Lab 7: Driven Harmonic Clock

The Project: Harmonic Clock

Company X is looking to build a clock using a vertical harmonic oscillator, with a mass hanging from a spring and oscillating with a constant amplitude and frequency.

Using your skills in visual odometry, you and your team will construct *at least* three different harmonic oscillator clocks (using various combinations of masses and springs). You will record and analyze the motion of each clock and discuss the effect of the design parameters on the clock's accuracy. You will need to provide video footage, as well as analytical evidence, to demonstrate to a Company X administrator the performance of your clocks.

Your team has now been hired to build and develop at least three harmonic oscillator clocks. Your task is to understand how the clock parameters affect its accuracy, and to present ideas about how an optimal clock could be constructed.

Equipment:

- Camera
- CNC
- Tracking Stickers
- Various Masses
- Various Springs
- White vertical backdrop for camera

The Requirements:

We ask that you design and implement a position measuring system that can be used to track the time dependent position of various objects, and to use this system to analyze your clocks:

1. Using any combination of masses and springs, construct at least three vertical harmonic oscillators that have a constant period and amplitude for many oscillations.
2. Use your tracking software to record the position, velocity, and acceleration of the oscillators as a function of time.
3. Analyze the position, velocity, and acceleration data that you collect to determine the period of the oscillator, along with estimated uncertainty.
4. Discuss how your measurements of the oscillating masses could be used to construct a set of working clocks that count one-second intervals. Include an estimate of the error that each of your clocks would have on a one-second interval measurement.

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Presentation of the solution:

Your team must prepare 2-3 page written report (including figures) summarizing the results of the project. The report must include the following:

- A description of the basic physics principles used in your project, including the equations that theoretically determine the position, velocity, and acceleration of the mass as a function of time.
- Plots of the position, velocity, and acceleration of your oscillators vs. time.
- A discussion of how your position, velocity, and acceleration data were used to calculate the period of your oscillator.
- A calculation of the spring constants of your oscillator from your position, velocity, and acceleration measurements.
- Discuss the error of each of your harmonic oscillator clocks. If some of the clocks are more accurate than others, discuss why this might be the case. Discuss any improvements that could be made to build a more accurate clock in the future.