Vernier Detect Position Lab

This lab introduces the student to the Vernier Motion Detector Sensor and teaches concepts in displacement. The student must learn how to connect to the ELVIS II prototyping board to make the necessary signal connections for the sensor.

Theory:

Vernier has provided a sensor that measures motion. The way that the Motion Detector works is by emitting ultrasonic sound waves from the gold foil of the transducer. The sound waves travel to the object being measured, bounce off the object, and return to the Motion Detector. The time that it takes this echo of sound to make the round trip from the sensor, to the object, and back can be used to calculate the distance of the object from the Motion Detector. The formula uses the speed of sound in air.

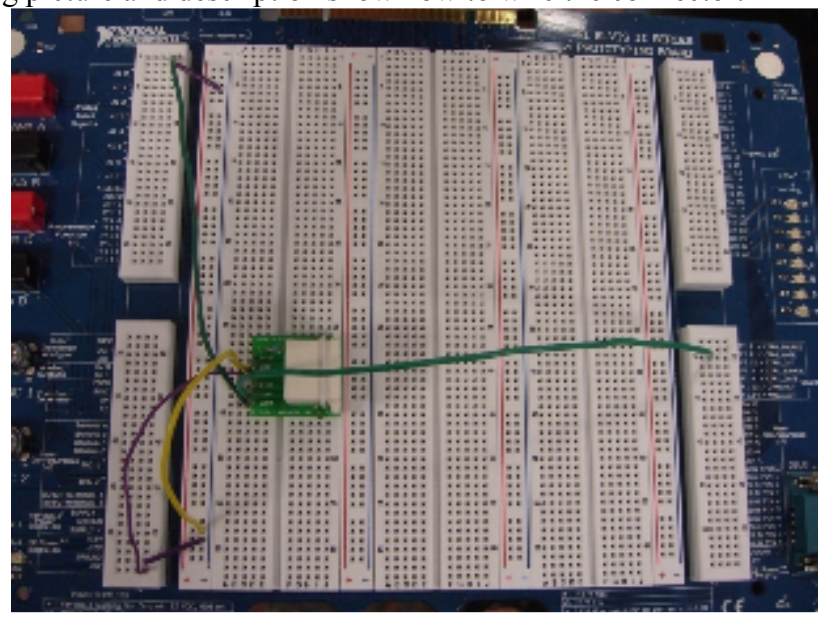
$$Tatal\ Distance\ (m) = \frac{Round\ trip\ time * speed\ of\ sound\ in\ air\ \left(\frac{m}{s}\right)}{2}$$

We divide the entire equation in half because we have to calculate the time to go to and back from the object. Half of this round trip correlates to the distance from the transducer.

How to build the experiment:

The Motion Detector is connected to the Digital Proto Board Connector (BTD-ELV), which is connected to the NI-ELVIS prototyping board. The Proto Board Connector provides easy access to the 6 pins of the transducer.

The following picture and description show how to wire the connector.



Wire the following pins:

1) CTR0 Out to DIO 1 of the Digital Proto Board Connector
2) ACH0+ to DIO0 of the Digital Proto Board Connector
3) ACH0- to Ground on the ELVIS board.
4) ELVIS DC Power Supply +5V to 5 V pin of the Digital Proto Board Connector
5) ELVIS DC Power Supply Ground to GND pin of the Digital Proto Board Connector

How the Motion Detector VI runs:

