lab1_pendulum

September 4, 2019

1 Lab 1: Pendulum

The purpose of this lab is to measure readings from a pendulum. An analog discovery is connected to the analog potentiometer, which is coupled to the pendulum.

[1]:
```
import pandas as pd
%matplotlib inline
```

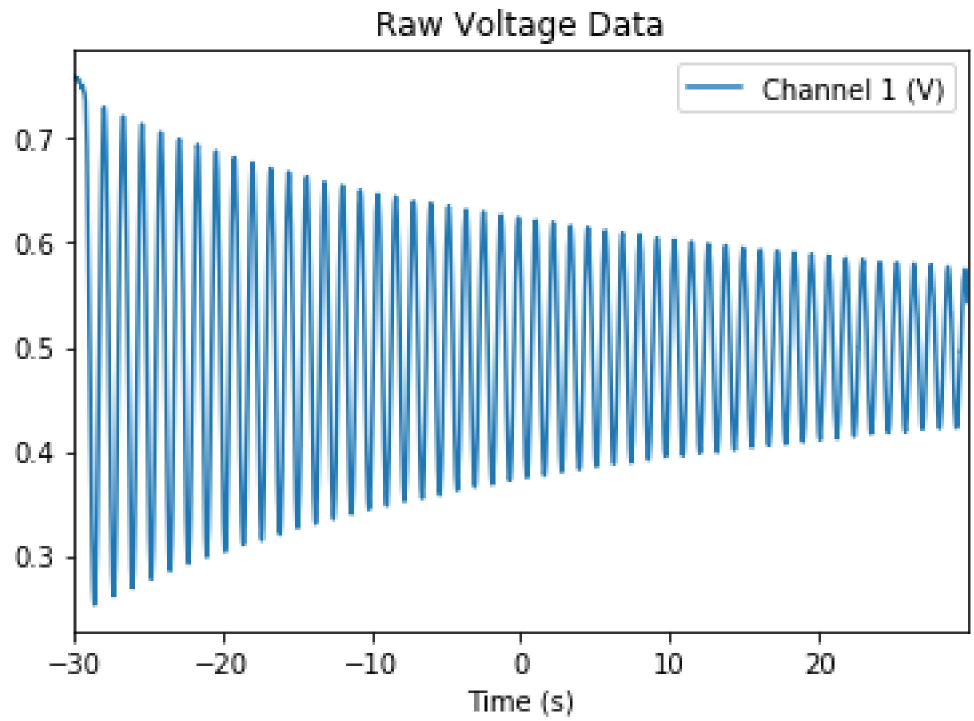
[2]:
```
# Read Raw Data

raw_data_filename = 'pendulum_scope_raw.csv'

# Calibration data is a lookup table formatted in (angle in degrees, voltage)
calibration_data = [
    (-80, 0.73),
    (-60, 0.68),
    (-40, 0.62),
    (-20, 0.56),
    (0, 0.50),
    (20, 0.44),
    (40, 0.38),
    (60, 0.32),
    (80, 0.26)
]
```

1.0.1 Raw Data

The raw data gathered was from the oscilloscope function of the Analog Discovery. This captured the voltage output from the potentiometer over time.

[3]:
```
# Read data
data = pd.read_csv(raw_data_filename)
data.plot('Time (s)', 'Channel 1 (V)', title='Raw Voltage Data')
```

[3]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f4e81bb2128>
```

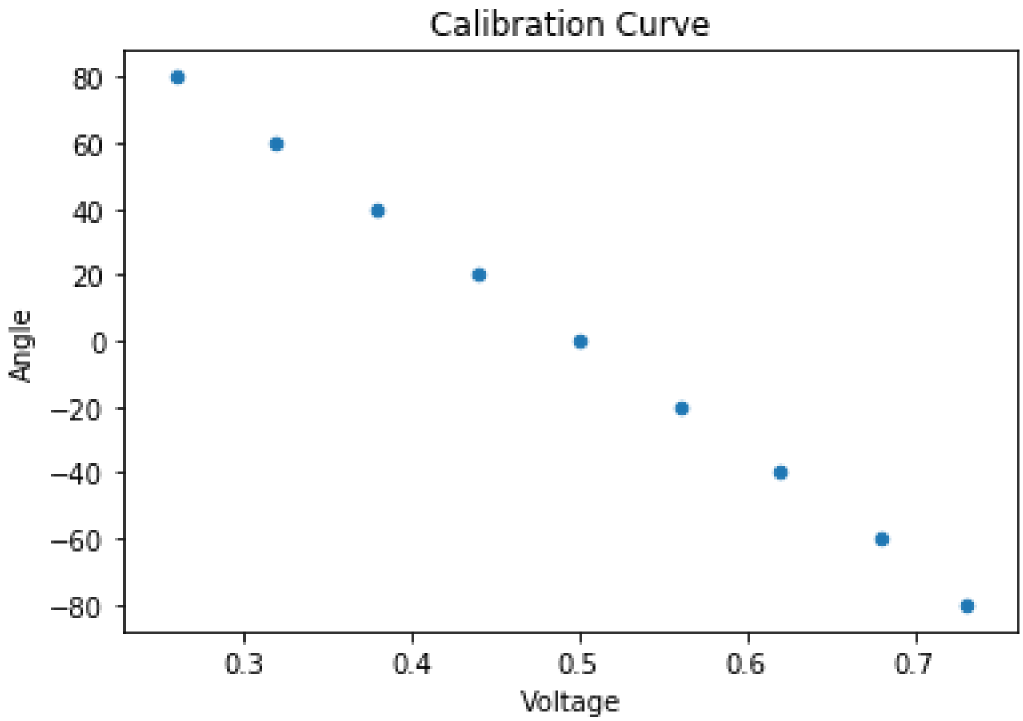


1.0.2 Potentiometer calibration

The potentiometer was calibrated by taking the voltage readings at specific angles, in 20 degree increments. Zero degrees was defined as the pendulum pointing straight down, and a positive angle was defined as the pendulum on the right side of the vertical.

[4]:
```
# Plot calibration curve
calibration_data_df = pd.DataFrame(calibration_data)
calibration_data_df.columns = ['Angle', 'Voltage']
calibration_data_df.plot.scatter('Voltage', 'Angle', title='Calibration Curve')
```

[4]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f4e81afb2b0>
```



