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Other Fun Project With Raspberry Pi (RP)

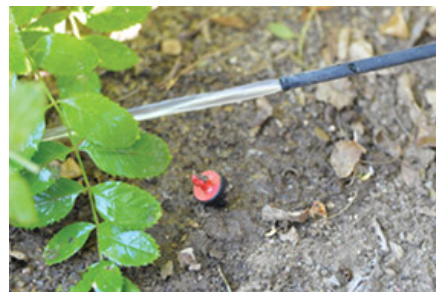
Michael Bao

AI6BJ

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Water Problems at Home

- Typically,
 - Broken sprinkler head
 - Broken drip emitter
 - Broken hose from a toilet or sink
 - Pipe burst or leaked
 - Unintended usage
- And it happened to me ☹️



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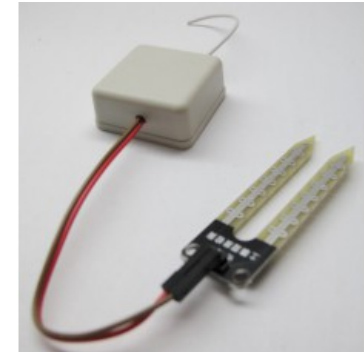
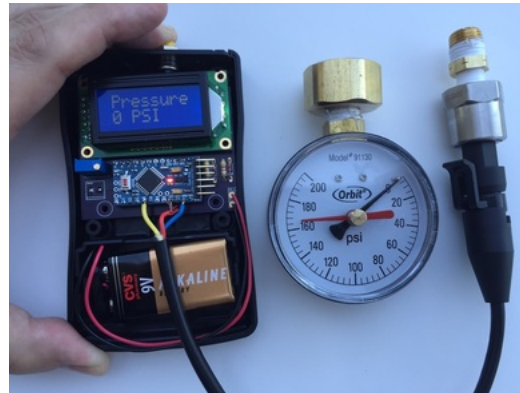
What I Need is

- Whole house monitoring including pipes up to main water meter
- Real time alerts (text/email) when a water pressure threshold is reached
- All data is stored in a database for record or analysis
- A low-cost and home-brewed system
- Sensitivity, accuracy and reliability
- Configurable online
- No intensive plumbing nor electrician skills needed

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Looking For A Solution

- Bad news: no such complete system/kit is available on the market
 - No real time alerts
 - Rather expensive or not configurable
 - Not monitoring the whole house
 - Some intensive plumbing or electrician skills needed



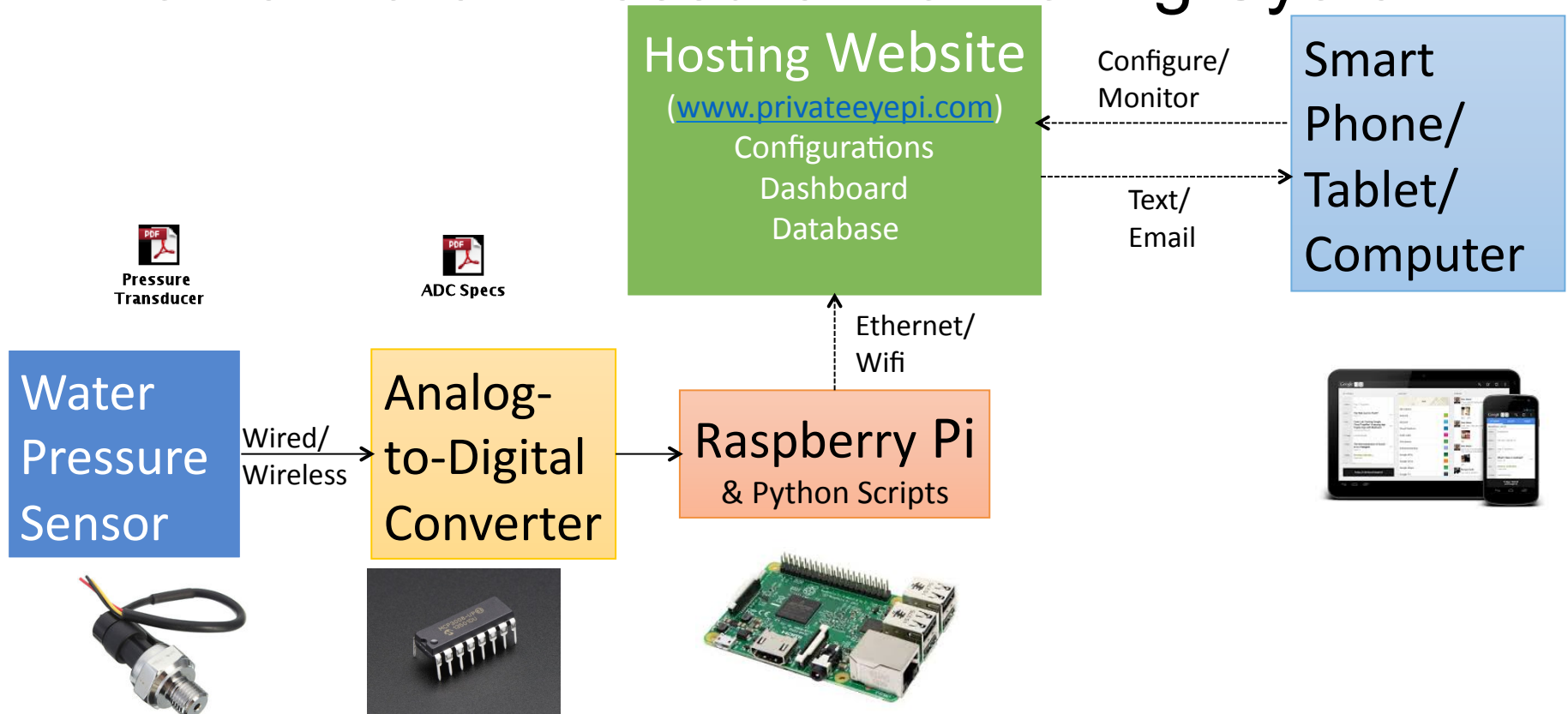
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A Solution Found