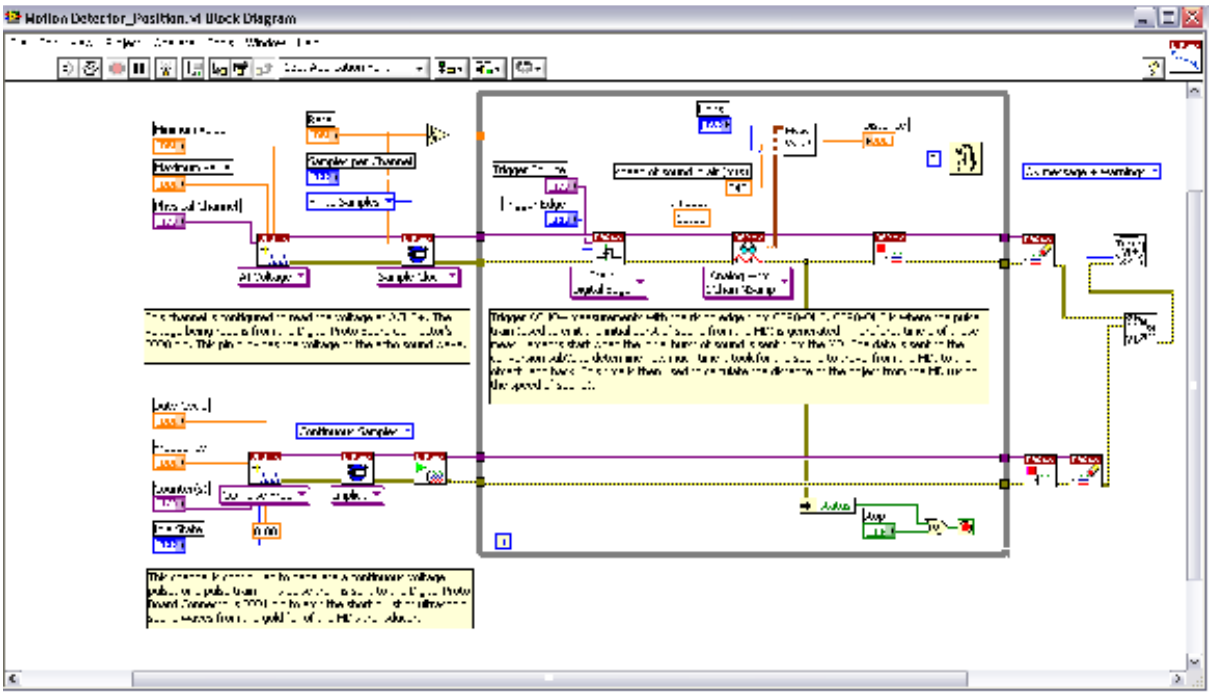
1) Generate Sound Pulse: To create the pulse of sound at the Motion Detector, input a voltage pulse at pin DIO1 of the connector. In this example a continuous pulse is generated from Counter 0 (CTR0-OUT) which is connected to DIO1. The counter can be configured, using the DAQmx VIs or the DAQ Assistant Express VI, to generate digital pulses. The pulses appear on the default output terminal of the counter unless you select a different output terminal.

2) Record Sound Echo: The pulse of sound returned from the object creates a voltage pulse that can be measured from pin DIO0. The trick is to accurately determine the amount of time it took for the pulse to travel from the Motion Detector and back. This means that we must measure the time beginning exactly when the sound pulse is generated until the echo sound pulse returns. To do this we configure the measurement at DIO0 to start the measurement with a rising edge trigger. The generation of the initial sound requires a voltage pulse at DIO1, we use the rising edge of this pulse to trigger measurement at DIO0. The measurement at DIO0 will therefore be an accurate measurement of the sound's round trip from the transducer and back.

