CloudLab *Statistics Feature* Preview: *Determining Curve Radius*

Introduction

Collection of angular velocity and acceleration sensor data is prone to seemingly random "noisy" variations, even when the associated motion appears to be smooth to the observer. The easiest way to compensate for this variation is to compute the mean value for the duration of such a random variation. The up-and-coming, but not yet leased, ***CloudLab*** software from PocketLab provides an easy way to compute means, standard deviations, and other statistics for a selected region of PocketLab data.

This lesson provides a sneak preview of this CloudLab feature, allowing students to compute the radius of a curve on an Anki OVERDRIVE supercar racetrack from data collected by PocketLab's angular velocity and acceleration sensors. This lesson is motivated from a previous lesson by the author, in which the radius of curvature of a gradual street turn is determined with PocketLab mounted in an automobile. The new lesson brings the previous lesson into the classroom by using a toy race car set rather than an actual automobile—opening an instructive investigation up to a much larger audience of students.

The Experiment

Figure 1 shows acceleration and angular velocity data obtained from ***CloudLab***. A small picture of the figure-8 shaped race track is shown in the upper right corner, with its two loops A and B. Voyager is shown on loop A moving to the left. The close-up picture of Voyager mounted (using removable mounting squares) to the Anki supercar informs us that the z angular velocity is of interest since the car is moving in the x-y plane. In addition, it tells us that the y-component of acceleration is of interest, as it will give us the centripetal acceleration when the car is negotiating the turns of the figure-8.
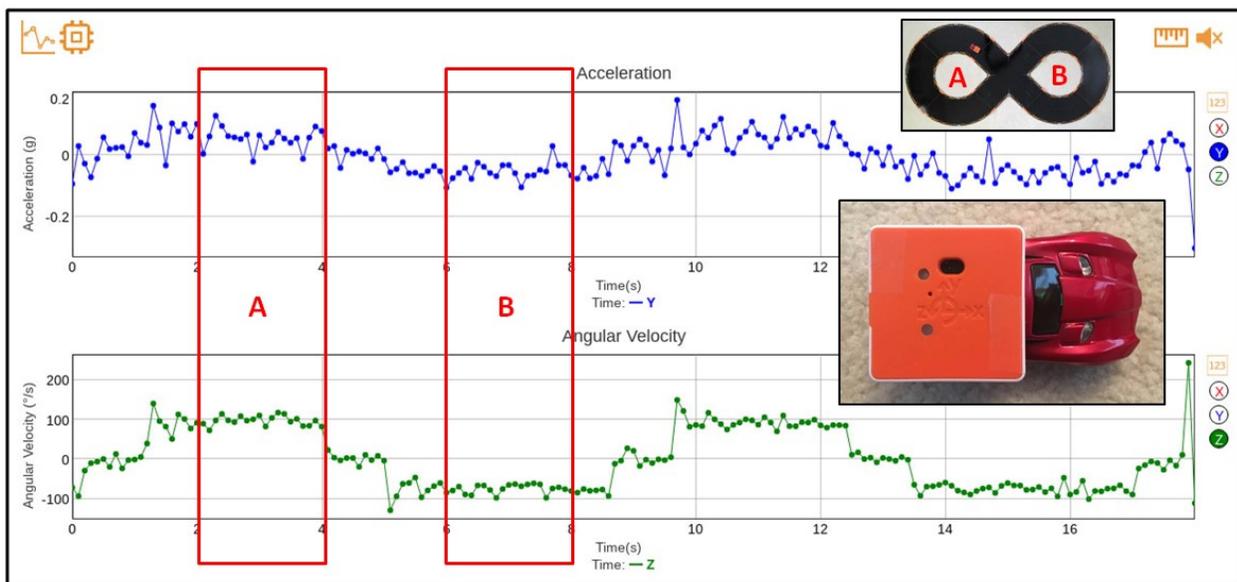

