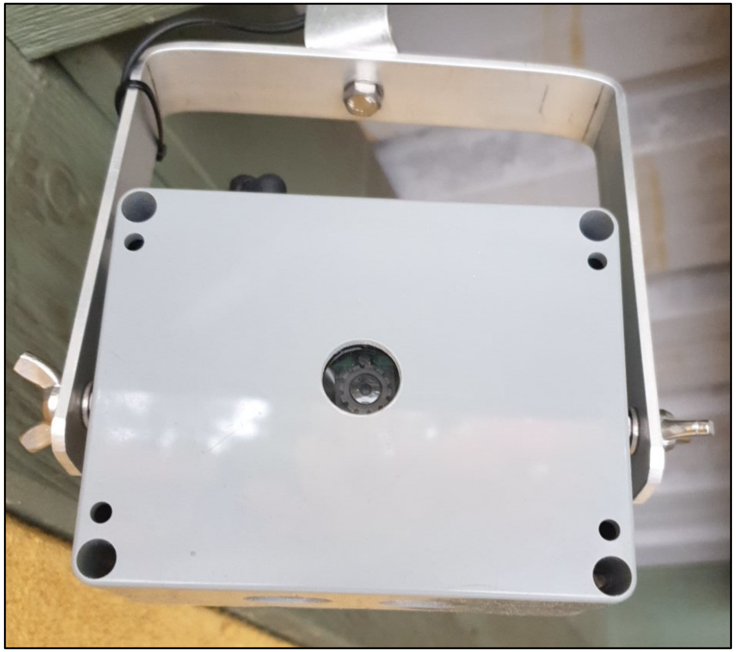
Remote Outdoor Webcam Installation with Temperature and Humidity Monitoring

Melbourne Linux Users Group



29 March 2021
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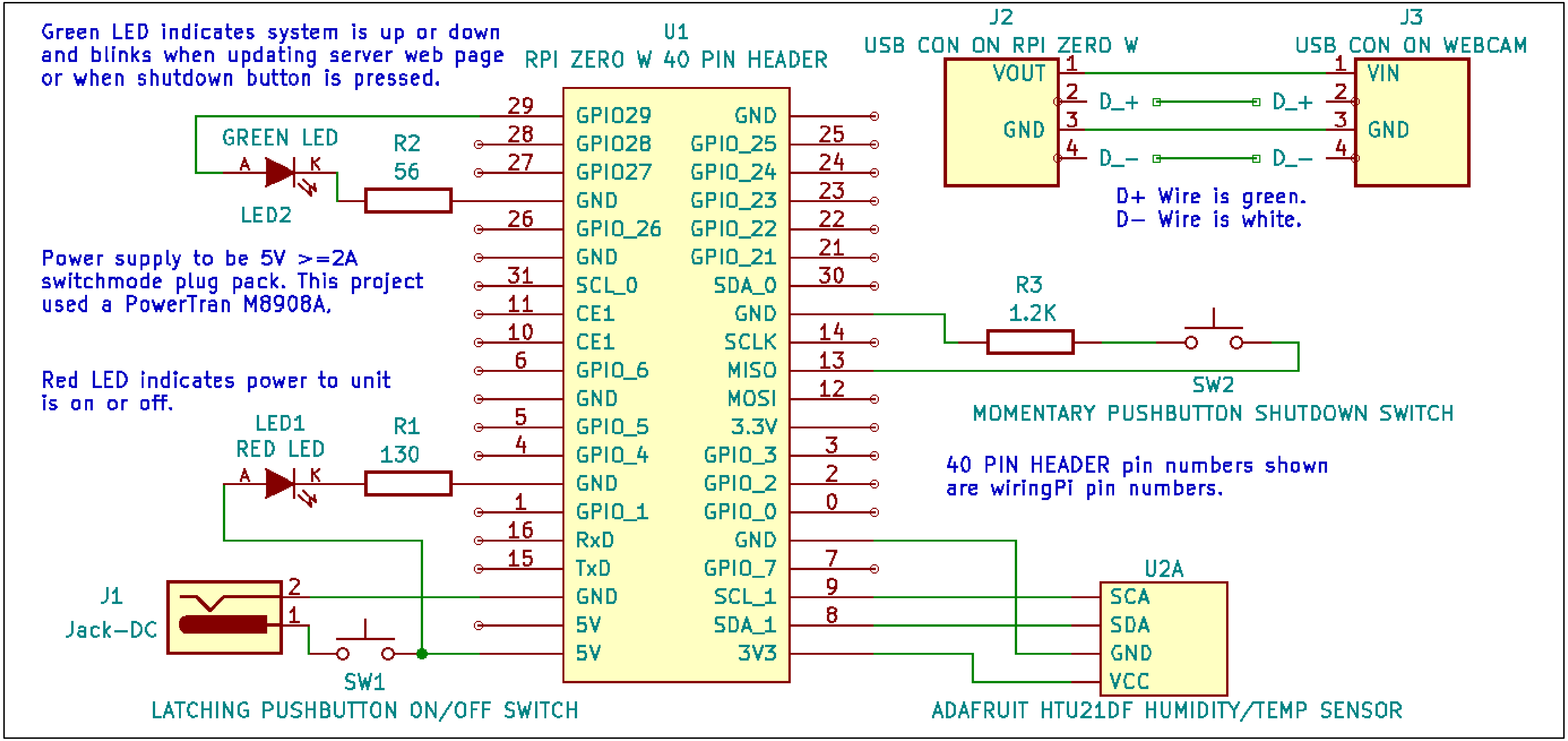
Specifications:

- Inexpensive SBC with small form factor and good wireless capabilty.
- Open source software.
- Inexpensive UVC standard webcam.
- Ability to integrate environmental sensor(s).
- Easily accessed via lan by computers and android devices.
- Installation in a sealed, ventilated, insect proof enclosure.

Software Required:

- *hawkeye*, “a simple, robust, easy to use USB webcam streaming web server which uses MJPEG as the video codec”.
- *i2c-tools*
- *Bc*
- *imagemagick*
- *wiringPi*
- *bash and gcc*
- Current installation uses a Raspberry Pi Zero W running *2021-01-11-raspios-buster-armhf-lite.*

Project Schematic



Green LED indicates system is up or down and blinks when updating server web page or when shutdown button is pressed.

Power supply to be 5V >=2A switchmode plug pack. This project used a PowerTran M8908A.

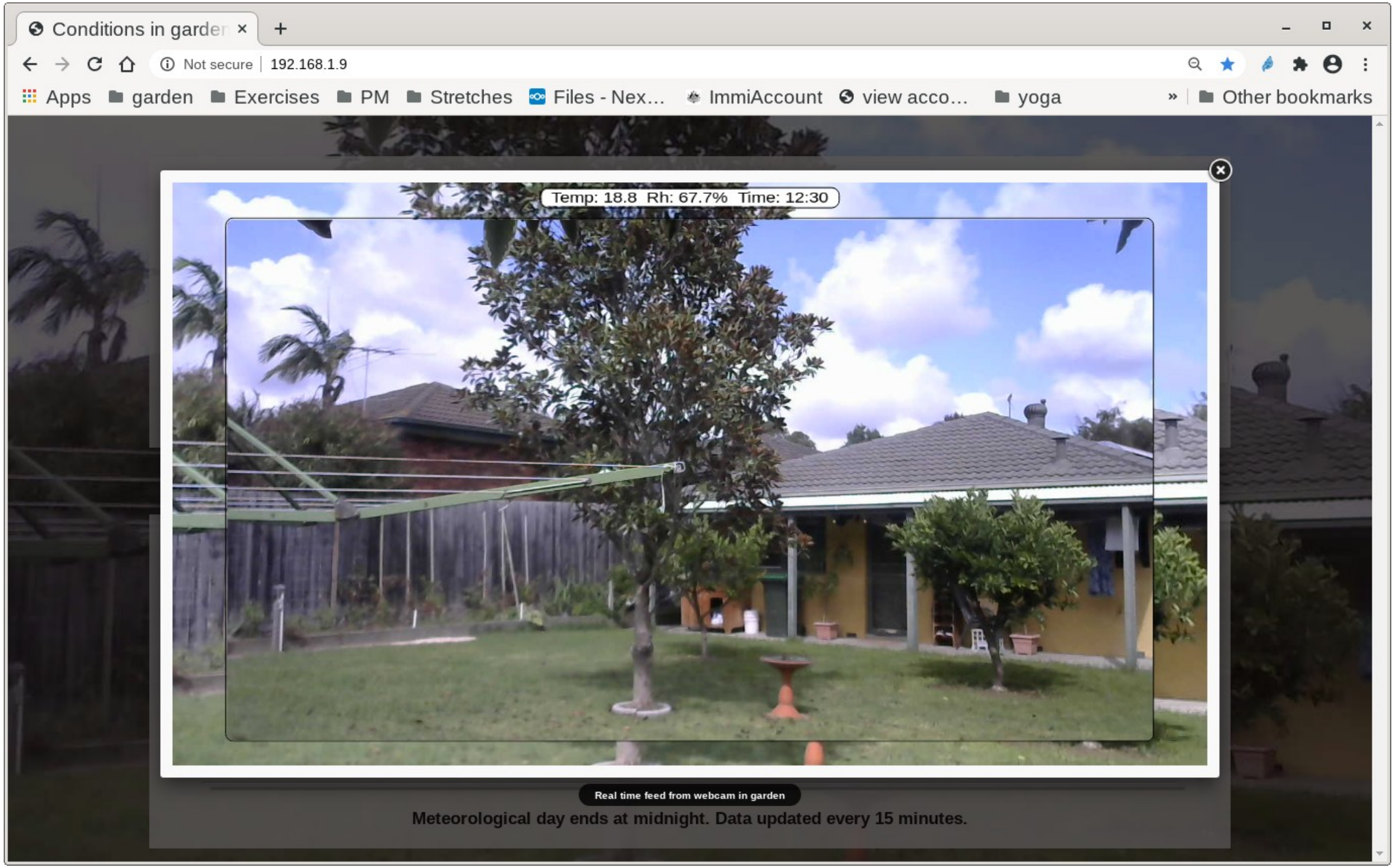
Red LED indicates power to unit is on or off.

