WiiExperiment – Circular Motion

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http://wiiexperiment.org

Ingredients:

two Wiimotes, one computer, lazy susan, ruler, stopwatch

Brief Instructions:

Open two graph displays and arrange them so you can see both as well as possible.

Tape the two Wiimotes to the lazy susan so that the length of each Wiimote lies along a radius of the lazy susan. Situate the Wiimotes to that the plus-shaped keys at the top are at two different radii. The accelerometer is approximately under this button.

Change the vertical scale on both graphs to 1*g* or 2*g*.

Spin the lazy susan at as close to a constant, slow speed as you can manage.

Look at the ratio of the two accelerations that jump up (or down) and stay somewhat steady. What pattern do you see in the values?

You should also see another acceleration for each Wiimote that changed when you started spinning but then settled back down to nearly zero. What does this represent? How can you use it to see whether or not you are maintaining a constant rate of rotation?

Try to speed the rotation rate up to twice your previous rate. What happens to the acceleration for each Wiimote? Estimate the ratio of the new acceleration to the old acceleration in the radial direction for each Wiimote.

You may want to save data to a file using the CSV option and then open a spreadsheet (e.g. Excel or OpenOffice.org) and use that to open the file you just saved (comma delimited). Try taking ratios of accelerations. What is this?

Detailed Instructions – quantitative analysis:

Starting up WiiExperiment

1. Set up two Wiimotes. Set each Wiimote to show a graph and to save to CSV.

Setting up the experiment

1. Use masking tape to tape paper to the top of the lazy susan.
2. Draw a diameter across the lazy susan and mark the center of the lazy susan.
3. Mark the diameter off in cm from the center.
4. Tape the Wiimotes along the diameter you just drew in such a way that the plus-shaped button of one Wiimote is twice as far from the center of the lazy susan as the plus-shaped button of the other Wiimote.
5. Make a mark that is big and easy to see somewhere on the rim of the lazy susan. Make a corresponding mark with tape on the table next to the lazy susan.

6. One lab partner is going to be the spinner – in charge of spinning at a constant rate. The other partner is in charge of timing.
7. The spinner should get the lazy susan going at a steady, slow rotation rate.
8. Do the next steps quickly to avoid excessively large file sizes. (100 lines per second adds up quickly!)
    a) Click both start buttons in the file output windows that appeared when you selected CSV output.
    b) Knock sharply on the lazy susan as a time-stamp for aligning the two output files. (You can't have clicked both start buttons simultaneously, so the files will start at slightly different times.)
    c) The timer starts the stopwatch when the mark on the rim of the lazy susan passes the mark on the table. The timer then counts to 10 starting with the next time the marks line up.
    d) At 10, the timer stops the stopwatch and records the time and one partner clicks stop in the two csv windows.
9. In each window, click "Save". Give the files different names and save them.

<u>Analyzing the Data</u>

1. Open a spreadsheet program (OpenOffice.org or Excel, for instance) and ask the program to open each of the files you just saved.
2. Copy one set of data and paste it into the other file so you have one spreadsheet with data from both carts in it.
3. Make an xy graph of each coordinate for each cart. You should end up with 6 sets of data on your graph. Display legends so you can keep track of the various sets.
4. For each Wiimote, find the spikes showing where you knocked on the lazy susan. Hover your mouse over a data point and you will see information about that will help you locate the rows in your data. Delete rows of data in all sets before the knock. Now, the times for the two carts should be synchronized.
5. Use your graph to figure out which two sets of data correspond to radial acceleration.
6. Make a new column in your spreadsheet showing the ratio of the two sets you found in the previous step for every row of data.
7. Graph the new data against time. What do you notice about the variations in this line? What do you notice about the average value of the ratio?
8. Repeat steps 7 through 16, but this time the spinner should try to spin twice as fast as before.
9. Now compare the radial accelerations for Wiimote 1 in the two sets of data. Do this by taking the ratio of the average radial acceleration in each set of data. Do the same for Wiimote 2. How does this ratio compare to the ratio of times from the stopwatch?