Speed of sound by reflection.

Apparatus

Sound sensor

Metre rule / expandable tape

Long and wide tube e.g. Vent or drain pipe 110mm diameter. At least 1 metre long.

Piece if solid board to cover end of tube

Data recording setup.

Both Waveform and Sound Level ranges selected

Interval time at 50us (or as fast as allowed)

Start = Value rises above

Trigger channel = waveform

Trigger value = 10 mv (edit this to match ambient noise)

Pretrigger time = 5ms

Stop = after duration

Duration = 20 ms

Introduction

In this practical a sound is sent down a pipe, which is closed at one end. The time taken for the sound to enter the pipe and echo back to its starting point is measured using a sound sensor. The human ear would not be able to detect the time interval between the original sound and its echo, but the sensor will

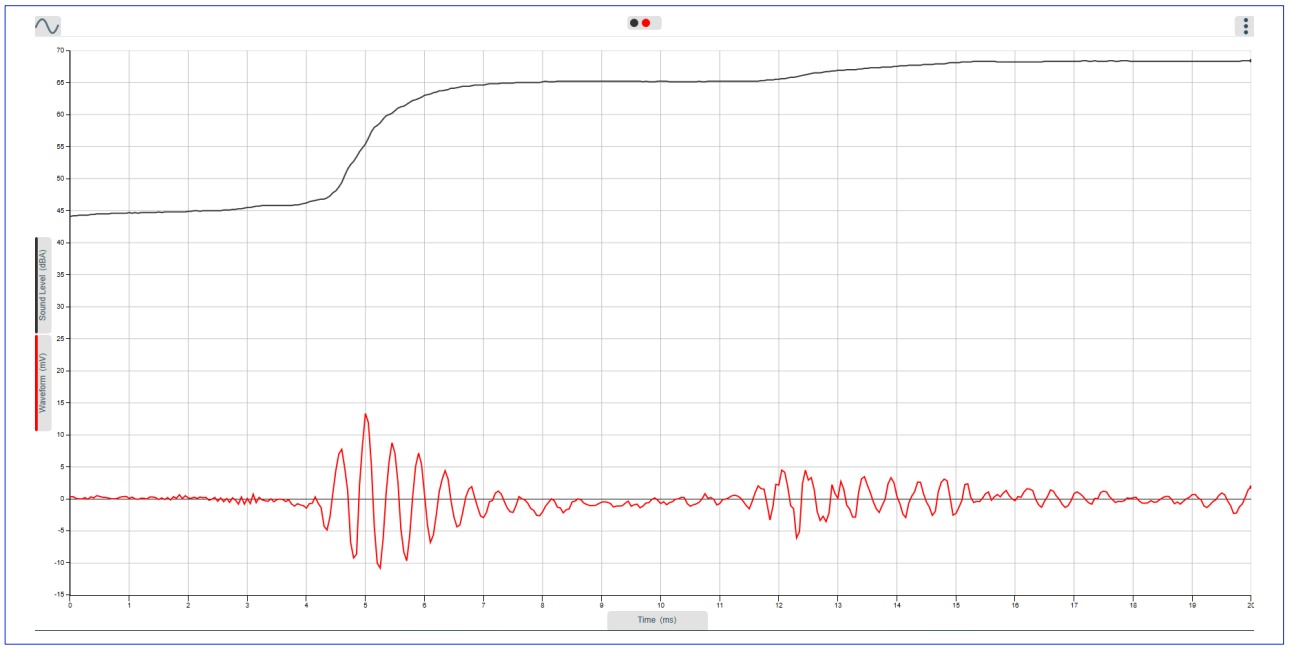
Method

Creating a short sharp noise is quite difficult, what you think is a single sharp sound is seen by the sensor as a whole mass of linked sounds. For this work snapping your fingers is the best option.