Figure 1

Data from 2 to 4 seconds for loop A has been highlighted with a red rectangle. The "random" acceleration data is slightly positive at approximately 0.1 g. The "random" angular velocity is approximately 100 °/s. Data from 6 to 8 seconds for loop B has been highlighted with a red rectangle. The "random" acceleration data is slightly negative (since the car has changed its direction of revolution) at approximately -0.1 g. The "random" angular velocity is approximately -70 °/s, again negative for the same reason. The red region for loop A is selected in CloudLab by clicking and dragging rectangles for acceleration and angular velocity. CloudLab then zooms in on the selected regions and provides the statistics shown at the bottom left of Figure 2. The statistics tell us that the mean acceleration is 0.054 g, and the mean angular velocity is 97.302 °/s for loop A. Similarly, as shown in Figure 3, the mean acceleration of loop B can be found as -0.05 g, and the mean angular velocity can be found as -74.133 °/s.
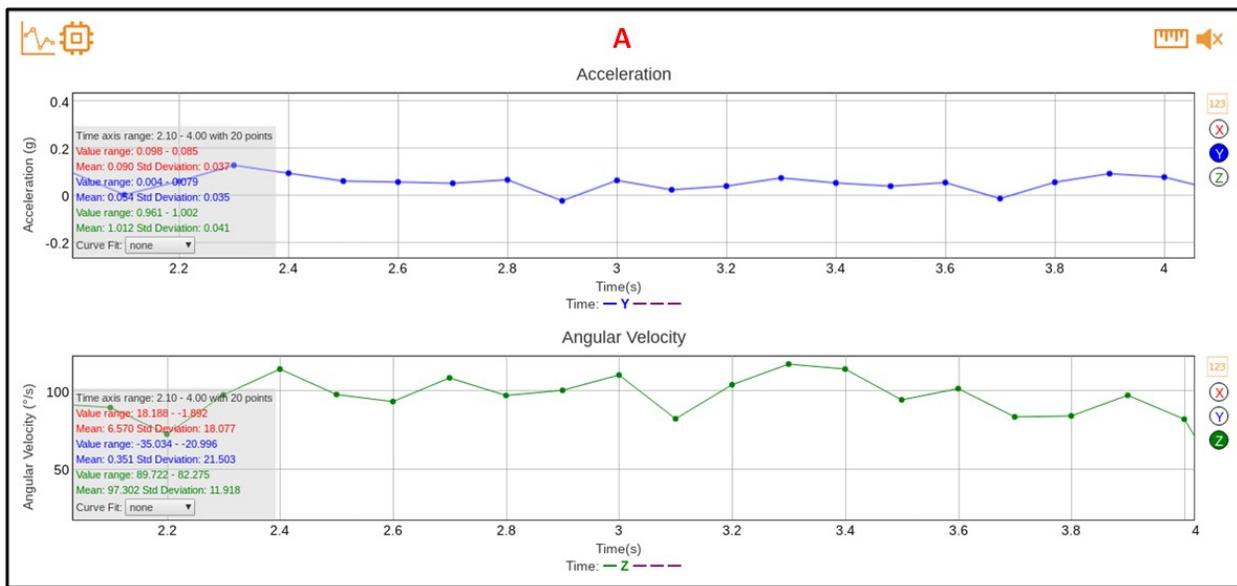

Figure 2

Calculation of the Radius of the Loops

As both loops are the same size, we'll use the average of the acceleration and angular velocity values for the two loops in our calculation: centripetal acceleration a_c = 0.052 g and angular velocity ω = 85.72 °/s. Converting centripetal acceleration to m/s^2, a_c = 0.51 m/s^2. Converting angular velocity to rad/s, ω = 1.50 rad/s. Since $a_c = \omega^2 r$, then $r = a_c/\omega^2 = 0.51/1.50^2 = 0.23$ m. Figure 4 shows that the radius of the turn is very close to our calculated value!

