Passive Infrared Sensors (PIR)

Introduction:

Passive infrared sensors or PIR are commonly used as a cheap and effective method to detect human activity in an area. This tutorial aims to demonstrate simple setup and use of such sensors. A HC-SR501 PIR motion detector model will be used through out this tutorial but, the concepts in general apply to most other models. Simple electrical output will be demonstrated along with Arduino microcontroller support to show how it can be used with other applications. Special features on the device will be explained below.

Some more info on PIR operation: https://en.wikipedia.org/wiki/Passive_infrared_sensor

Materials Used:

- HC-SR501 PIR motion detector
- Analog Discovery 2
- Arduino UNO
- LED w/ 150Ω resistor in series

Electrical Output

Procedure:

- Begin by connecting your AD2 with WaveForms on your local machine.

- Connect the PIR sensor to the AD2. Look at figure 1 to see the pinout of the HC-SR501 model. Connect GND on the sensor to GND on the AD2. Out on the sensor in this tutorial will be connected to the oscilloscope in +5V line on the AD2(this sensor can also run at 3.3V). Note*, connect the – line for oscilloscope channel 1 to GND on the AD2 since the grounds between the supply voltage and the sensor are common. Finally, connect the Vcc on the PIR to V+ supply line on the AD2.

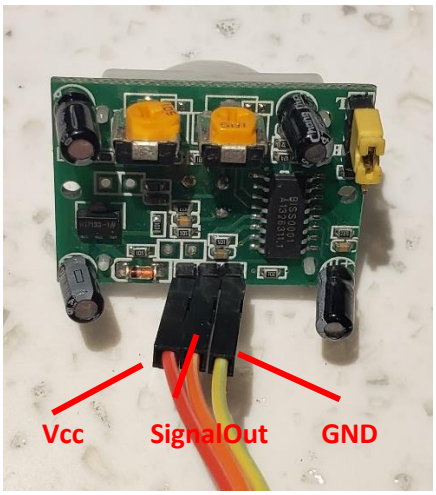

Figure 1: pinout PIR

NOTE : These sensors work on a heated element that is covered by a Fresnel Lense. A rule of thumb for PIR is to let the sensor heat up for 20-60 seconds before collecting data. This allows it to achieve a steady state of the infrared light in room or environment the sensor is sitting in.

- In WaveForms, turn the supply line on to +5V, this is the operating voltage specified in the sensors data sheet. Then, connect the oscilloscope line. Look at figures 4&5 for more information on the output

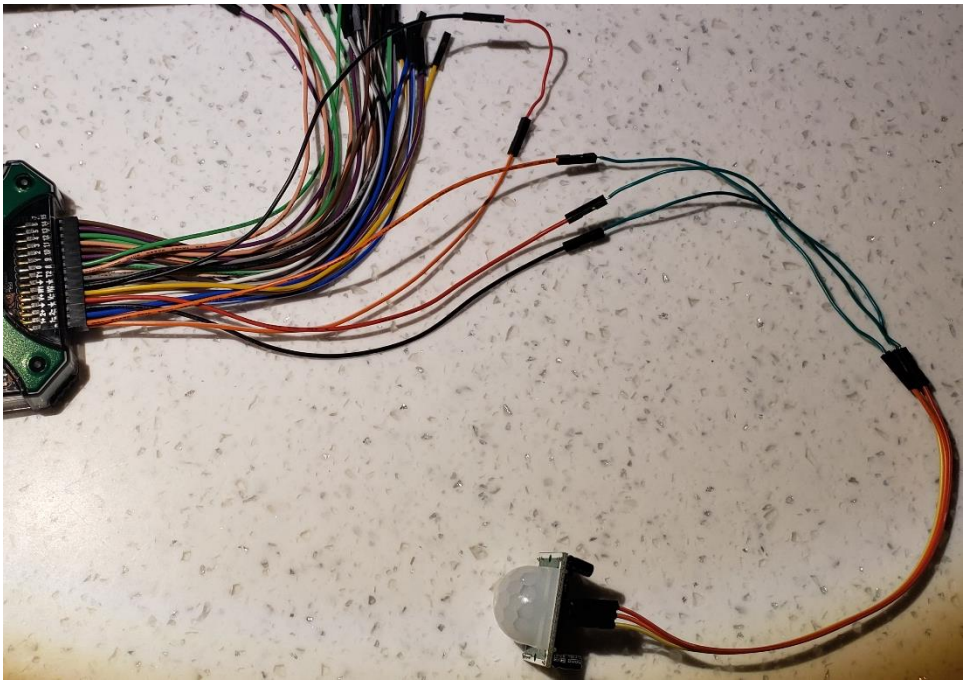
Figure 2: AD2/PIR setup

- This PIR sensor has two types of operating modes. A repeated trigger mode and a single trigger mode. Thankfully, it is a simple switching of a jumper header to flip between modes. Go down to the special features section for more information. The following two modes output should be displayed below.