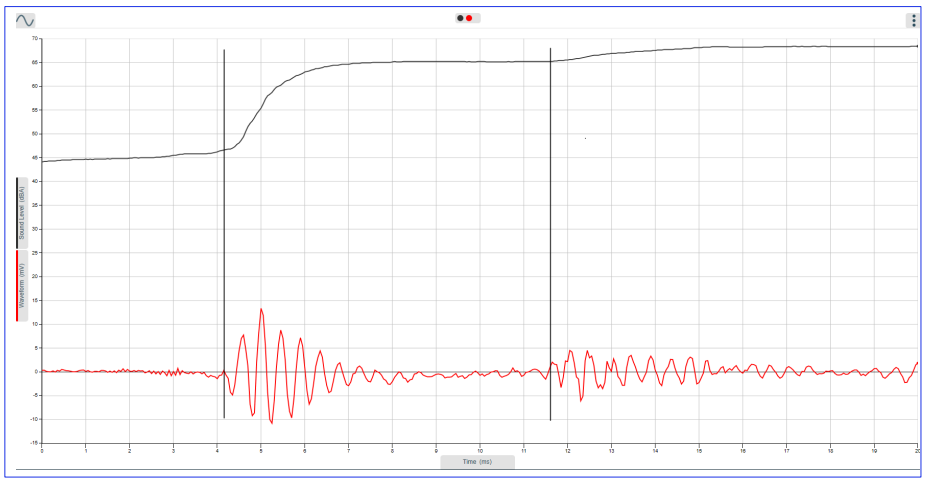
1. Set up the apparatus as shown in the diagram. Make sure the pipe is pushed up against the reflecting surface (a wall or piece of wood).
2. The sensor needs to be as close to the mouth of the pipe as can be achieved. Placing the sensor just touching the edge of the pipe will give good results.
3. Start the software and connect the sound sensor to it. Make sure the dBa and Waveform (mV) ranges are selected.
4. Events will happen very quickly. The recording protocol will need a trigger and a collection of some data before the noise arrives. The setup details in the Data Recording details should be used.
5. Once the setup has been entered, wait for a quiet period and click start. With your fingers about 5 cm behind the sensor but in front of the pipe snap your fingers. You should get a recording similar to the example shown.

Example data

The example data shown was collected using a 1.3m length of pipe. The interval was determined to be 7.5 milliseconds. Both mV and dBa data were collected



Use the difference tool to find the time interval between the start of the initial noise and the start of the echo. You may need to discuss with others about exactly were you will measure from to. If you look carefully at the dBa data you will see a slight uptick in the data that lines up with the echo, you can use this to get a more precise start point to the echo.



Difference tool use to identify the start of the two sound pulses. With the echo the slight uptick in the dBa curve has been used to find the start of the echo.

Measure the length of the pipe in metres. The distance travelled by the sound is from the open end of the pipe to the reflector at the back and back to the opening.

Calculate the speed of sound, taking care with decimals - the time data will be in milliseconds.

Correcting speed of sound with temperature

If you measure the temperature in the room before the experiment starts you can make the correction for temperature.

The value of the velocity of sound increases with temperature.

At 0˚C velocity = 331.3 ms^{-1}

The velocity of sound increases at 0.607 ms^{-1} C^{-1}. (Ref: Kaye and Laby)

For example at 24˚C Velocity = 331.3 + 24 x 0.607 = 331.3 + 14.6 = 345.9 ms^{-1}.

Questions

1. Sonar is a device used for the detection and location of underwater objects. Sonar uses the same principle as was used in this experiment. What is Sonar an acronym for?

2. If the Sonar equipment used by a ship to measure the depth of the sea floor, gave a time-interval reading of 0.2 seconds, what was the depth of water under the ship (given the speed of sound in water = 1482 m/s at 20˚C)?

3. What would be the effect of measuring the speed of sound in a warmer room?

4. How does the speed of sound that you have measured compare to the speed of light?

5. What commonly encountered phenomenon illustrates the difference in speeds in Q4?

6. What is an echo? Use the information in the experiment to make an explanation.

7. What errors in the experiment would account for the difference between the calculated value (Kaye + Laby) and the experimentally derived value?

8. What was the error between the experimental and theoretical value? Is it significant?