D+ Wire is green.
D– Wire is white.

40 PIN HEADER pin numbers shown are wiringPi pin numbers.

Example of remote webcam live stream

Live stream from weather station running hawkeye showing temperature, humidity and time of data reading displayed in a *Fancybox* popup.

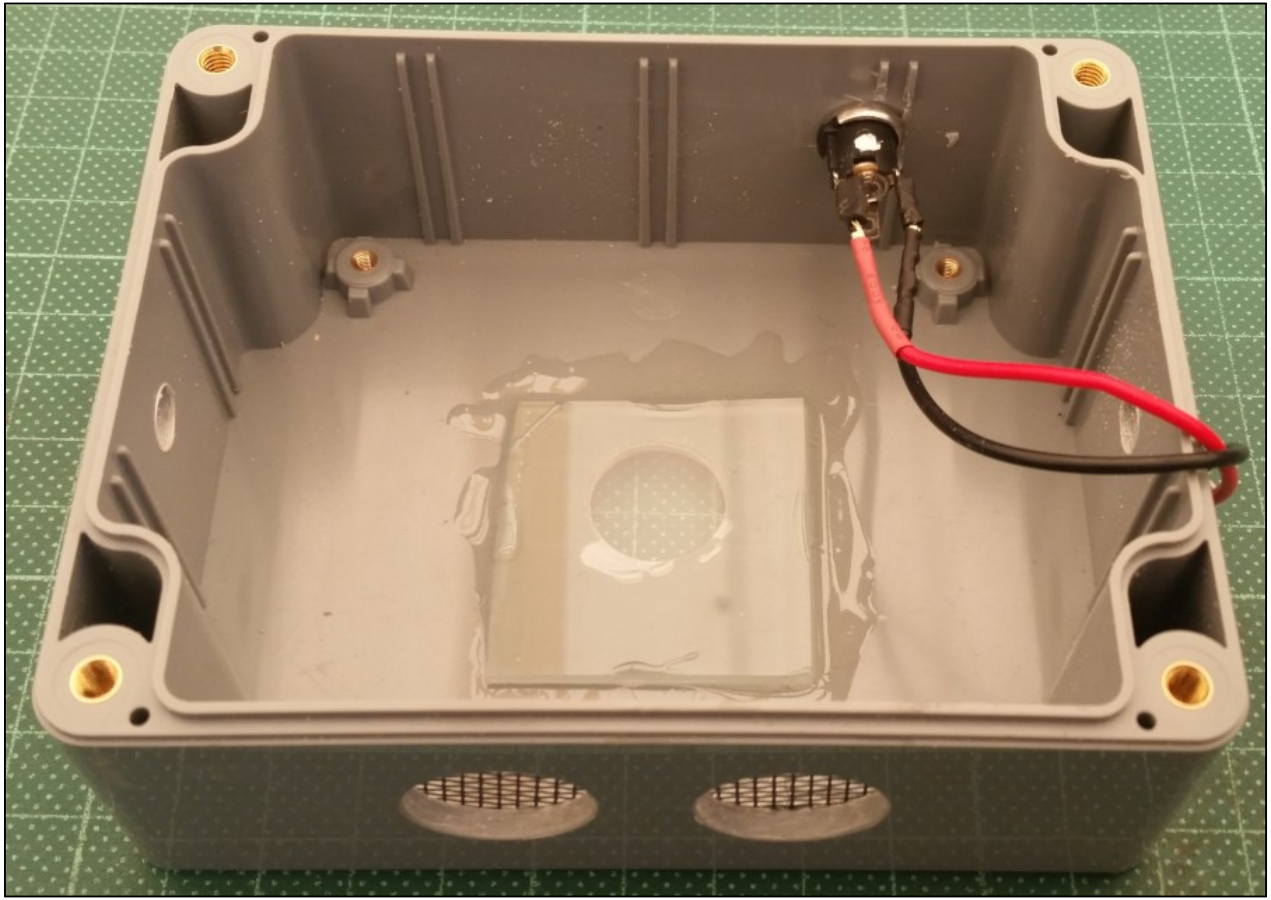


Temp: 18.8 Rh: 67.7% Time: 12:30

Real time feed from webcam in garden

Meteorological day ends at midnight. Data updated every 15 minutes.

