computer** in the **Project Explorer** window and select **New» NI SoftMotion Coordinate Space** from the shortcut menu to open the **Configure Coordinate Space** dialog box, shown in Figure 5.
2. Move **Axis 1** and **Axis 2** from the **Available Axes** column to the **Coordinate Axes** column using the arrow. Double-click the coordinate space name to rename the coordinate space and give it a descriptive name.

Figure 5. Configure Coordinate Space Dialog Box

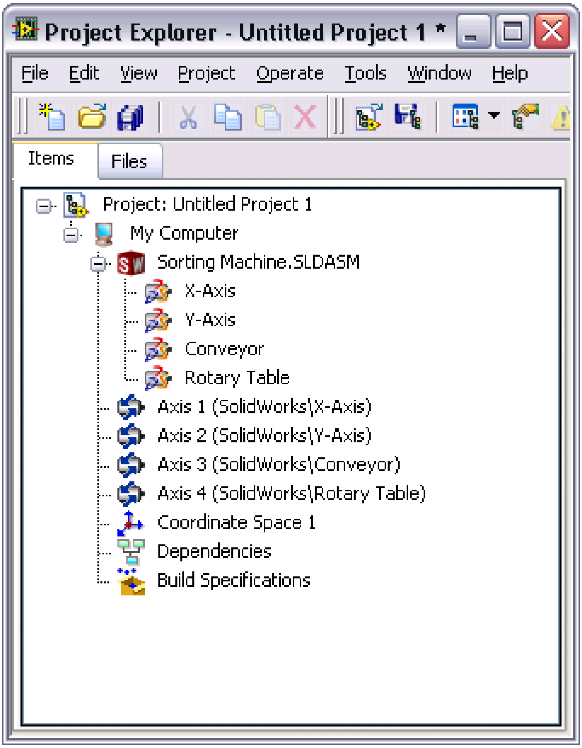


Note When using coordinate resources, target position and other information is contained in a one-dimensional array with axis information provided in the order that axes are added using this dialog box. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information.

3. Click **OK** to close the **Configure Coordinate Space** dialog box and add the new coordinate space to the LabVIEW Project.

Your project is now set up with the axes and coordinate spaces you will use in the application. Your LabVIEW project should look similar to Figure 6.

Figure 6. LabVIEW Project With NI SoftMotion Axes and Coordinates

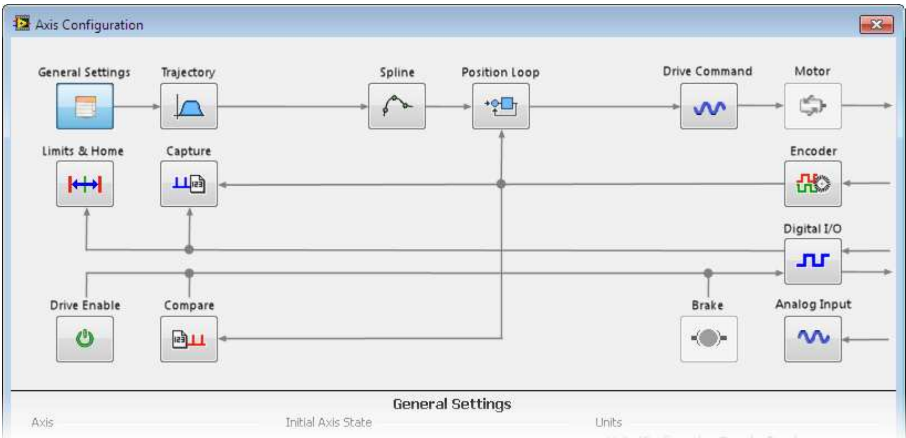


Step 2: Configuring the Axes

Axes associated with SolidWorks motors are assumed to be servo motors. Since the axes are not associated with actual hardware, you only need to perform minimal configuration to get started. Once you set up your simulation, you can change configuration settings on the axes for easy deployment to the final hardware using the profiles you create. Complete the following steps to configure the axes for use in your simulation:

1. Right-click the axis in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box. Figure 7 shows the parts of the **Axis Configuration** dialog box for SolidWorks axes. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for detailed information about each configuration option.

Figure 7. Axis Configuration Dialog Box for NI SoftMotion SolidWorks Axes



Note The **Axis Configuration** dialog box user interface may not match this image exactly depending on which version of the LabVIEW NI SoftMotion Module you are using.

2. On the **General Settings** page ( ) confirm that the **Axis Enabled** and **Enable Drive on Transition to Active Mode** checkboxes contain checkmarks. This automatically activates all axes when the NI Scan Engine switches to Active mode.

Tip You can also use Power to activate and enable axes.

3. Click **OK** to close the **Axis Configuration** dialog box.
4. Complete steps 1 through 3 for each remaining axis.

Step 3: Creating a Motion Profile and Running the Simulation

You create motion profiles for simulation with the SolidWorks assembly using the NI SoftMotion VIs and function on the **NI SoftMotion** palette. The NI SoftMotion Module offers Express VIs, properties and methods, and function blocks that allow you to perform straight-line moves, arc moves, contoured moves, gearing and camming operations, and read status and data information. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about using the NI SoftMotion VIs and functions.

