The SMART Resonance Tube

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SMART

A NSF funded RET program

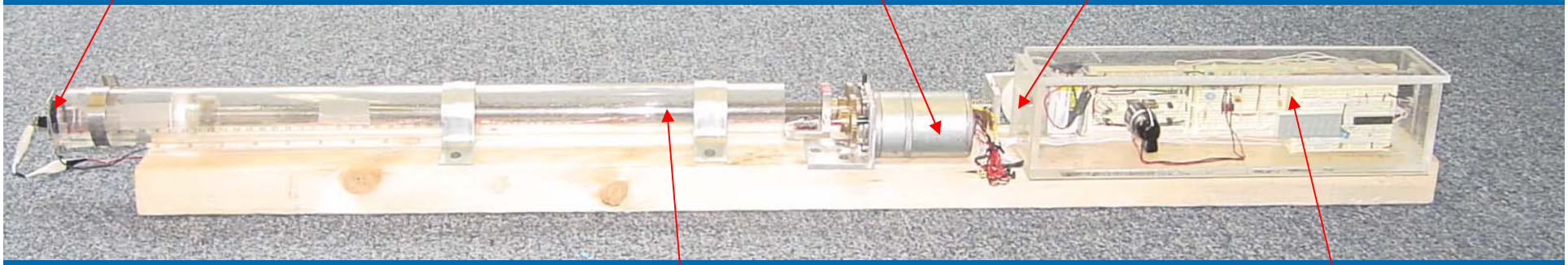
Project Objective

The SMART Resonance Tube will accurately determine the tube length which forces the tube into its first mode of vibration. This essentially makes the tube accept the selected frequency as its first harmonic frequency. This is automated and controlled by a microcontroller.

In the high school Physics lab, students perform a speed of sound lab using a resonance tube. The students have a hard time accurately determining the speed of sound for several reasons. These include

- The students have to hold a tuning fork, meter stick, and resonance tube at the same time. The students have a hard time doing these three things at once.
- The water used in most experimental setups has a meniscus resulting in a measurement error.

Apparatus Setup



The Physics Behind the Noise

A sound wave inside a closed tube will become noticeably louder when a standing wave is formed. This occurs when the reflection from the closed end and the incident wave constructively interfere at the tube opening.

The relationships between the length of the closed tube (L), the wavelength of the sound (λ), and the diameter of the tube (d) is

$$L = \frac{\lambda}{4} - 0.4\,d$$

The relationships between the wavelength of the sound (λ), the speed of sound (v), and the frequency (f) is

$$v = f\,\lambda$$

Program Logic

- ✓ Emit frequency selected from potentiometer
- ✓ Reset piston to end of tube and start
- ✓ Compare sound amplitudes
- ✓ If newer amplitude is higher then continue piston motion
- ✓ If newer amplitude is lower then turn piston around
- ✓ Compare sound amplitudes
- ✓ If newer amplitude is higher then continue piston motion
- ✓ If newer amplitude is lower then stop piston

Conclusions

The SMART resonance tube accurately found the closed tube length corresponding to the emitted frequency.

Future Enhancements

- Include temperature sensor to calculate the speed of sound
- Display length, temperature, and speed of sound on the LED Display
- Find a better microphone!!!!

Special Thanks

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