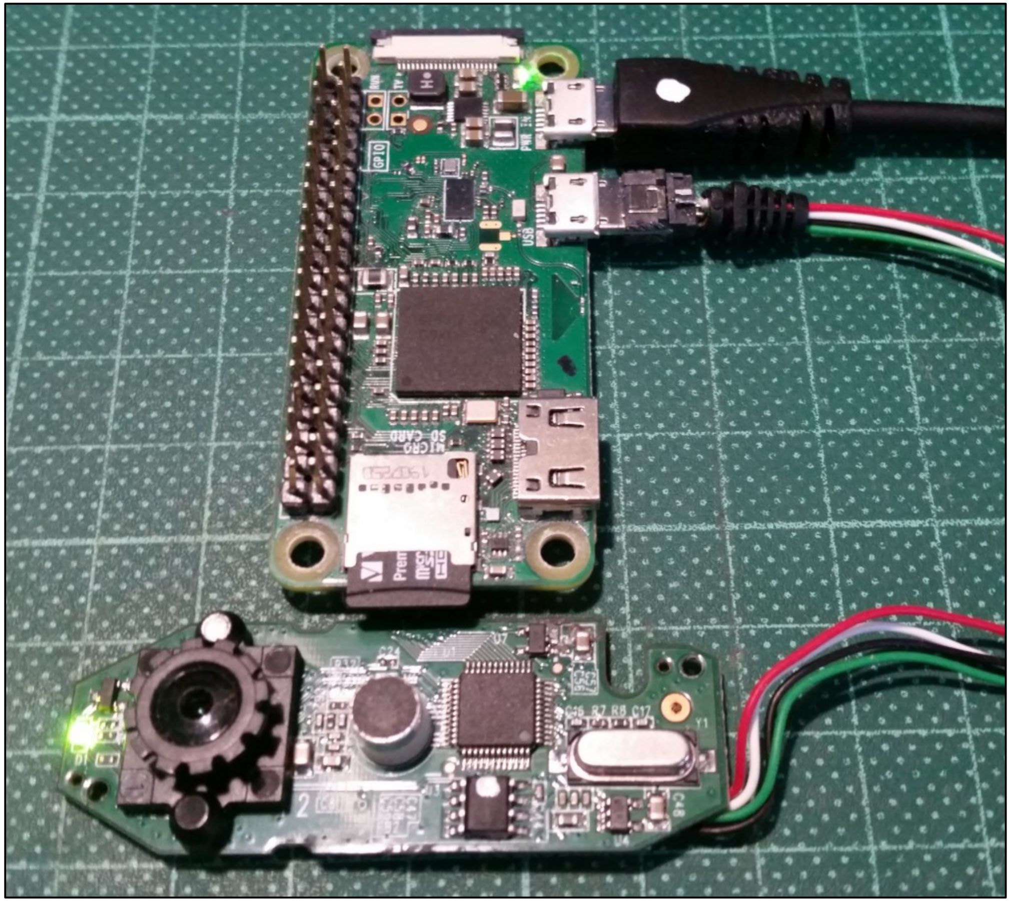
Fixing glass to enclosure viewport

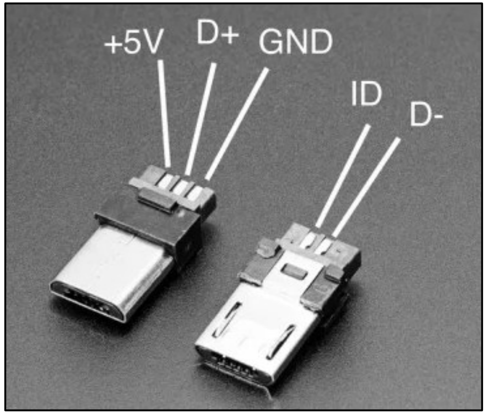


The remote webcam will be installed outdoors. In order to prevent insects taking up residence a piece of 1mm picture frame glass is placed over the webcam viewport and flywire is placed over the ventilation holes. Both are fixed in place with 2 part epoxy.

Note the power supply barrel jack installed in the top right side of the enclosure.

Connecting webcam to Raspberry Pi Zero W

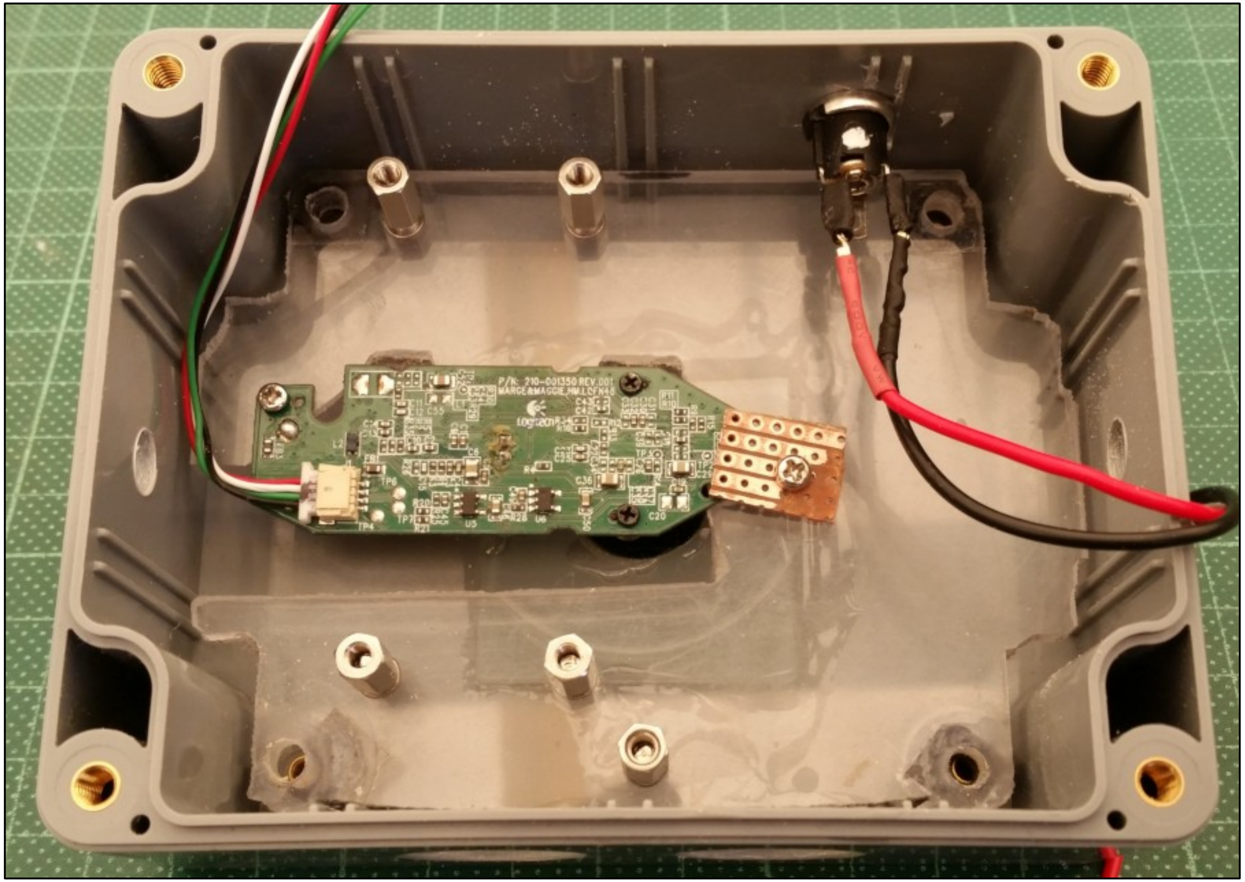




The C270 circuit board was removed from its enclosure and the usb cord was cut off leaving 200mm still attached. The cord was stripped leaving 4 wires which were soldered to an *Adafruit DIY Micro-B USB Plug.* Refer to the schematic for correct wire colours.

Black out the webcam LED to prevent reflection in webcams glass viewport.

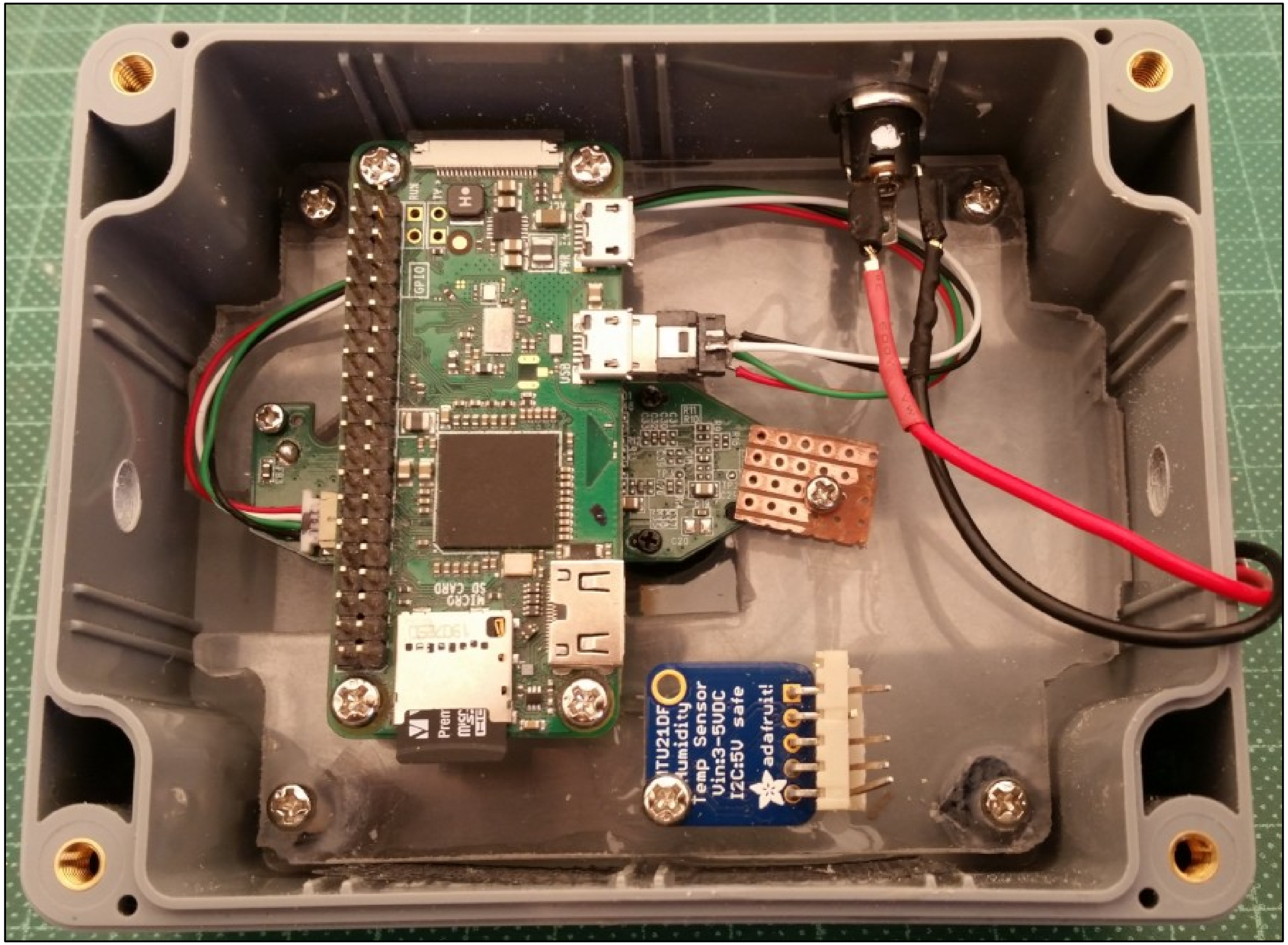
Fixing webcam into enclosure



The webcam circuit board is fixed onto a piece of perspex over an opening large enough to allow for ventilation. A screw was used through an existing hole on one end. The other end was clamped in place with a piece of vero board.

