

Equipment and Materials

The sensors used were HC-SR04 Ultrasonic sensors (4 total) with Arduino uno boards. One of the sensors was deconstructed so that the receiving piece could be used independently. A LM358 amplifier was used with a changeable resistor in order to make the signals easier to obtain and read. An OWON SDS6062 60 MHz oscilloscope was used in order to get a visualization of signals for different ground conditions. Three helping hands were used in order to keep the prototype at a consistent height for testing. Figure 1 below shows the final setup for the ground condition detection prototype.

A variety of materials were used to test the ground condition detection prototype. Tile, metal (aluminum pan), plywood, hardwood, glass, carpet, ice, water, snow, skin, and soil were all able to be sourced from materials at home or outside. Snow, ice, and soil were the three main materials sourced from the outside. A measuring tape was used in order to measure actual distance in the obstacle detection testing.

Obstacle Detection

The first working prototype was made for obstacle detection. One of the HC-SR04 Ultrasonic distance sensors was attached to the Arduino uno. The code (in appendix **) was used to create pings and interpret the distance to the closest obstacle. This method, if applied in a device, would be adapted to include a feedback mechanism that outputs based on the given distance.

Ground Condition Detection Device

The second goal was to detect/differentiate between different ground conditions. In order to do so, a signal from an un-modified HC-SR04 was transmitted towards the surface being detected. This signal was first amplified in order to produce more visible data. This signal was received by the modified HC-SR04 receiver. The first prototype used an Arduino Uno and obtained output amplitude readings from the received signal. However, the Arduino Uno could not sample at a fast enough rate to obtain the full curve. For the second iteration of the prototype, the receiving sensor piece was connected to the oscilloscope in order to show the signal visually.

Ground Condition Detection Testing

Multiple materials were obtained in order to test the ground condition detection prototype. The material was first measured to obtain its thickness in centimeters. The material was then placed underneath the transmitter and receiver being held by the helping hands. The transmitter was held at 20.0 cm above the countertop and the receiver was held at 14.20 cm above the countertop. The transmitter bounced a signal off of the material which returned to the receiving sensor. The signal was then able to be seen on the oscilloscope. The oscilloscope was set up so that max voltage would be displayed. The type of material, thickness, and maximum voltage were collected and recorded.