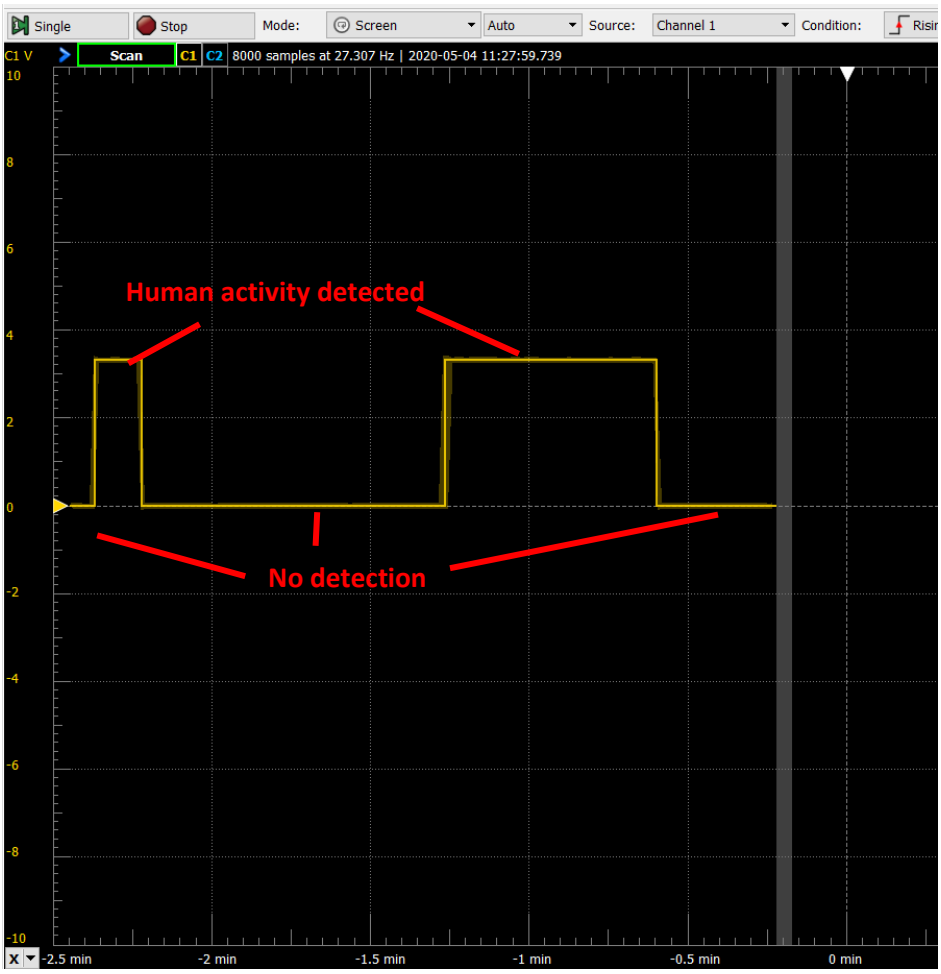

Figure 3: Repeated trigger output

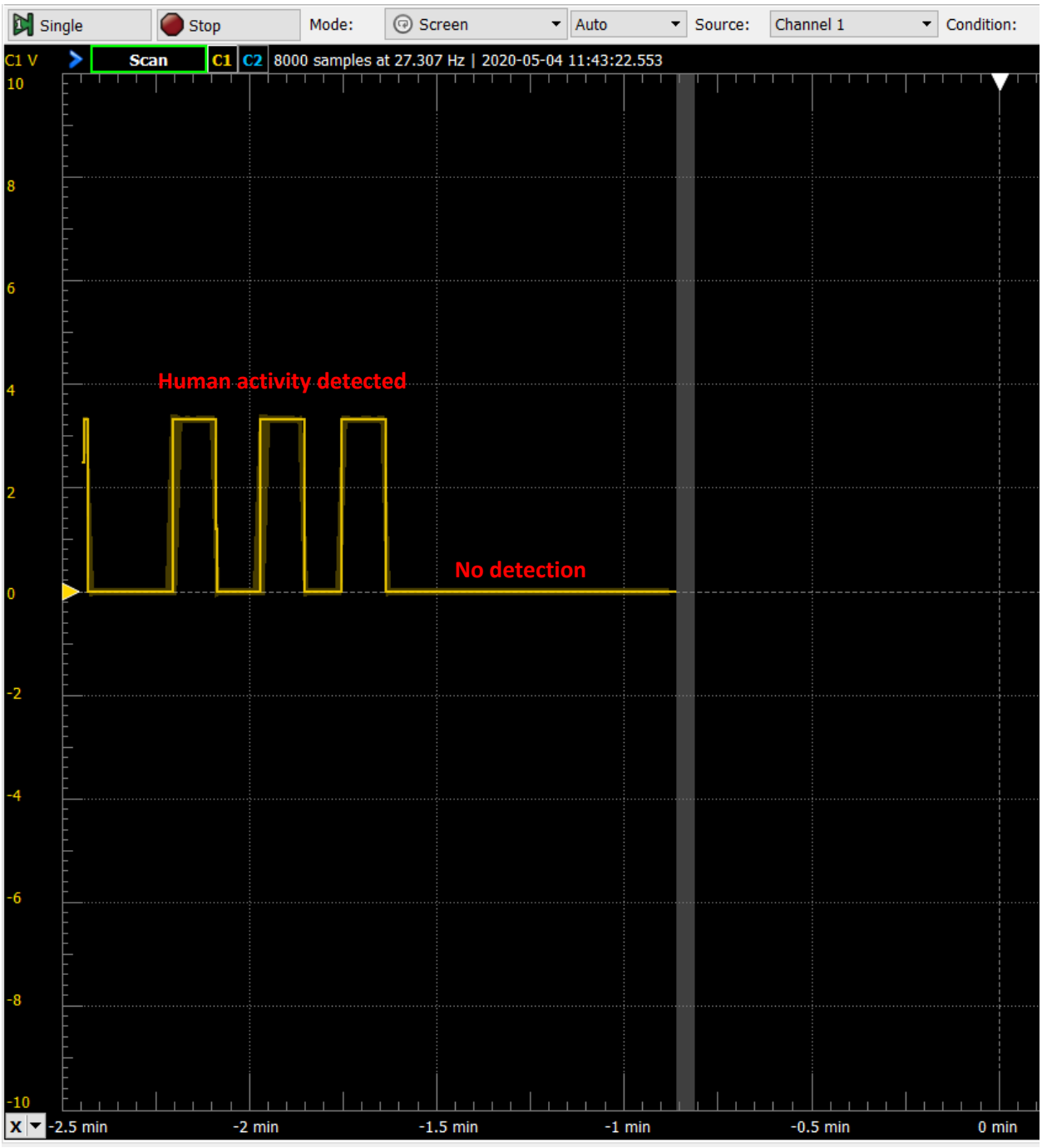

Figure 4: Single trigger output

- As seen in the triggering modes repeated will continually keep an active high as output as long as there is infrared radiation different from the ambient background. The single trigger on the other hand will pulse positive and then turn off with a specific delay before checking again if there is a human in the vicinity. More info on the adjustments can be found in special features.

Note repeated trigger will be used for the remainder because of its ease of processing output

Microcontroller Example

This segment uses the simple and open source Arduino IDE to demonstrate PIR interfacing to microcontrollers. The application of these sensors are numerous; to keep things short we will use a status LED to show if an infrared disturbance (human activity) is in the cone of the sensors field of view (FOV).

Procedure:

- Using an Arduino interface supply the PIR with the appropriate 5V and ground connections. Route the signal pin to a chosen DIO pin on the Arduino. Pin 3 was used in this example.
- Source code for simple detection and a decision is attached to the webpage for PIR sensors.
- Connect a resistor (if needed) and an LED to pin 13 on the Arduino acting as a digital output to easily see if a detection was made.

