Simple Pendulum Lab

Qingmu "Josh" Deng

September 15, 2017

Abstract

The purpose of this pendulum lab is to familiarize students (in this case, the author) with the process of taking measurements with the Analog Discovery as a simple physical system, making calibrations, creating plots for experimental data, and writing lab reports in Introduction to Sensors, Instrumentation, and Measurement.

1 Description

In this lab, a ruler is attached to a potentiometer so that they turned into a simple pendulum whose oscillatory motion could be easily tracked by the voltage output of the the latter. As shown in Figure 1, the Analog Discovery acted as a translator between the potentiometer and the laptop by taking analog signals from the potentiometer and uploading the analog inputs which would then be plotted in the software Waveform on the laptop.

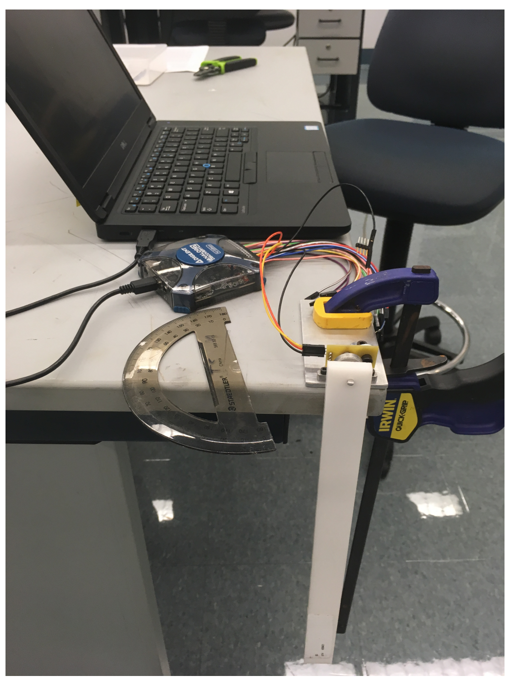

Figure 1: A side view of the pendulum setup. A clamp is used to secure the metal plate on which the potentiometer is mounted.

A calibration process was also necessary for this lab. At the vertical, or resting, position of the pendulum, an average voltage would be recorded as a reference point. Then, the angle of the pendulum would be changed by hand with a step size of 20 degrees that should cover ± 80 degrees, and each corresponding voltage would also be recorded. A protractor was used to determine the target angles manually.

2 Evidence

The following is a table displaying the measured angles and voltages in the calibration process.

Table 1: Measured Voltages and Angles

Voltages(mV)	226	296	344	411	470	554	606	667	728
Angles(degrees)	-80	-60	-40	-20	0	20	40	60	80

The calibration function, angles as a function of voltage, is approximated with the equation (1):

$$\theta = a(V - V_0), \tag{1}$$

where a is a proportionality constant and V_0 is the reference voltage when the pendulum is at rest.

The proportionality constant is calculated to be 0.3155 while V_0 is shown in Table 1 to be 470 mV. Thus, the calibration function becomes:

$$\theta = 0.3155(V - 470), \tag{2}$$

A plot displaying the calibration data and the calibration function is provided below.

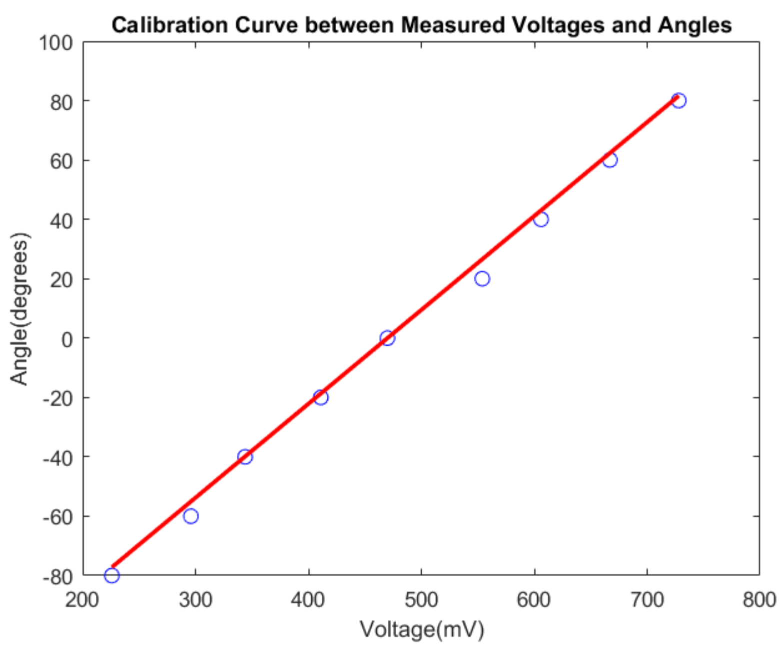

Figure 2: The blue empty circles represent the calibration data while the red solid line is the calibration curve.

The calibration function is then used to convert the voltages recorded during the pendulum's oscillatory motion, and a plot of angle as a function of time is generated.

(Please see the next page.)

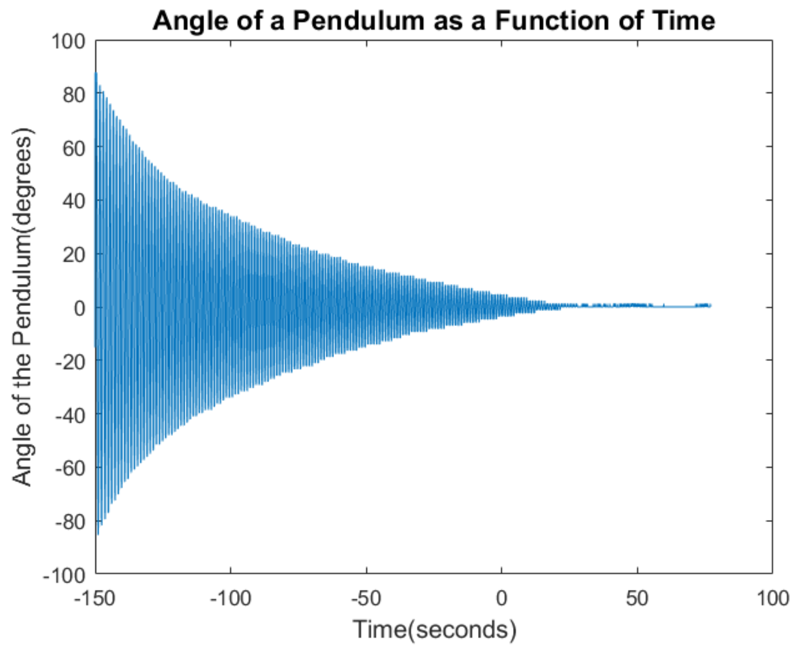

Figure 3: The back-and-forth motion of the pendulum started at almost 90 degrees and gradually receded over time. The negative time was probably due to the settings of Waveform.

3 Interpretation

By inspection, the maximum angles the pendulum reached narrowed over time. The speed at which the pendulum's maximum angles narrowed had slowed as the maximum angles themselves became smaller. Thus, a exponential decrease of maximum angle as a function of time is a possible model for a pendulum.