Fortunately, the data is visually linear. This is consistent with the electrical properties of the potentiometer. Assuming a linear fit, the angle can be found using a generic linear equation.

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$y - y_1 = m(x - x_1)$$
$$y = m(x - x_1) + y_1$$

[5]:
```
def lookup_angle(voltage, calibration_data=calibration_data):
    m = (calibration_data[-1][0] - calibration_data[0][0]) /␣
 ↪(calibration_data[-1][1] - calibration_data[0][1])
    output_angle = m * (voltage - calibration_data[0][1]) +␣
 ↪calibration_data[0][0]
    return output_angle
```

1.0.3 Convert data to angles

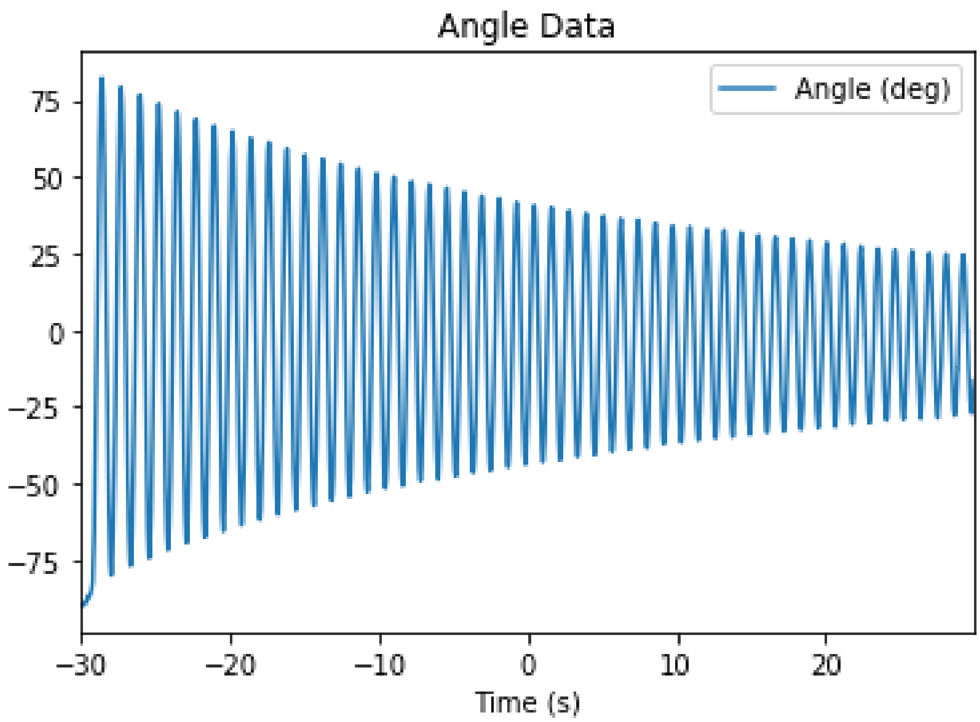
To get useful data out of the raw data, we must convert the raw voltages into angles, based on the calibration table.

[6]:
```
# Generate dataframe in angles
angles = []
```

```
for i in data['Channel 1 (V)']:
    angles.append(lookup_angle(i))

data.insert(2, 'Angle (deg)', angles, True)
```

[7]:
```
# Plot angle data
data.plot('Time (s)', 'Angle (deg)', title='Angle Data')
```

[7]: <matplotlib.axes._subplots.AxesSubplot at 0x7f4e814016a0>



1.0.4 Conclusion

The data from this lab met the expectations of a pendulum in the real world. Fortunately, there was little electrical noise, so the signal was fairly clean. There was a significant decrease in amplitude as time increased, but this is expected from the mechanical friction inherent to the system.