- Good news
 - A working system with water pressure sensor (WPS), RP and a hosting website
- Concept of operation
 - A sensor hooked up under a sink to monitor water pressure of the whole house
 - The sensor sends data to a RP via wired/wireless connection
 - The RP uploads data to a hosting website via Ethernet/Wifi
 - The hosting website stores, displays data and sends out alerts via text/email
 - The user analyzes alerts and/or review stored data

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Home Water Pressure Monitoring System



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Parts

- Raspberry Pi 3 Model B (\$40, amazon.com)
- Water pressure sensor (\$16-\$30, amazon.com)
 - I used HONEYWELL PX2AS2XX100PAAAX (0-100 psi, 3-pin) (\$61, verical.com)
 - Connector shell: 829-12110192 (\$7, mouser.com)
 - 3 connector pins: 829-12089290 (\$1.5, mouser.com)
- 8-channel 10-bit ADC chip (MCP3008, \$5.5, ebay.com)
- Assuming you have 1/2" OD under your sink, you need this adapter or similar one: iSpring 123Filter™ Water Supply Connector (1/2" NPT, Tube 1/4") #AFW2+ABV3 at (\$15, 123filter.com)
- Cobbler cable and a pair of small breadboards (\$10, amazon.com)
- Some jumper wires and data cables

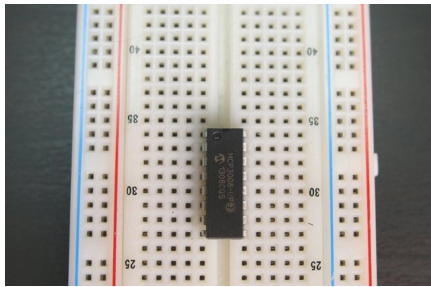


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Connections - Water Pressure Sensor to a Sink Hose

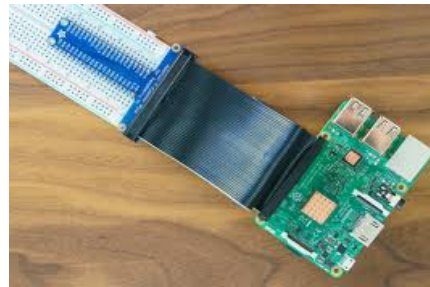
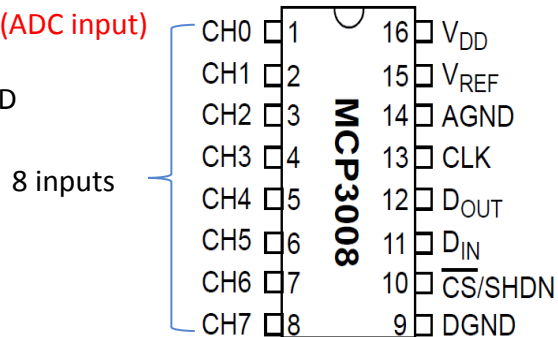


