MOTION DETECTOR

Description D03517

Figure 1. The Motion Detector

Short description

The Ultrasonic Motion Detector is designed to measure continuously the position of a body, without disturbing the movement of the body. The measurements are based on the reflection of ultrasonic pulses, which are emitted from the gold foil of the transducer. Distance is determined from the travelling time of an ultrasonic pulse from the transducer to the object and back.

The motion detector is packaged with a universal-mounting clam. Attach the clamp using the thumbscrew on the clamp and the mounting threads on the back of the unit. These threads are also compatible with typical tripod-mounting hardware.

While motion detector is operating a slight clicking sound from the motion detector will be heard and the green LED will be lit. The minimum range of the motion detector is about 0.5 meters. The maximum range is 6 m.

The motion detector can be connected to the following interfaces:

- UIB board (via a special cable 0775 that has to be ordered separately).
- CoachLab II (sonic inputs)
- Texas Instruments CBL™ data-logger (sonic input).

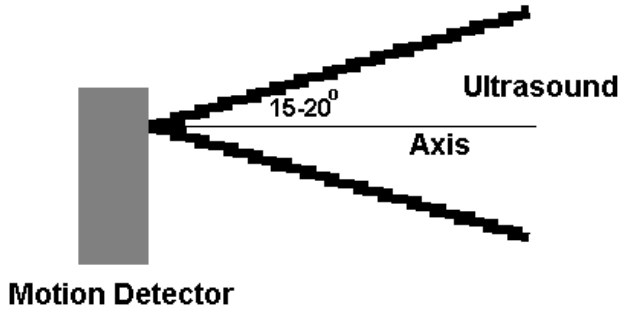
Suggestion for experiments

The motion detector can be used for studying a variety of motions including:

- students walking toward and away from the motion sensor;
- objects in simple harmonic motion, such as a weight hanging on a spring;
- pendulum motions;
- carts rolling on a table or track;
- air track experiments;
- bouncing objects;
- falling objects.

How the Motion Detector works

This Motion Detector emits short bursts of ultrasonic sound waves from the gold foil of the transducer. These waves fill a cone shaped are about 15° to 20° off the axis of the centerline of the beam. The detector then "listens" for the echo of these ultrasonic waves returning to it.



By timing how long it takes for the ultrasonic waves to make the trip from the detector to an object and back the distance to the object can be determined (based on the speed of ultrasound in air).

Note that the motion detector will report the distance to the closest object that produces a sufficiently strong echo. Object such as chairs and tables in the cone of ultrasound can be picked up by the detector.
The sensitivity of the echo detection circuitry automatically increases, in steps, every few milliseconds as the ultrasound travels outward. This is to allow for echoes being weaker from distance objects.
For accurate measurements the object should have a flat front perpendicular to the line between sensor and object.

Tips on getting good results with the Motion Detector
The most frequently reported problem with a motion detector is that it doesn't work beyond a certain distance. Here are some things to check if you have problems.

- Check for a stationary object (chair, table, etc.) in the cone of the ultrasound. This object may be detected when you are trying to study an object further away, It may not take a very large object to cause problems. If you have trouble with a stationary object causing unwanted echoes, try placing a cloth over it. This minimizes the sound reflection.
- Also note the cone of ultrasound extends downward from the center line. This can cause problems if you are using the motion detector on a hard, horizontal surface. In these cases, try pivoting the head of the Motion Detector to aim it slightly upward.

Other troubleshooting tips

- If there is another source of ultrasonic waves in the same frequency range, (like motors, and fans, air track blowers, the sound made by air exiting the holes on an air track, and even students making loud noises) this will cause erroneous readings.
- If the room in which the motion detector is being used has a lot of hard, sound-reflecting surfaces, you can get weird effects caused by the ultrasound bouncing around the room. Standing waves can be set up between the detector and a sound reflector. Try placing a cloth horizontally just in front of and below the detector. This sometimes helps eliminate ultrasound that is "skipping" into the detector.
- Try changing the data collection rate (measurement frequency in Coach program). Sometimes Motion Detectors work better at one data rate than another.
- If you are studying people moving, have them hold a large, flat object (e.g. a large book) as a reflector. If you have an irregular reflecting surface, sometimes the waves will be reflected back to the transducer, and sometimes not. The result will seem erratic.

Using the Motion Detectors at the same time as other sensors
The Motion Detector can be used at the same time as a sensor connected to

one of the analog inputs. This requires Coach Junior or Coach 5 software. Here are some examples:

- with a force sensor to study the relationship between force and motion;
- with a force sensor to study collisions and impulse;
- with a force sensor to study simple harmonic motion;
- with a light sensor to study the inverse square law;
- with a magnetic field sensor to study how magnetic field varies with position.

The name of the motion detector in the sensor library of Coach 5 program is **Ultrasonic Motion Detector (03517) (CMA).**

Technical data

Frequency of ultrasound	40 kHz
Aperture = (top angle) / 2	Aprox. 15 - 20º with respect to the central axis
Minimum range	0.5 m
Maximum range	6 m
Typical accuracy	± 2 mm
Resolution	1 mm
Supply	5 V external (supplied by the interface)
Current	About 51 mA @ 5 VDC while running
Speed of ultrasound in air used to calculate a position	343 m/s

Note: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

CENTRE FOR MICROCOMPUTER APPLICATIONS
Kruislaan 404, 1098 SM Amsterdam, The Netherlands
Fax: +31 20 5255866, e-mail: cma@science.uva.nl, http://www.cma.science.uva.nl/english