Spacers are used to hold the perspex high enough so that the camera’s lense does not come in contact with the viewport glass .

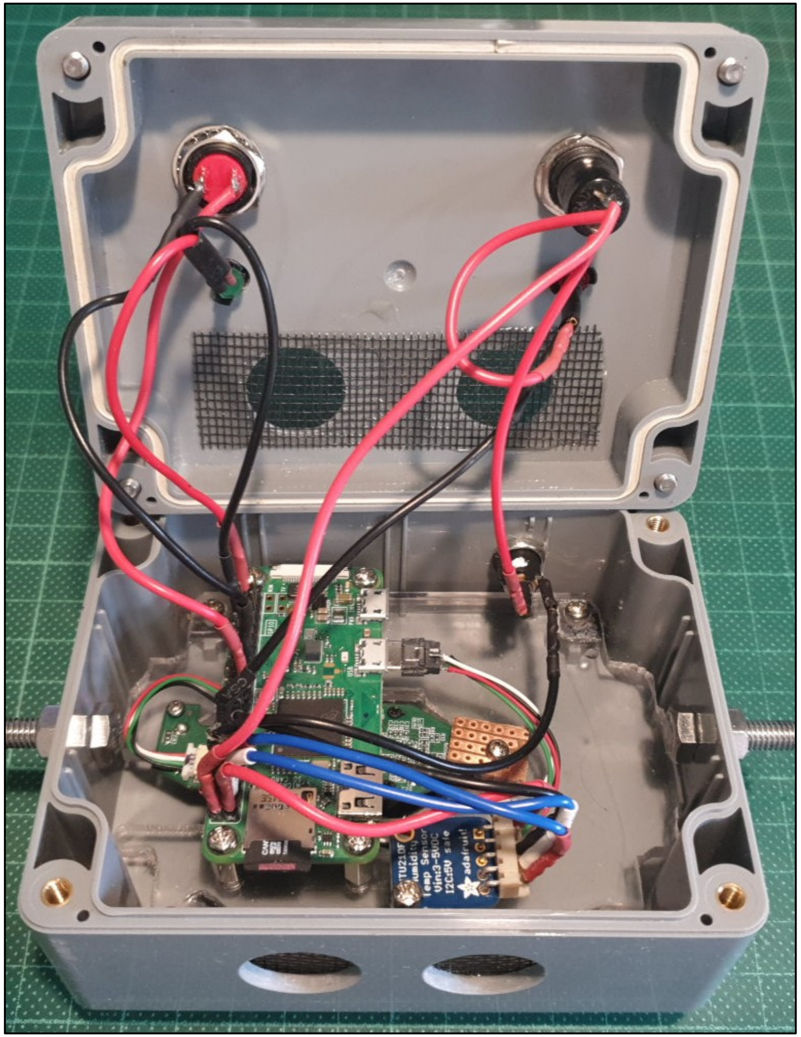
Raspberry Pi Zero and HTU21 mounted in enclosure



The perspex plate is secured to the enclosure bosses with 3mm screws and the Raspberry Pi Zero and HTU21 have been secured to their standoffs with 3 mm screws

Holes in left and right side of enclosure are for M6X20mm stainless steel mounting bolts.

View with back cover and wiring in place



Left to right on the inside of the enclosure cover: the momentary pushbutton shutdown switch with green 5mm LED mounted in a black plastic bezel and the push button latching on/of switch with red LED in plastic bezel.

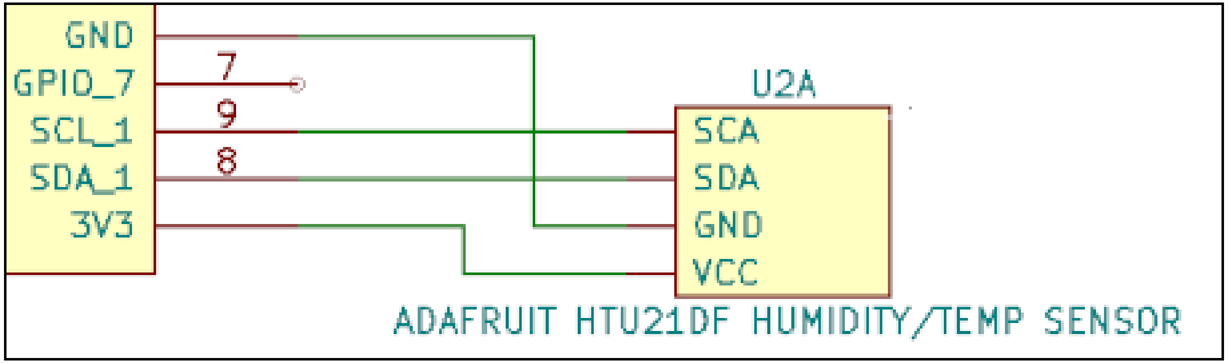
Wires to switches and LEDs were soldered. Wires to pins were connected using soldered female crimp pins wrapped in shrink wrap.

Resistors were soldered inline to wires and wrapped in shrink wrap.

Setting up the HTU21 Sensor

The HTU21sensor will be accessed as an I2C device on the Industrial IO bus which will simplify access to humidity and temperature readings.

The HTU21 breakout board is connected as shown on the schematic.



Enabling the HTU21 Sensor

Install *i2c-tools* and then add ‘*i2c-dev*’ to */etc/modules* to load the i2c-dev module at boot.

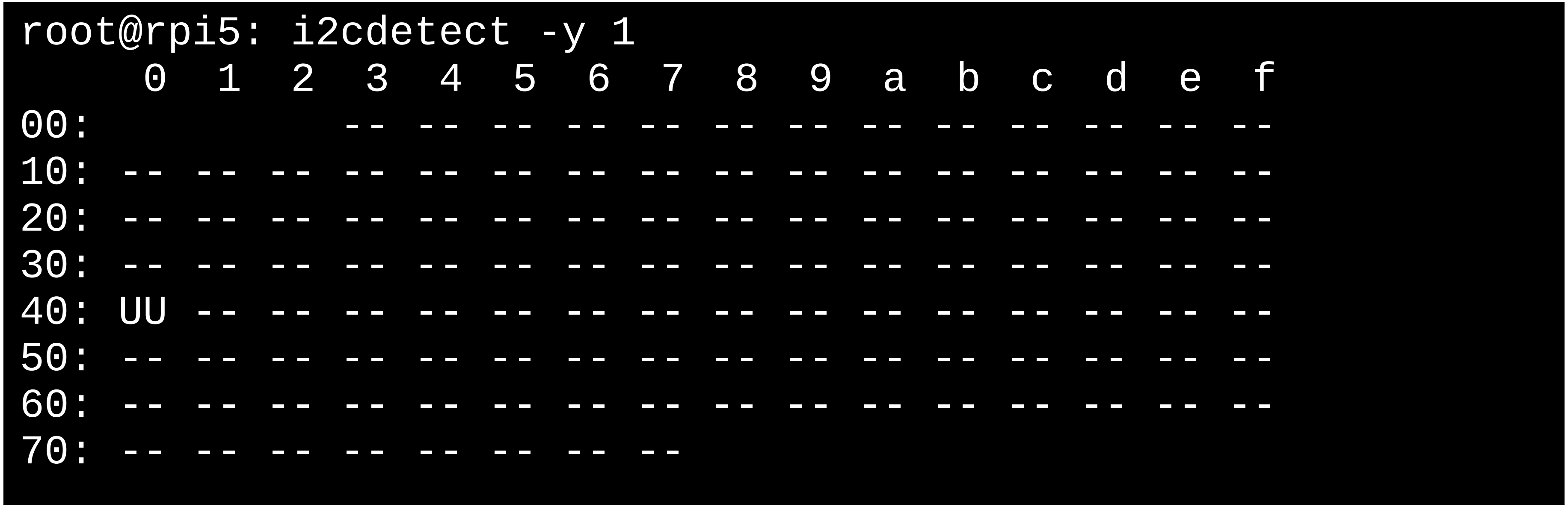
```
root@rpi5: echo 'i2c-dev' >> /etc/modules
```