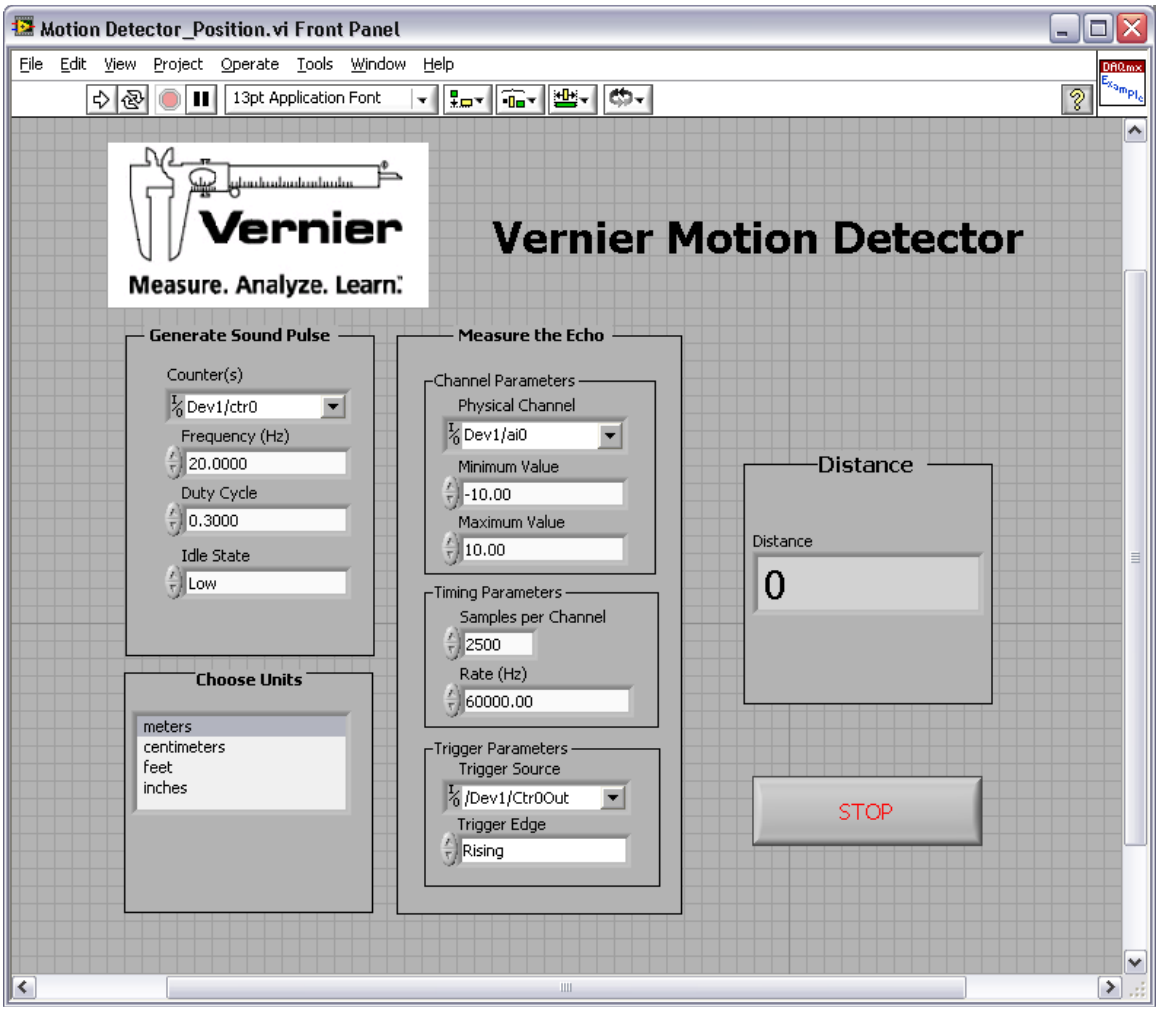
3) Program and Wire: There are two ways to wire and program this trigger and measurement. In both cases, the measurement of the echo pulse is done by wiring from DIO0 to ACH0+ and measuring the voltage. The difference is how the trigger is wired. With some DAQ Cards and VIs it is possible to simply choose CTR0-OUT as the trigger. Because this is where the voltage pulse is created, no wiring is required. However, it is not always possible to choose CTR0-OUT as the trigger pulse (for example, the DAQ Assistant Express VI does not provide this choice). In these cases simply wire CTR0-OUT directly to CTR0-GATE. This allows CTR0-GATE to be the trigger to start the AI measurements. (This wiring would be done for the Express VI example)

4) Measurement Conversion: Once we have received the data back in meters, a software conversion is called using the Motion Detector_Conversion SubVI.vi. This uses a case structure to return the results in the units chosen on the front panel.

Here is a picture of the block diagram configuring both the Counter Output and Analog Input Tasks.



When you open the Front Panel (Motion Detector_Position.vi), configure the following parameters to match with your device. Under **Generate Sound Pulses,** configure the counter to be ctr0 of your device. Under **Measure the Echo,** choose ai0 to be your physical channel and Ctr0Out to be the trigger source. This is shown in the following screenshot.



When you run the VI, you should see the distance displayed in the units you have chosen.

Summary:

With the Vernier sensors, you can take advantage to NI ELVIS II to acquire data by plugging in with a simple Proto Board Connector. The Motion Detector uses analog and counter channels to calculate the time it takes for sound waves to travel from the transducer to the object to be measured. This way a student can use LabVIEW and DAQmx VIs to do acquisition and calculation.