Added Mass Lab Diagram
GitHub: https://github.com/Marine-Science-and-Technology-Lab/Added-Mass-Lab

Test setup:
1. Build t-slotted framing fixture
1.1 Build Arduino setup
1.2 Attach Arduino and springs to fixture
1.3 3D print shapes, dunk in Acetone to smooth surface, then install helicoils

Step 1.1:
Arduino should be wired such that:
5v -> VCC
7 -> Trig
8 -> Echo
GND -> GND
See Figures 1 through 3 in Appendix for closeups of this setup

Software Download

2.1 Python: download Anaconda (https://www.anaconda.com/download) to use Spyder

2.2 Arduino IDE (https://www.arduino.cc/en/software)

2.3 Download **PuTTY**; can be downloaded from the Microsoft Store (https://apps.microsoft.com/detail/XPFNZKSKLBP7RJ?hl=en-us&gl=US) or online (https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html) and input proper settings (these settings can be saved for later use)
PuTTY will be used to send position data from the sonic sensor to a .txt file

2.4 If using a webcam, the camera may require a native video capturing software to work

3. Download Python and Arduino code

3.1 Python: will have 3 separate codes: first is for **camera calibration**, second for **video tracking**, and third for a portion of the **data reduction**

3.2 Arduino: connect Arduino to computer. Run the downloaded Arduino code. Open PuTTY, put in corresponding working directory and desired name of position data

4. Camera calibration: download and print the checkerboard. Place on a flat surface. Take a video of the checkerboard using the camera that will be used during the test.
Important: try not to rotate the phone during the video. Try and ensure the checkerboard reaches all corners of the video frame but also ensure all parts of the checkerboard do not leave the frame

4.2 Send this video into the camera calibration code

4.3 Code will produce a **camera matrix** and **distortion coefficients**. Copy these down for use in the video tracking code

5. Test setup

5.1 Place fixture in open area. Ensure sonic sensor is secure and pointing towards the ground.

5.2 Place checkerboard in front of or directly behind the test fixture--as long as it will be in view of the camera and not interfering with the test

5.3 Place camera in front of test setup. Ensure entire test fixture and the checkerboard are in view. Also ensure that the area is well lit. It is recommended that the background behind the test setup be a consistent color, ideally one that contrasts with the mass attached to the spring

6. Test 1: dry test, in which the mass will be oscillating in air

6.1 Ensure that Arduino has power and the appropriate PuTTY settings are being used Ensure the camera is setup properly and turned on

6.2 Place mass on spring. Hold the mass at the top of the springs extension, such that it is not being stretched

6.3 Begin video capture. Press "open" in PuTTY. a window should open that should have 'time' and 'position' data being logged. If it is not, halt experiment and recheck putty settings

6.4 Once video capture and PuTTY are initiated, release spring and allow it to oscillate. The spring will gradually reduce the amplitude of its oscillations, users can stop video capture and data collection once the amplitude is significantly smaller than the original oscillation height. This usually occurs at ~25 to 30 seconds but could take longer depending on how large the mass is and the magnitude of the spring stiffness

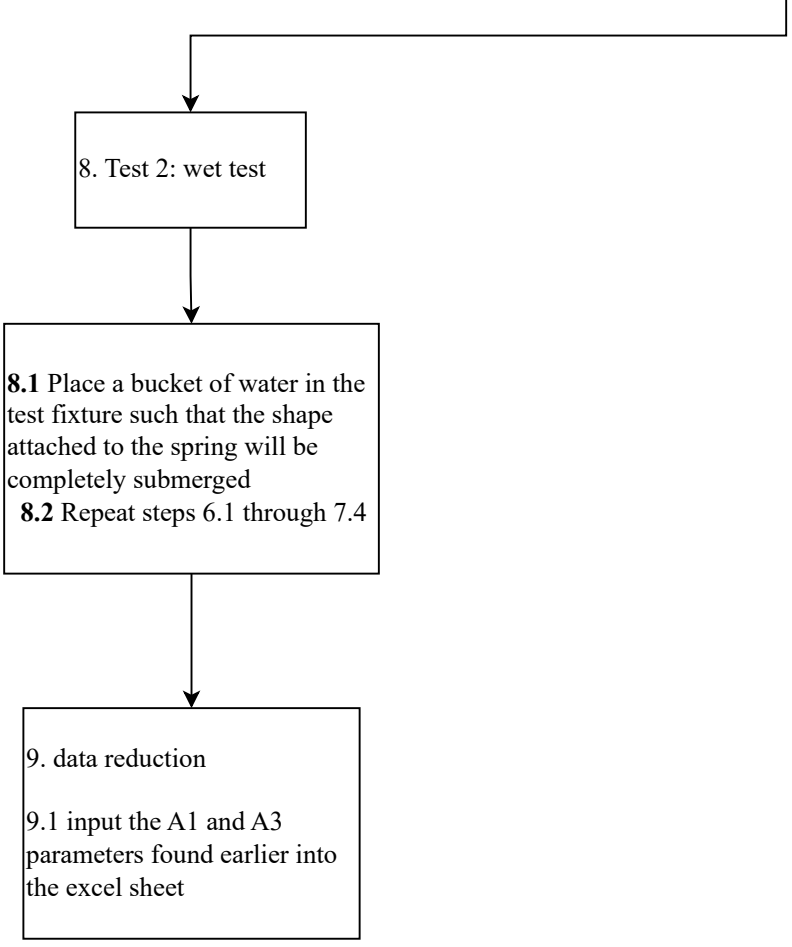
7. Data Mangling

7.1 Crop the beginning of the experiment video such that the mass begins to oscillate a second or two after the beginning of the video

7.2 Send the cropped video into the camera tracking Python code. Users will be prompted to input certain parameters, such as the directory of the video, the camera's framerate, the checkerboard dimensions, etc.
This code produces a .txt file of the tracked position, the directory of which will have to be input

7.3 for curve fitting, it is important the .txt files of the position data from the video tracking and sonic sensor only consist of the oscillations and not the stagnant position of the mass at the beginning of the experiment. copy and paste the data from the .txt files and plot the data. at the beginning, you should be able to see the mass's unchanging position, find the threshold where the experiment began, and delete the position points before this

7.4 send the position .txt files into the data reduction python code. this will produce the coefficients of the fitted curve; A1 and A3 are of interest, copy these for later use


8. Test 2: wet test
8.1 Place a bucket of water in the test fixture such that the shape attached to the spring will be completely submerged
8.2 Repeat steps 6.1 through 7.4
9. data reduction
9.1 input the A1 and A3 parameters found earlier into the excel sheet