Calculating the speed of sound

Overview:
The speed of sound in dry air at 20 °C (68 °F) is 343.2 metres per second. This investigation demonstrates a simple method by which this can be calculated using a uLog Ranger.
The uLog Ultrasonic Ranger works by sending an ultrasonic pulse at a target and waiting for the return echo - the time taken to receive the echo, given the speed of sound, equates to twice the distance between the Ranger and the target. The Ranger can display distance (default) or echo time**.**

Aim:
Using the uLog Ranger, calculate the speed of sound in air and check how accurate the results are using a uLog Temperature sensor to compensate for the temperature of air.

Equipment required: uLog Ranger
uLog Temperature sensor
Computer
Measuring tape (optional)
Spreadsheet or calculator

Hazards:
Do not place your ear close to the Ranger.
Always check your local regulations or the school advisory service for guidance on the use of laboratory equipment.
Students should be supervised at all times.

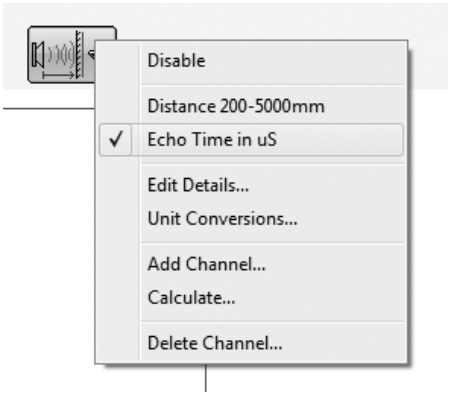
Method:
1. Connect the uLog ranger to the computer and start the SensorLab software.

2. Position the uLog Ranger a set distance from a solid object such as a wall. (The larger the target the better).

Calculating the speed of sound - continued

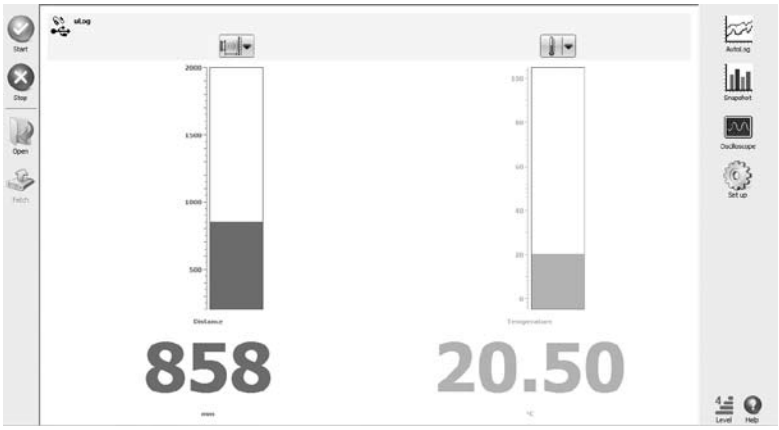
3. Note the distance recorded by the Ranger and convert to metres (1000mm = 1m). Now, change the scale to 'Echo time in uS' and note the time for the echo. Convert to seconds (1s = 1,000,000 uS) and calculate the speed of sound using the following equation:

Speed of sound (m/s) = Distance for echo to travel (m) / Echo time (s)



If the calculated speed of sound is half what it should be, don't forget that you need to divide the time for echo by 2. This is because the echo time is the time taken for the sound to travel from the Ranger, to the wall and back again. We are only interested in the time to the wall.

4. To test how accurate the measured speed of sound is, we need the temperature of the air. Connect a uLog temperature sensor and record the temperature of the air in the room in ^{O}C.



Substitute '∂' (room temperature in ^{O}C) into the following equation to calculate the true speed of sound.

Speed of sound (m/s) = 331.3 x √(1 + (∂ /273.15))

Results:

How accurate are your results?
How did you make sure that the experiment was as accurate as it could be? (Think about how the Ranger works).
Could you have improved your experiment?

Going further:

Why might the speed of sound be important for musicians and sound engineers at concerts?
If you were designing a concert hall, why might you be interested in sound echoes?
Investigate the speed of sound in solid objects. How does this differ from the speed in air?