CCE2301—MATLAB: Practical 5

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Simulink

Objective

The objective of this practical is to use MATLAB Simulink.

Procedure

A ball is dropped from a height $h_0 = 10$ m. The ball starts to fall with an initial velocity $v_0 = 0$ m/s. The acceleration due to gravity is $g = 9.8$ m/s^2. Thus, the velocity of the ball will change according to the equation

$$\frac{dv}{dt} = -g$$

until it reaches the ground.

When the ball reaches the ground, it will bounce. If the velocity before the bounce is v_{before}, the velocity after the bounce, v_{after}, will be

$$v_{\text{after}} = -0.8 v_{\text{before}}.$$

1. Start Simulink and create a new model.

2. Add a Constant block from the Sources library. This block will contain $\frac{dv}{dt}$. Edit its block parameters as follows:

Constant value:	-9.8

   Change the block name to `-g`. To do this, click on the word `Constant` and edit the text field.

3. Add an Integrator block from the Continuous library. This block will be used later on to give us the velocity v by integrating $\frac{dv}{dt}$. Edit its block parameters as follows:

External reset:	rising
Initial condition:	external
Show state port:	true

   Change the block name to `Velocity`. Connect block `-g` to the first input of block `Velocity`.

4. Add another Integrator block, which will be used later on to give us the height h by integrating the velocity v. Edit its block parameters as follows:

External reset:	rising
Initial condition:	external

   Change the block name to `Height`. Now, connect the output of block `Velocity` to the first input of block `Height`.

5. Add a Compare To Zero block from the Logic and Bit Operations library. This block will detect when the ball hits the ground. Edit its block parameters as follows:

Operator:	`<=`
Output data type mode:	`boolean`

   Change the block name to `Bounce`. Connect the output of block `Height` to the input of block `Bounce`.

6. When the ball hits the ground, we need to reset the integrators. Connect the output of block `Bounce` to the reset input of block `Velocity` and to the reset input of block `Height`. The reset inputs are labelled by a rising step.

7. Now we need to set the initial conditions of the integrator blocks. Create an IC block from the Signal Attributes library. Edit its block parameters as follows:

Initial value: 0

Change the block name to `Initial Velocity`. Then, connect the output of block `Initial Velocity` to the initial-condition input of block `Velocity`. The initial-condition input is labelled as x_0.

8. Create another IC block. Edit its block parameters as follows:

Initial value: 10

Change the block name to `Initial Height`. Connect the output of block `Initial Height` to the initial-condition input of block `Height`.

9. When the ball bounces, its height will be 0 m. Create a Constant block. Edit its block parameters as follows:

Constant value: 0

Change the block name to `Bounce Height`. Connect the output of block `Bounce Height` to the input of `Initial Height`.

10. When the ball bounces, its velocity v_{after} will become $-0.8v_{\text{before}}$. Create a Gain block from the Math Operations library. Edit its block parameters as follows:

Gain: −0.8

Change the block name to `Bounce Velocity`. Connect the state port of block `Velocity` to the input of block `Bounce Velocity`. The state port is the ouput which is at the top of the block.

Connect the output of block `Bounce Velocity` to the input of block `Initial Velocity`.

11. Now we need to create viewers for our height and velocity.

    (a) From the **Tools** menu, choose **Signal & Scope Manager...**.

    (b) From the Types tree on the left, choose Viewers, Simulink, Scope.

(c) Click on the button **Attach to model** >>. Now, on the Viewers tab on the right, you can see a scope with name `Scope1`.

(d) Change the number of inputs for `Scope1` from 1 to 2, by clicking on the column under the title **# in**.

(e) Edit the signal connections for `Scope1` by right clicking on Scope1 and choosing the appropriate menu.

(f) For Axes 1, check the box for Height.

(g) For Axes 2, check the box for Velocity.

(h) Close the Signal Selector window and the Signal & Scope Manager window.

12. Now we need to set the simulation parameters.

    (a) From the **Simulation** menu, choose **Configuration Parameters...**.

    (b) Set the Stop time to 15.

    (c) Set the Max step size to 0.01.

13. To run the simulation, from the **Simulation** menu, choose **Start**.

14. To see the viewers, double click on the spectacles icon which is next to the block `Velocity` or the spectacles icon which is next to the block `Height`. Then, in the viewer window, click on the binoculars icon to autoscale the plots.

Report

Your report should include a diagram of the Simulink workspace and the output graphs.