Open */boot/config.txt*. Uncomment the line ‘*dtparam=i2c_arm=on*’ and add the line ‘*dtoverlay=i2c-sensor,htu21*’.

```
# Uncomment some or all of these to enable the optional
hardware interfaces
dtparam=i2c_arm=on
dtoverlay=i2c-sensor,htu21
# dtparam=i2s=on
# dtparam=spi=on
```

Confirm HTU21 Sensor is an IIO device

Upon reboot, use the command ‘i2cdetect -y 1 to check that the htu21 device has been loaded as an Industrial IO (iio) device.



```
root@rpi5: i2cdetect -y 1
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: UU -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- --
```

If the letters *UU* are displayed as above instead of the number *40* the HTU21 is set up as an iio device and can be found on the iio bus

Get data from the HTU21 Sensor

The HTU21 is the only iio device in this setup. It will present on the *iio bus* as *device0.* The current temperature and humidity are provided in the files *in_temp_input* and *in_humidityrelative_input*.

```
root@rpi5: ls /sys/bus/iio/devices/iio\:device0
battery_low    in_humidityrelative_input   of_node    sampling_frequency_available
dev            in_temp_input               power      subsystem
heater_enable  name                        sampling_frequency       uevent
```

The command ‘*cat*’ will return the current temperature and humidity. The *Industrial I/O ABI requires that temperature* and humidity values are to be returned on a scale of 1000. The temperature is 29.92 degrees celsius and the humidity is 38.10%

```
root@rpi5: cat /sys/bus/iio/devices/iio:device0/in_temp_input
29920

root@rproot@rpi5: cat
/sys/bus/iio/devices/iio:device0/in_humidityrelative_input
38100
```

Install and configure Hawkeye webcam server

- *Hawkeye* is a lightweight webcam server compared to *mjpg-streamer*. I did not consider *motion* an option although with a motion sensor added to this installation I could take pictures of any movement in the view range.
- *Hawkeye* was developed by Igor Partola for personal use on a Raspberry Pi. It is available at https://github.com/ipartola/hawkeye. The *README.md* provides links to debs as well as source code. I have built and installed the two debs *hawkeye-dbgsym_0.7_armhf.deb* and *hawkeye_0.7_armhf.deb* from the source on the Raspberry Pi Zero W used in this project.
- For anyone interested, it is possible to compile the Hawkeye source for use on other SBC's. I have Hawkeye running on the *Lemaker Banana Pro* that runs my weather station and weather station server. After compiling I had to manually put together, create and then install the *Slackwarearm* package.
- If anyone needs more info on how to get Hawkeye running on a non-systemd system contact me on the MLUG list.

Install and configure Hawkeye webcam server

Once installed, *Hawkeye's* configuation file can be found at */etc/hawkeye/hawkeye.conf*.

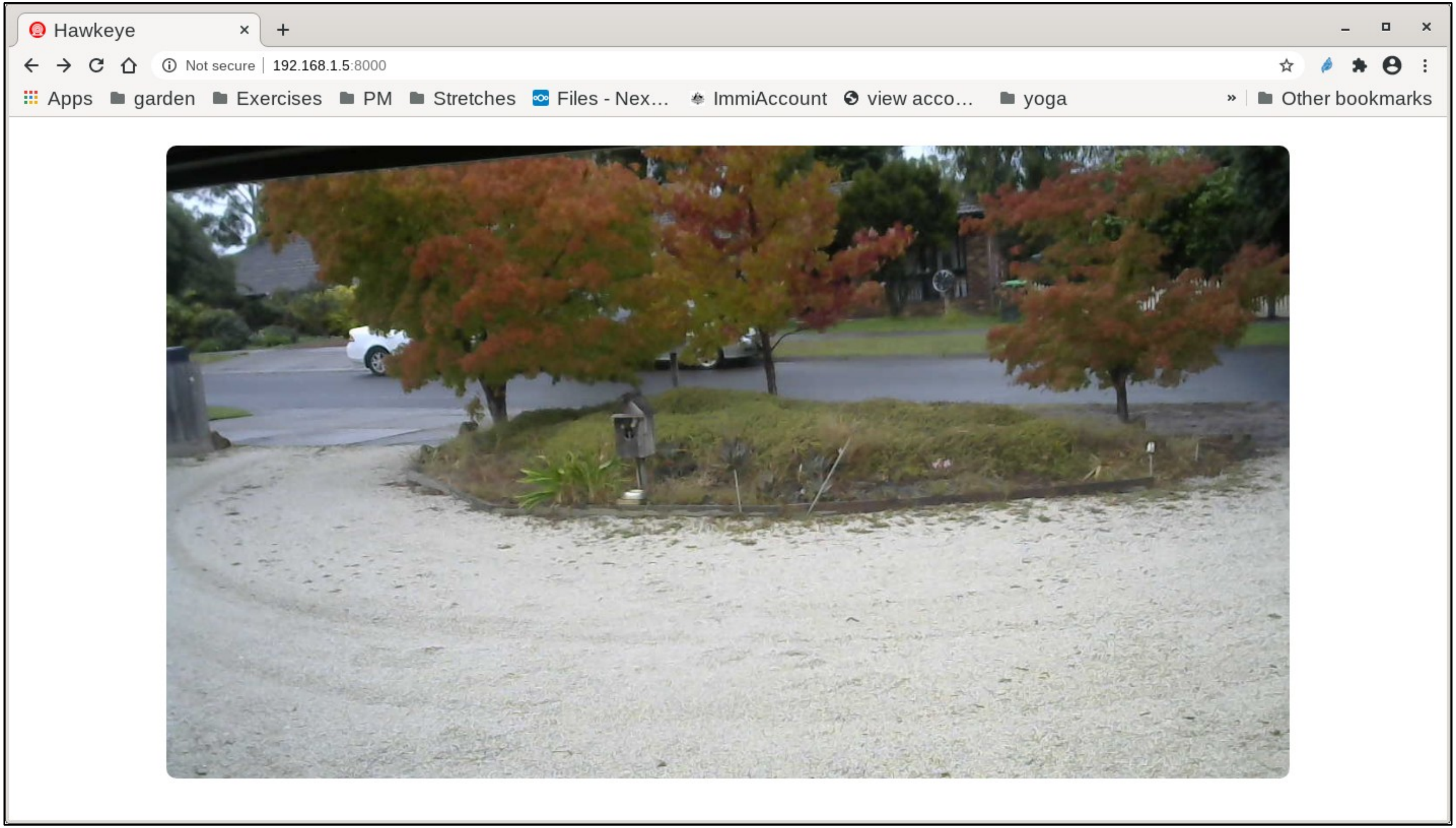
The Raspberry Pi Zero has been given a static IP address. The address in the config file has to be edited from *localhost* to *192.168.1.5*. Also the webcam resolution and frame rate is modified to maximum available on the Logitech C270.

```
# IPv4 and IPv6 addresses and hostnames are supported.
host = 192.168.1.5  # Secure default.
port = 8000
```

```
fps = 20
width = 1280
height = 720
# Only has an effect if format is set to yuv
Quality = 80
```

After editing the config, file restart hawkeye with '*systemctl restart hawkeye'.* The *hawkeye* webcam stream can now be accessed at *192.168.1.5:8000.*

Real time stream from the Hawkeye webcam server



Create a background image and data label

The *Hawkeye* server provides a blank webpage with the webcam stream in the centre and without the temperature and humidity. With *‘bc’* installed for simple math and ‘*imagemagick*’ installed to work with images a bash script *‘mk-background.sh’* is used to create a background image and a label containing the temperature, humidity and time data was read.