Note If you are new to LabVIEW, refer to *Getting Started with LabVIEW*, at **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals**, for more information about creating, editing, and using LabVIEW VIs.

Creating a Move Profile

This example uses an existing NI SoftMotion Arc Express VI example with an NI SoftMotion coordinate resource to perform a circular arc move to deliver the test tube.

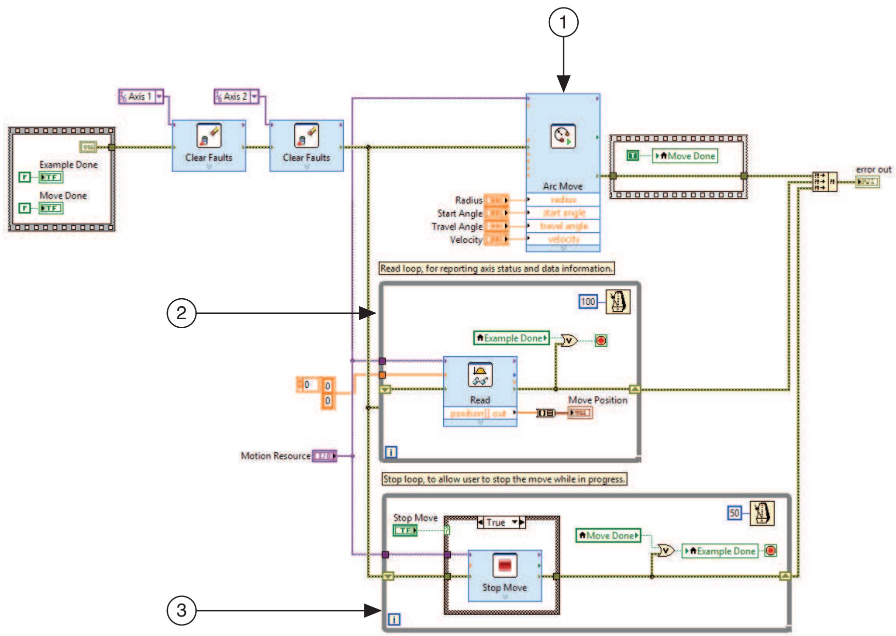
Tip The NI SoftMotion palette is not visible by default. Refer to the *Showing and Hiding Palette Categories* topic in the *LabVIEW Help* for information about editing the palette view to make the NI SoftMotion VIs and functions more accessible.

Complete the following steps to modify an existing example VI for your project:

1. Right-click the **My Computer** project tree item and select **Add»File** from the shortcut menu.
2. Navigate to the <LabVIEW>\examples\motion\ExpressVIs\Circular Arc Move folder and select the Circular Arc Move.vi file.
3. Open the VI from the project.
4. Navigate to the front panel and change the arc move parameters from the default values to the following:
   - **radius**: 50
   - **start angle**: 180
   - **travel angle**: 180
5. Keep the value for **velocity** at the default for now. You can change the velocity and run the simulation again to see how changes to the move constraints impact the system.
6. Save the VI.
7. Save the project.

Figure 8 shows the Circular Arc Express VI example block diagram.

Figure 8. NI SoftMotion Circular Arc Express VI Example



1 Arc Move Express VI.
2 Read loop, for reporting axis status and data information.
3 Stop loop, to allow user to stop the move while in progress.

Deploying, Running, and Stopping the Simulation

Complete the following steps to deploy and run the VI and start the SolidWorks simulation:

1. Right-click **My Computer** in the **Project Explorer** window and select **Properties** to display the **My Computer Properties** dialog box.
2. Select **Scan Engine** from the **Category** list and place a checkmark in the **Start Scan Engine on Deploy** checkbox.
3. Click **OK** to close the **My Computer Properties** dialog box.
4. Select the axes and coordinate items in the **Project Explorer** window, right-click and select **Deploy** from the shortcut menu. LabVIEW deploys all associated I/O resources and settings the VI uses.
5. Click **Apply** in the **Conflict Resolution** dialog box, if it appears.
6. Right-click **My Computer** in the **Project Explorer** window and select **Utilities»Scan Engine Mode»Switch to Active** to verify that the NI Scan Engine is in Active mode. If the **Switch to Active** option is disabled in the shortcut menu the NI Scan Engine is already in Active mode.

7. Right-click the SolidWorks assembly and select **Start Simulation** to start the SolidWorks simulation.
8. Run the VI. LabVIEW acts on the SolidWorks assembly using the move profile you created.
9. Right-click the SolidWorks assembly in the **Project Explorer** window and select **Stop Simulation** to stop the SolidWorks simulation.
10. Save the SolidWorks model, LabVIEW Project, and LabVIEW VI you created to apply any changes made.