It should be noted that the ***CloudLab*** screen prints are from a prelease version and are therefore subject to possible future modification. Never-the-less, we can see that CloudLab provides some very essential statistics for analyzing PocketLab experiments.
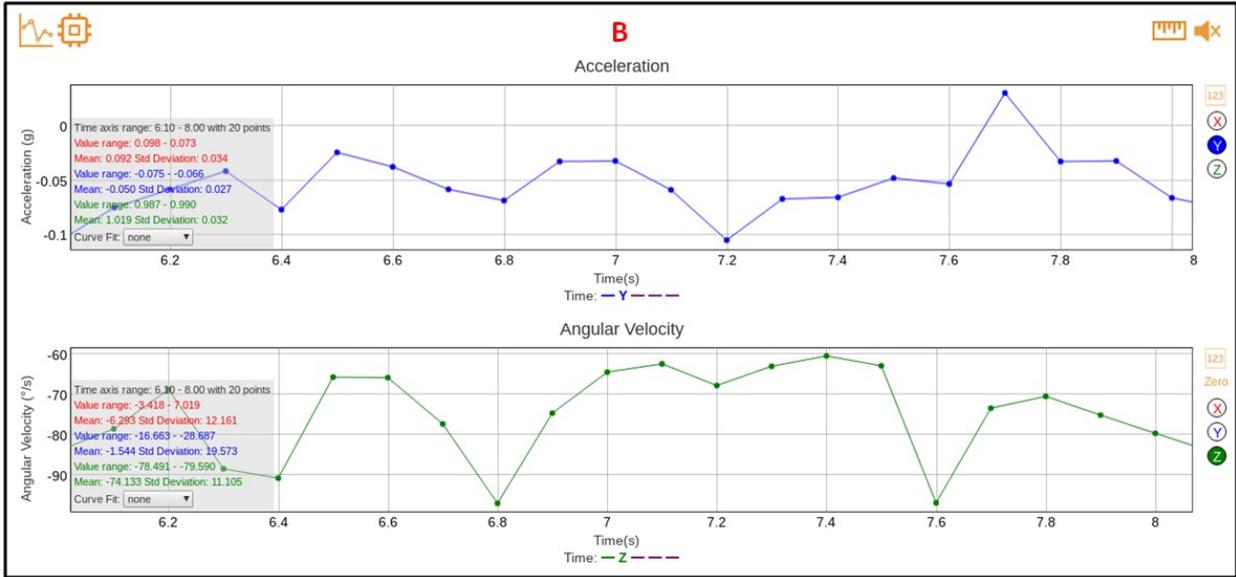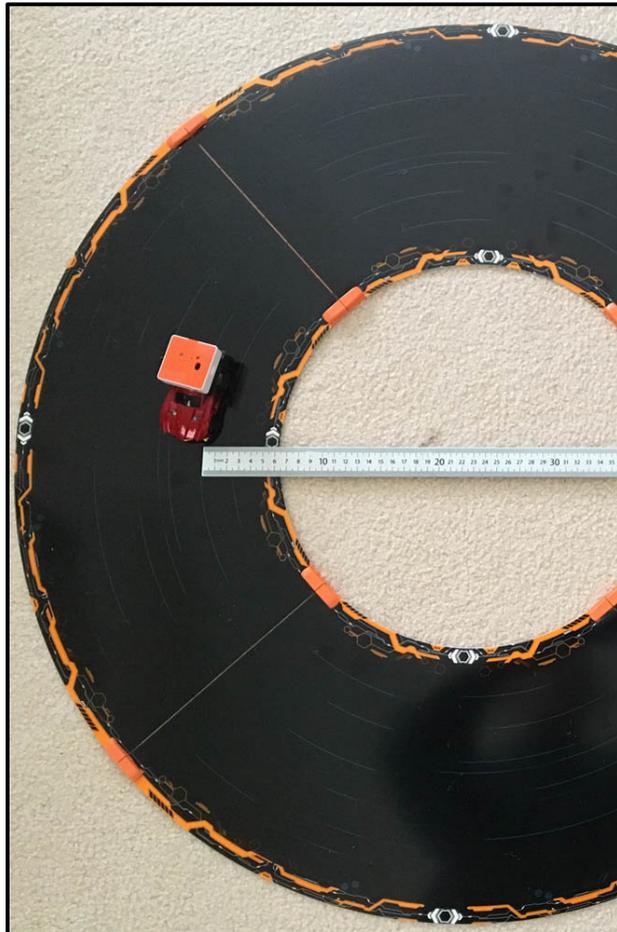
Figure 3

Figure 4