The script is run by cron every 15 minutes to provide a fresh background and fresh data.

```
# Blink green LED to show script is running.
/usr/local/bin/wc_jobs -b
#
# Get current humidity and create a humidity variable.
in_humid=$(cat/sys/bus/iio/devices/iio:device0/in_humidityrelative_input)
humid=$(echo "scale=3; $in_humid / 1000" | bc)
humid=$(printf "Rh: %.01f%%" $humid)
#
# Get current temperature and create a temperature variable.
in_temp=$(cat /sys/bus/iio/devices/iio:device0/in_temp_input)
temp=$(echo "scale=3; $in_temp / 1000" |  bc)
temp=$(printf "Temp: %.01f" $temp)
```

Create a background image and data label

```
# Grab a webcam image, modify and create a background image.
wget -O /tmp/output.png http://192.168.1.5:8000/still/0 2> /dev/null
#
convert /tmp/output.png -quality 25 \
-gravity North -chop 0x50 -gravity South -chop 0x50 \
/var/lib/hawkeye/www/background.png 2> /dev/null
#
# Create an information label as a .png image.
convert -background white -fill black -font Liberation-Sans \
-pointsize 22 label:"\  $temp  $humid  Time: $(date "+%H:%M")  " \
/var/lib/hawkeye/www/header.png
```

This script saves both images to /var/lib/hawkeye/www. The complete *mk-background.sh* script is provided in Addendum 1.

To run the script every 15 minutes append the following line to root’s crontab.

```
*/15 * * * * /usr/local/bin/mk-background.sh 1> /dev/null
```

Edit /var/lib/hawkeye/www/index.html

Open */var/lib/hawkeye/www/index.html* and insert the CSS on this slide and the next slide directly above the HTML tag </head>.

```
<style type="text/css">
body{
    background-image: url('background.png');
    background-size: cover;
    -webkit-background-size: cover;
    -moz-background-size: cover;
    -o-background-size: cover;
    background-repeat:   no-repeat;
    background-position: center center;
    }
```

Edit /var/lib/hawkeye/www/index.html

```
section{
    position: absolute;
    top: 50%;
    left: 50%;
    margin-right: -50%;
    transform: translate(-50%, -50%)
    }
img{
    border-radius: 10px;
    border: 2px solid black;
    }
</style>
```

Edit /var/lib/hawkeye/www/index.html (continued)

Add the following lines directly below the HTML tag <body>.

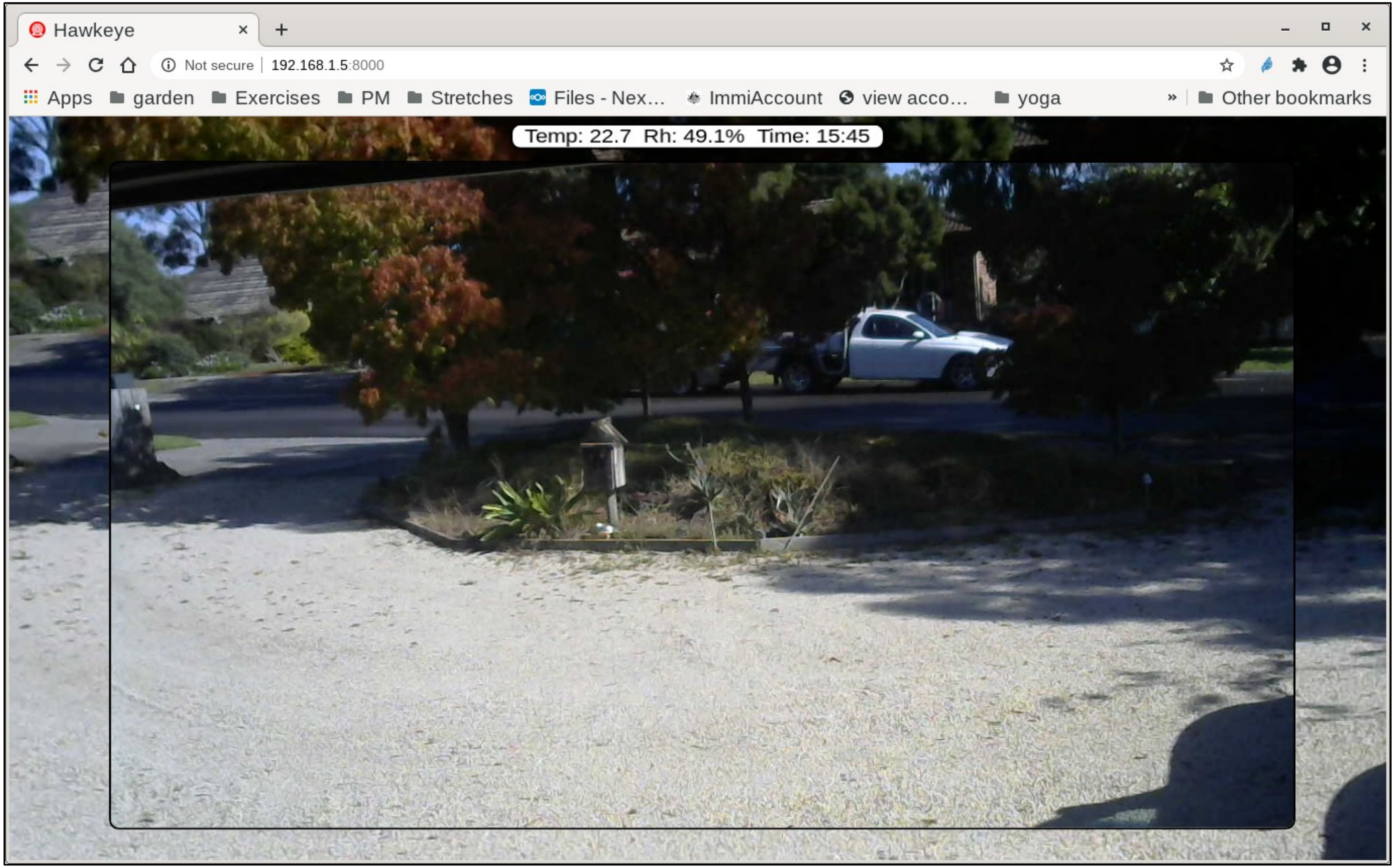
```
<section>
<div style="text-align: center;"><img src="header.png" width="371"
height="26" alt=""></div>
```

Add the following line directly above the HTML tag </body>.

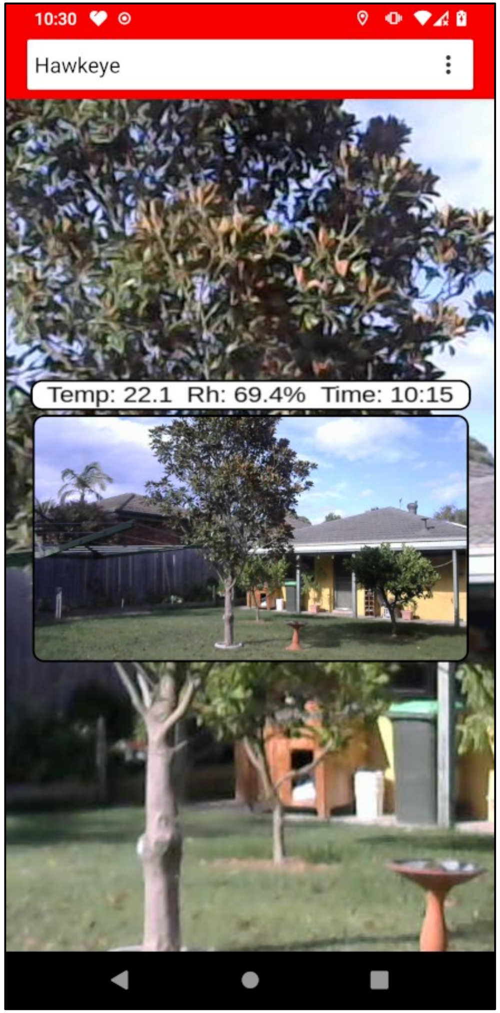
```
</section>
```

The next time the remote webcam is accessed at *192.168.1.5:8000* the webpage will present with the most recent image of the webcam’s field of view as a background as well as the most recent temperature and humidity at the remote webcam’s location displayed in a label.

