Introduction to Motion

Introduction

In this lab you will use an ultrasonic range finder to determine the distance as a function of time from the ultrasonic transducer to you (as a reflector of sound waves). The equipment (Universal Laboratory Interface or ULI) is connected to a computer with software (*MacMotion*) that can produce tables and graphs such as position versus time or velocity versus time.

There are a variety of "experiments" possible with this equipment that should solidify your understanding of motion. In this handout we'll suggest several that will aid in understanding the operation of the system. Then, you should construct other options that are appealing to you.

Helpful hints.

Make sure the ULI is connected to the computer into port #2. The red switch on the board must be on – a green light will come on when it is. Double click on the MacMotion icon and select “printer port” if asked.

When you are ready to start graphing distance, click once on the Start button in the bottom left-hand corner of the screen. Notice that there may be a time delay of a second or two before the detector starts clicking, and another second or two delay in the data getting from the detector to the screen. The system works by detecting reflected sound waves. Reflections occur from objects directly in front of the detector, including your arms - don't swing your arms as you walk.

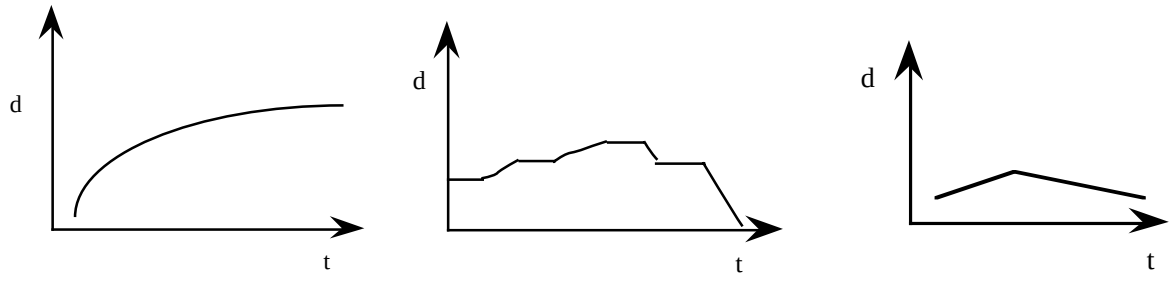
Calibrate the distance reading. If you have a number line and want the detector to produce readings that agree, stand at the 2 meter mark and have someone move the detector until the reading is 2 meters.

Determine the range of your detector (distances, both near and far, that produce meaningful readings). Does the range depend on the size of the reflector; how small can be the reflector be?

Make some distance - time graphs for different walking speeds and directions just to see if the system is working correctly. Use Data/Clear Data A to clear one set of data before starting another.

Distance - time graphs

The following three graphs show distance versus time plots. Duplicate these plots in MacMotion by walking in front of the detector. Draw the curve and explain what you did to reproduce the curves in your lab notebook.

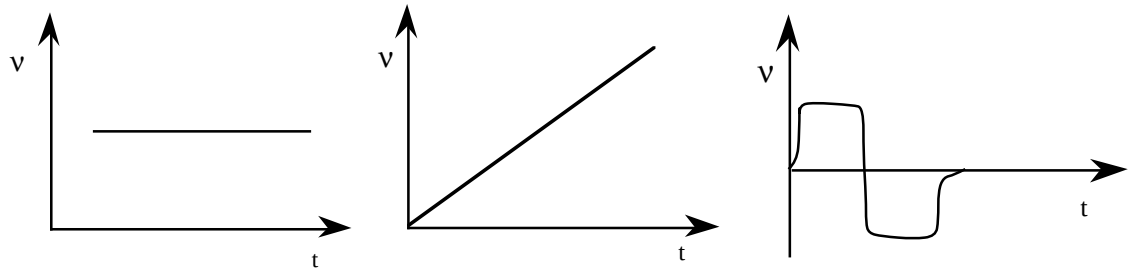


Now, draw some more imaginative curves and reproduce these as well. You can also try to reproduce a curve the computer stores in File/Open/Distance Match.

Velocity - time graphs

You can also make velocity versus time graphs with MacMotion. Display the dialog box; move the Mouse pointer to the Distance label, hold down the button and select Velocity. Set the Velocity axis from -1 to 1 m/sec. Also change the Time axis to read 0 to 5 sec. You will want to change these scales later so the graphs fill more of the screen and are clearer.

The following three graphs show velocity versus time plots. Duplicate these plots in MacMotion by walking in front of the detector. Draw the curve and explain what you did to reproduce the curves in your lab notebook.



Now, draw some more imaginative velocity versus time curves and reproduce these as well. Again, try File/Open/Velocity Match.

Some interesting questions

What if the sound wave reflector remained fixed and you moved the source? Would your curves change?

Does the value of the speed of sound influence the graphs? Often with such questions, it's appropriate to consider extreme situations; for example, if the speed of sound were very low, say 1 meter per second, how would your graphs change?

Can you think of other interesting experiments (or practical uses) for this equipment?