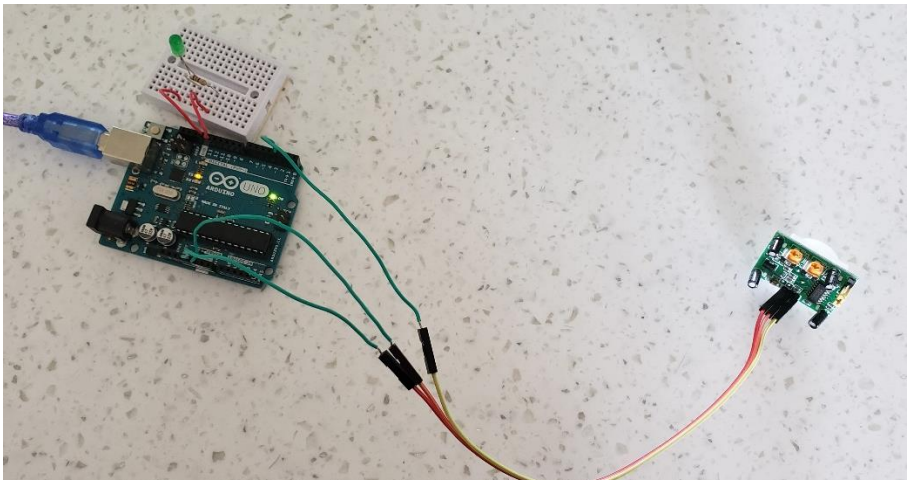

Figure 5: Arduino PIR setup

Special Features

The HC-SR501 has several unique parameters that can be adjusted / adapted on the sensor itself.

Triggering modes: As stated before there are single and repeated trigger captures. This is adjusted by the yellow jumper as seen in figure 6.

Sensitivity: A variable resistor connected to the pcb of the sensor as seen in figure 6 can be adjusted. This will determine how small the difference in ambient infrared light is needed for the sensor to trigger active high.

Delay Adjust: Adjacent to the sensitivity, the delay adjust is more useful for single trigger mode. This determines the delay between triggering pulses that the PIR is reading. The longer the delay the longer it will take for the PIR to trigger successively after an initial trigger event.

Photo Resistor mount: A photo resistor can be added here so the PIR only functions at nighttime.

Temp sense mount: Like the photo resistor a temp sensor can be added to control the operation of the PIR.

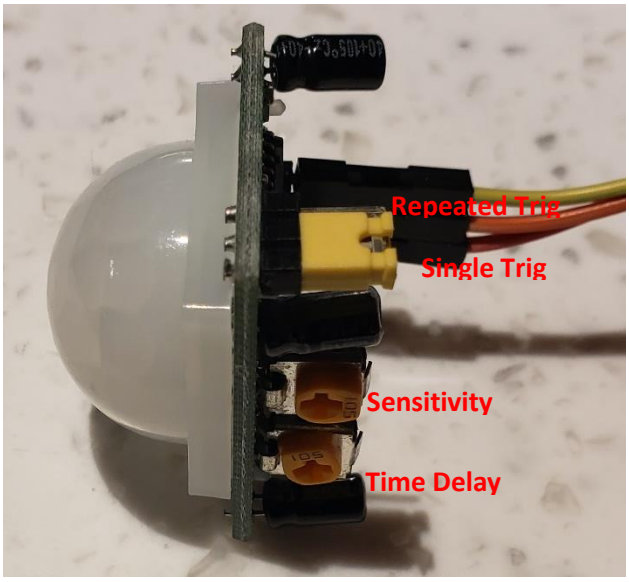

Figure 6: peripheral close up

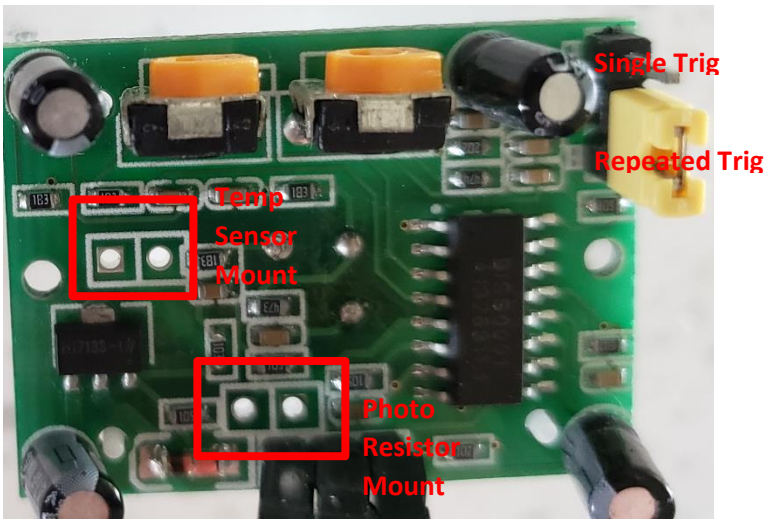

Figure 7: PCB close up