Live stream with webpage background and data label



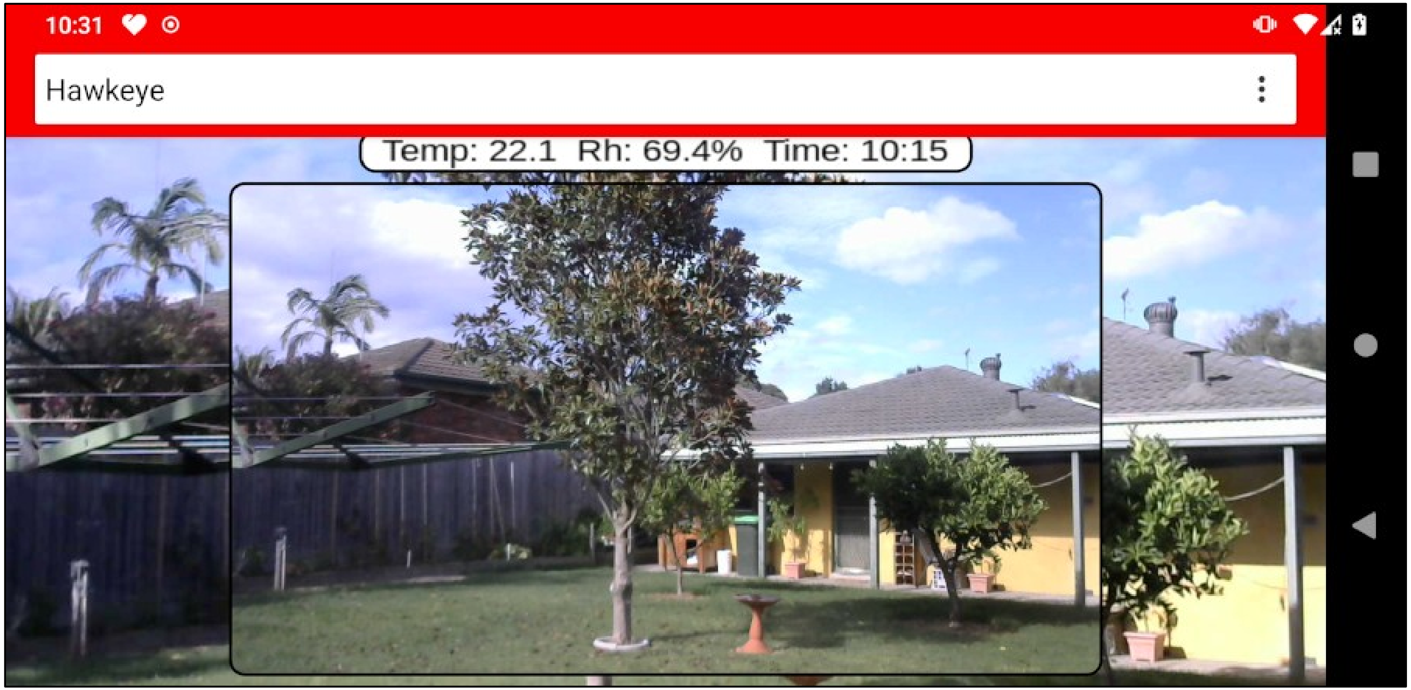
Live stream displayed in the LineageOS Jelly browser



10:30

Hawkeye

Temp: 22.1 Rh: 69.4% Time: 10:15



10:31

Hawkeye

Temp: 22.1 Rh: 69.4% Time: 10:15

C program, wc_jobs, carries out system tasks

While turning on and blinking a LED could be accomplished in a *bash* script, a system can not be shut down with a *bash* script. The C program wc_jobs is used to shut down the system as well as turn on or blink the green LED.

‘*wc_jobs -u’* turns on the green LED.

‘*wc_jobs -d’* turns off the green LED.

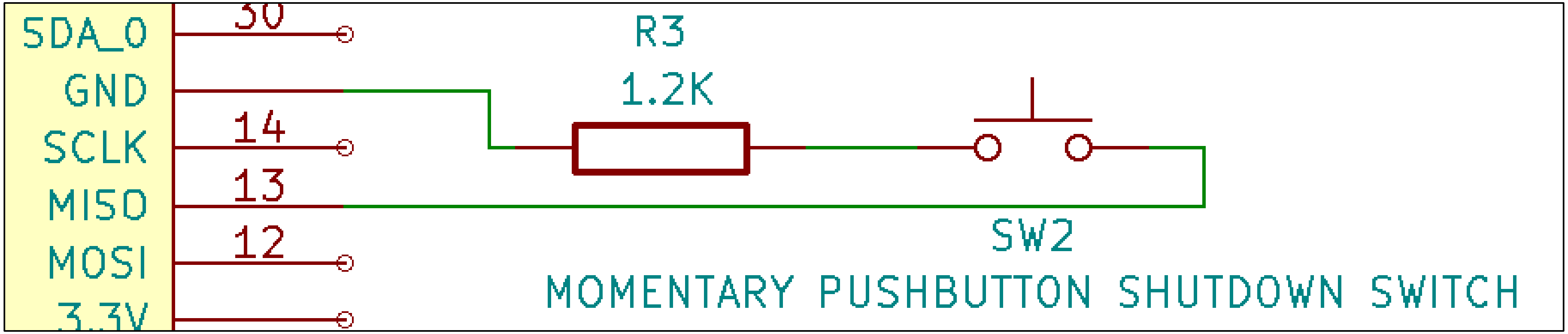
‘wc_jobs -m’ monitors the shutdown switch and shuts down the system when it is pressed.

‘*wc_jobs -b*’ blinks the LED 12 times.

It shouldn’t be necessary to discuss switching LEDs on and off. However, *‘wc_jobs -m’* involves changing the logic level of a gpio pin and deserves a closer look.

C program, wc_jobs, carries out system tasks

Pin 13 is configured as an input pin and pulled up. This makes the logic state of the pin HIGH (1). When the momentary switch is pressed, pin 13 is shorted to Ground which changes the pin's logic state to LOW (0). When the logic state changes to LOW the command *'/sbin/shutdown -h now'* is run.



The code for *'wc_jobs -m'* follows on the next slide.

C program, *wc_jobs*, carries out system tasks

```
case 'm':               // Monitor for momentary switch press
                        // and shut down system if pressed.
    wiringPiSetup();
    pinMode(SHTDWN_PIN, INPUT);
    pullUpDnControl (SHTDWN_PIN, PUD_UP);
    for(;;)
    {
        int killval = digitalRead(SHTDWN_PIN);
        if (killval == 0)
            {
                system("/usr/local/bin/wc_jobs -b");
                system("/sbin/shutdown -h now");
            }
    }
```

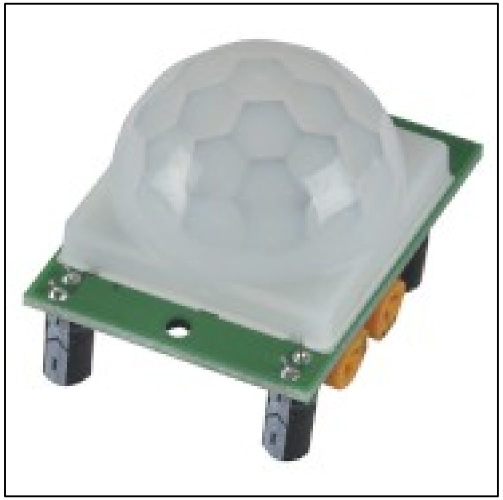
The complete source code for *wc_jobs is provided in Addendum 2.*

The End?

Not quite!

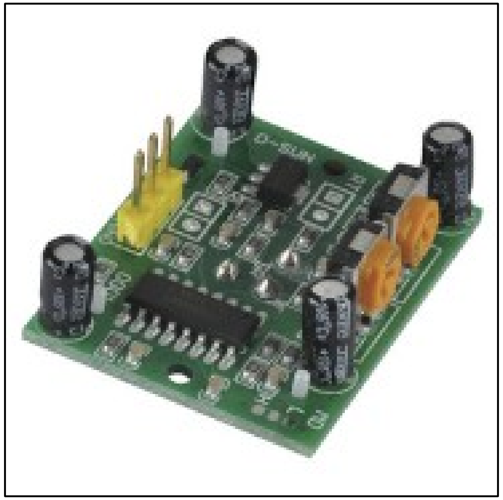
Setting up a pyroelectric infrared (PIR) Motion Sensor

A couple days ago I picked up an Arduino compatible PIR sensor at Jaycar. Too late to make the cut and be included in the Remote Webcam Mark I but I couldn't resist testing how it could be integrated into a future iteration of this project. Jaycar does not provide much in the way of documentation. It appears to be a clone of the *HC-SR501* and you can find information here https://lastminuteengineers.com/pir-sensor-arduino-tutorial/.



This sensor will run on 4.5-12VDC. Its logic voltage (output) is 3.3VDC out. This is compatible with the Raspberry Pi Zero's GPIO pins, i.e. 3.3VDC.

I can use the shutdown switch code to monitor the sensor but in this instance the GPIO pin will be input, pulled down LOW (0) with the sensor pulling it HIGH (1) when motion is detected. I have measured the logic voltage at ~3.3V but will put a resistor between the sensor and the GPIO pin as a precaution.