Step 4: Deploying to Hardware (Optional)

In this section you will deploy the code written using the SolidWorks assembly to a CompactRIO system containing two NI 9512 C Series stepper drive interface modules.

Complete the following steps to run your simulation code on an actual hardware target:

Tip Refer to the *Getting Started with NI 951x Modules and LabVIEW* document, installed at `labview\manuals`, for detailed instructions for steps 1 through 3.

1. Add the RT target containing the NI 9512 C Series modules to the project.
2. Create an NI SoftMotion axis for each module, then add them to a coordinate space.

Note You can also drag the axes created in the *Adding Axes to the Project* section of this document under the RT target and remap them to the NI 9512 modules using the **Axis Manager** dialog box. All configuration options you selected previously are maintained.

3. Configure the axes:
   a. Right-click the axis in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box.
   b. On the **General Settings** page ( ), confirm that **Loop Mode** is set to **Open-Loop**. Axes configured in open-loop mode produce step output but do not require feedback from the motor to verify position.
   c. Also on the **General Settings** page, confirm that the **Axis Enabled** and **Enable Drive on Transition to Active Mode** checkboxes contain checkmarks.

   Note Disable these options to prevent axes from automatically activating when the NI Scan Engine switches to Active mode.

   d. If the modules do not have physical limit and home input connections, you must disable these input signals for proper system operation. To disable limits and home, go to the **Limits & Home** page ( ) and remove the checkmarks from the **Enable** checkboxes in the **Forward Limit**, **Reverse Limit**, and **Home Switch** sections.
   e. Configure any additional I/O settings according to your system requirements.

Note Make sure that the units and scaling configured for **Steps Per Unit** on the **Stepper** page (if applicable) and **Counts Per Unit** on the **Encoder** page match your motion system requirements. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information.

f. Click **OK** to close the **Axis Configuration** dialog box.

g. Repeat steps a through f for Axis 2.

4. Drag the VI from under the SolidWorks assembly project item to the cRIO target and update the resource associations to use the axes associated with the NI 9512 modules rather than the SolidWorks motors.

Caution Make sure all hardware connections are made and power is turned on before deploying the project. Deployment switches the NI Scan Engine to Active mode and enables your axes and drive, if connected, so that you can start a move immediately. Refer to the *Deploying and Running VIs on an RT Target* topic in the *LabVIEW Help* for more information about deployment and deployment troubleshooting tips.

5. Right-click the controller item in the **Project Explorer** window and select **Deploy All** from the shortcut menu to deploy the axes, coordinate, and axis settings to the RT target.
6. Run the VI. The VI and all associated resources are deployed to the hardware target.

Tips and Troubleshooting

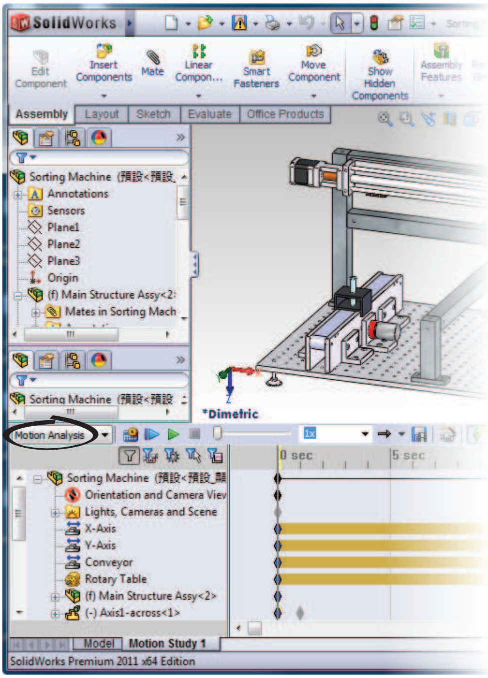
Receive Error -77095

(`NIMCDM_solidworksMotionStudyTypeNotSupportedError`)

Verify that the SolidWorks Motion add-in is enabled from the **Tools»Add-ins** menu in SolidWorks and that there is a checkmark in both the left and right checkboxes. This automatically enables the SolidWorks Motion add-in when SolidWorks launches.

If the SolidWorks Motion add-in is already enabled, also verify that the motion study type is set to **Motion Analysis**. Figure 9 shows the location of the motion study type dropdown list.

Figure 9. Motion Study Type Selection



Simulation Appears Jittery

During simulation, motion on the axes appears jittery. This is a normal result of the memory-intensive simulation process and the fact that simulation time is not the same as actual time. When the simulation is played back, the timing is reflective of real-world time and the jitter disappears.

Worldwide Support and Services

The National Instruments Web site is your complete resource for technical support. At `ni.com/support` you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

Visit `ni.com/services` for NI Factory Installation Services, repairs, extended warranty, calibration, and other services.

Visit `ni.com/register` to register your National Instruments product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting `ni.com/certification`. If your product supports calibration, you can obtain the calibration certificate for your product at `ni.com/calibration`.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at `ni.com/support` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

372876E-01 Aug12