Setting up a pyroelectric infrared (PIR) Motion Sensor

This is the code added to *wc_jobs* that pulls a GPIO pin down (0) and waits for it to be pulled up (1) by the PIR sensor. When pulled up it runs a script *get-image.sh.*

```
case 's':                   // Monitor input pin connected to a
                            // PIR sensor and grab a still image
                            // when sensor detects movement.
    wiringPiSetup();
    pinMode(SNAP_PIN, INPUT);
    pullUpDnControl (SNAP_PIN, PUD_DOWN);
    for(;;)
    {
        delay(50);
        int snapval = digitalRead(SNAP_PIN);
        if (snapval == 1)
        {
            system("/usr/local/bin/get-image.sh");
            system("/usr/local/bin/wc_jobs -b");
        }
    }
```

Setting up a pyroelectric infrared (PIR) Motion Sensor

A short bash script *'get-image.sh'* will be run by *'wc_jobs -s'* when motion is detected. It will grab an image from the webcam and name that image using a time stamp.

```
#!/bin/bash
# /usr/local/bin/get-image.sh RM20210326
# Obtains an image from webcam when PIR Sensor is triggered,
# adds a timestamp to the image and saves the image named
# with the timestamp.
#
wget -O /tmp/output.png http://192.168.1.6:8000/still/0 2> /dev/null
#
timestamp=$(date +%d-%b-%R)
#
convert /tmp/output.png -pointsize 20 -fill white \
-gravity South -annotate +0+25 "$timestamp" \
/tmp/$timestamp.png
```

A preliminary test was undertaken by setting a spare Raspberry Pi Zero W with webcam and the PIR sensor up on the veranda dining table and calling the dog.

Setting up a pyroelectric infrared (PIR) Motion Sensor

Setting up a pyroelectric infrared (PIR) Motion Sensor

In the image on the previous slide our dog was ~3 metres from the sensor when it detected his movement. The acacia behind the dog was ~4 metres away from the sensor. The sensor detected the acacia branches moving in the breeze.

The maximum view angle of the sensor is said to be 110 °. However, after connecting an LED to the 3.3V output and putting my hand in different locations it seems the maximum view angle is more like 150 °-160 °. I will have to play with the adjustments and possibly tape over part of the fresnel lense to narrow the sensor view angle before I decide if this will be suitable for use with my remote webcam.

Bill of Materials

Logitech C270 Webcam	Kogan.com	
Raspberry Pi Zero W	Core Electronics	CE04754
Adafruit HTU21DF Temperature + Humidity Sensor	Core Electronics	ADA1899
USB DIY Connector Shell-Type Micro-B Plug	Core Electronics	ADA1390
5VDC 13W Regulated Plugpack (switchmode)	Ocean Controls	PLP-009
PIR Motion Detector Module	Jaycar	XC4444
115x90x55 ABS Sealed Enclosure	Jaycar	HB-6124
SPST N/O Momentary Action Switch	Jaycar	SP0700
SPST Pushbutton - Black Actuator – Latching	Jaycar	SP0718
5mm Green Diffused LED	Jaycar	ZD0170
5mm Red Diffused LED	Jaycar	ZD0150
5mm LED Clips Black	Jaycar	HP1102
M3 x 15mm Tapped Metal Spacers (standoffs)	Jaycar	HP0904
M3 x 10mm Steel Screws	Jaycar	HP0403

Wire, resistors, crimp pins, etc. were from personal stock or left over from other projects. Note that perspex or glass cut-offs can be sometimes be obtained for free or inexpensively from glaziers or plastic fabricators.

This is the end!

If you haven’t asked a question yet, now is the time ....

and thank you for your kind attention.

Addendum 1: mk-background.sh

```
#!/bin/bash
# /usr/local/bin/make-background.sh RM20210221
# Used with remote webcam installation.
# Creates a background image for Hawkeye's server index.html
# and a data label showing current temperature, humidity
# and time reading was taken.
#
# Blink green LED to show script is running.
/usr/local/bin/wc_jobs -b
#
# Get current humidity and create a humidity variable.
in_humid=$(cat/sys/bus/iio/devices/iio:device0/in_humidityrelative_input)
humid=$(echo "scale=3; $in_humid / 1000" | bc)
humid=$(printf "Rh: %.01f%%" $humid)
#
```

Addendum 1: mk-background.sh (continued)

```
# Get current temperature and create a temperature variable.
in_temp=$(cat /sys/bus/iio/devices/iio:device0/in_temp_input)
temp=$(echo "scale=3; $in_temp / 1000" |  bc)
temp=$(printf "Temp: %.01f" $temp)
#
# Grab a webcam image, modify and create a background image.
wget -O /tmp/output.png http://192.168.1.5:8000/still/0 2> /dev/null
#
convert /tmp/output.png -quality 25 \
-gravity North -chop 0x50 -gravity South -chop 0x50 \
/var/lib/hawkeye/www/background.png 2> /dev/null
#
# Create an information label as a .png image.
convert -background white -fill black -font Liberation-Sans \
-pointsize 22 label:"\  $temp  $humid  Time: $(date "+%H:%M")  " \
/var/lib/hawkeye/www/header.png
```

Addendum 2: wc_jobs.c

```
/*/////////////////////////////////////////////////////////////
/ wc-jobs.c RM20210221 compile to wc_jobs
/ gcc -Wall wc-jobs.c -o wc_jobs -l wiringPi
/
/ This program is used to control Gpio pins in order to power
/ up/down a green LED, blink the green LED, monitor a pin that
/ shuts down the system when a shut down button is pressed.
/ Usage: ws_jobs [OPTION]
/  -u, Power up the green LED
/  -b, Blink the green LED
/  -d, Power down the green LED
/  -m, Monitor the shutdown pin
/  -s, Monitor PIR sensor pin
/
/////////////////////////////////////////////////////////////*/
```

Addendum 2: wc_jobs.c (continued)

```
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <unistd.h>
#include <wiringPi.h>
#define LED_PIN 29     // The green LED is connected pin 25.
#define SNAP_PIN 7     // Pin 7 set INPUT DOWN when pulled up
                       // a still image will be taken from
                       // the webcam.
#define SHTDWN_PIN 13  // Pin 13 is set INPUT UP, 1, when it is
                       // is pulled DOWN, 0, with a button press
                       // the system is shutdown.

int main(int argc, char *argv[])
{
    int optchar;
```

Addendum 2: wc_jobs.c (continued)

```
    while((optchar = getopt (argc, argv, "ubdms")) != -1)
      {
      switch (optchar)
      {
      case 'u':              // Turn on green LED.
         wiringPiSetup();
         pinMode(LED_PIN, OUTPUT);
         digitalWrite(LED_PIN, HIGH);
         break;
      case 'd':              // Turn off green LED.
         wiringPiSetup();
         pinMode(LED_PIN, OUTPUT);
         digitalWrite(LED_PIN, LOW);
         break;
```

Addendum 2: wc_jobs.c (continued)

```
case 'b':               // Blink green LED.
wiringPiSetup() ;
pinMode(LED_PIN, OUTPUT);
int count_blinks = 1;
while(count_blinks <= 12)
{
    digitalWrite(LED_PIN, LOW);
    delay(75);
    digitalWrite(LED_PIN, HIGH);
    delay (75);
    count_blinks++;
}
```

Addendum 2: wc_jobs.c (continued)

```
        Case 'm':             // Monitor for momentary switch press
                              // and shut down system if pressed.
            wiringPiSetup();
            pinMode(SHTDWN_PIN, INPUT);
            pullUpDnControl (SHTDWN_PIN, PUD_UP);
            for(;;)
            {
                int killval = digitalRead(SHTDWN_PIN);
                if (killval == 0)
                {
                    system("/usr/local/bin/wc_jobs -b");
                    system("/sbin/shutdown -h now");
                }
            }   // Closes for loop
```

Addendum 2: wc_jobs.c (continued)

```
case 's':                   // Monitor input pin connected to a
                            // PIR sensor and grab a still image
                            // when sensor detects movement.
            wiringPiSetup();
            pinMode(SNAP_PIN, INPUT);
            pullUpDnControl (SNAP_PIN, PUD_DOWN);
            for(;;)
            {
                delay(50);
                int snapval = digitalRead(SNAP_PIN);
                if (snapval == 1)
                {
                    system("/usr/local/bin/get-image.sh");
                    system("/usr/local/bin/wc_jobs -b");
                }
            }   // Closes for loop
        }   // Closes switch
    }   // Closes while loop
    return 0;
}
```