Connections - Water Pressure Sensor to RP

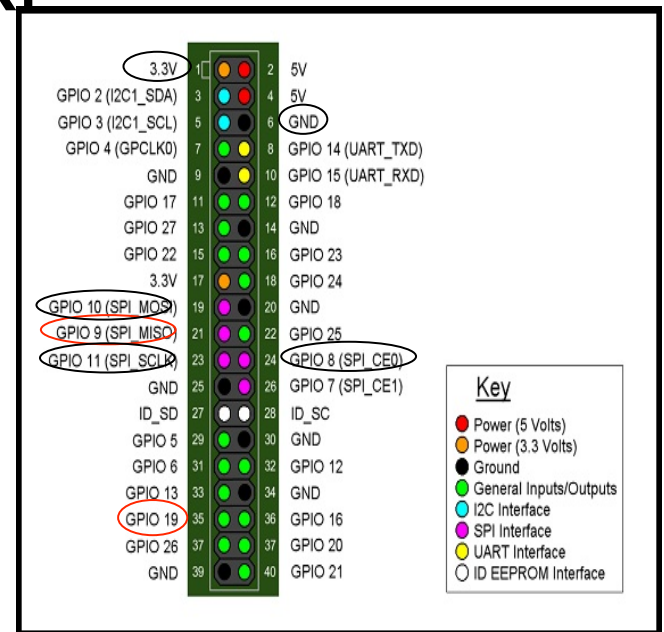


ADC

V+ -> VDD
GND -> AGND

 RP^*

- > 3.3V
- > 3.3V
- > GND
- > GPIO 11
- > GPIO 9 (I2C)
- > GPIO 10
- > GPIO 8
- > GND



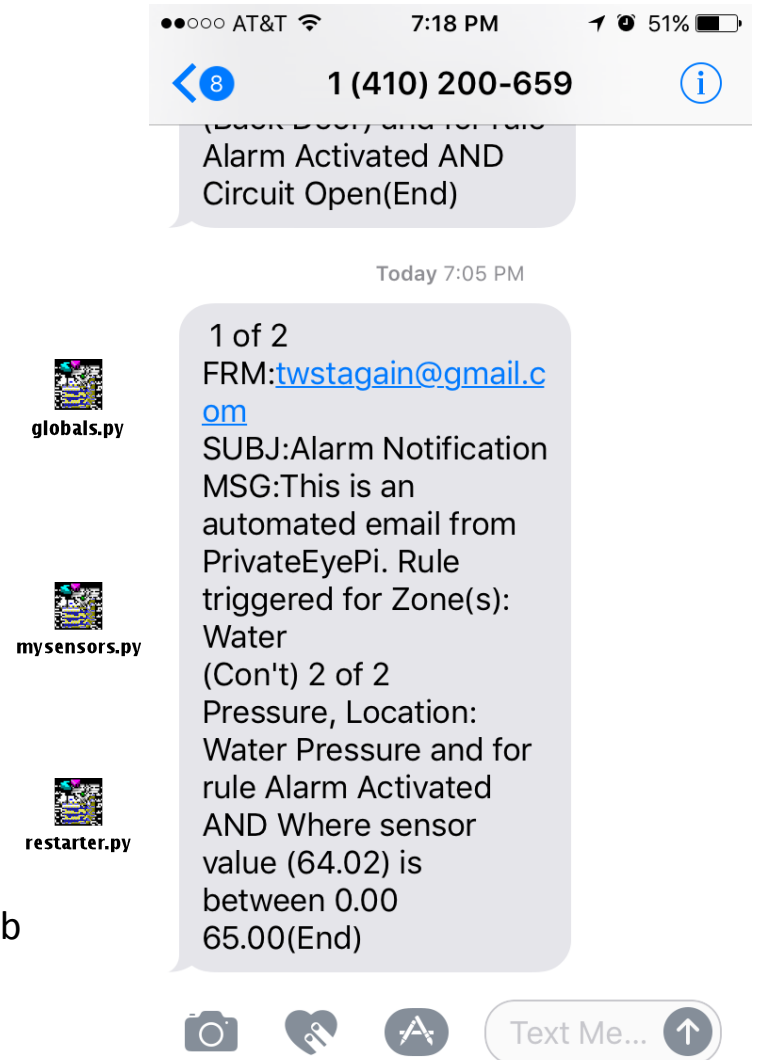
*: RP with SPI mode enabled using raspi-config

-> GPIO 9 (RP input) $\xrightarrow{\text{CH}_3}$ GPIO 19 (RP output) ---> Hosting Website

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Hosting website (privateeyepi.com)

- See how-to at projects.privateeyepi.com
- Python scripts run on RP
 - globals.py:
 - Declare variables: RP GPIO 19 (Pin No 35)...
 - Set up email account to receive alerts
 - Set up account to login hosting website
 - mysensors.py:
 - Map the data channel 3 with GPIO 19 (RP output)
 - Convert digital to analog value of water pressure
 - Upload data to hosting website periodically
 - restarter.py
 - Automatic re-execution of Python scripts by crontab
- Online configuration and monitoring



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mysensors.py

Function to convert analog data (mV) to water pressure level (PSI),

Rounded to specified number of decimal places.

```
def ConvertPSI(data,places):
```

```
    min_wps_mV = 330
```

```
    max_wps_mV = 2970
```

```
    ADC_range = 1024
```

```
    ADC_mV = 3300
```

```
    min_wps_tick = (min_wps_mV * ADC_range) / ADC_mV
```

```
    max_wps_tick = (max_wps_mV * ADC_range) / ADC_mV
```

```
    tick_range = (max_wps_tick - min_wps_tick)
```

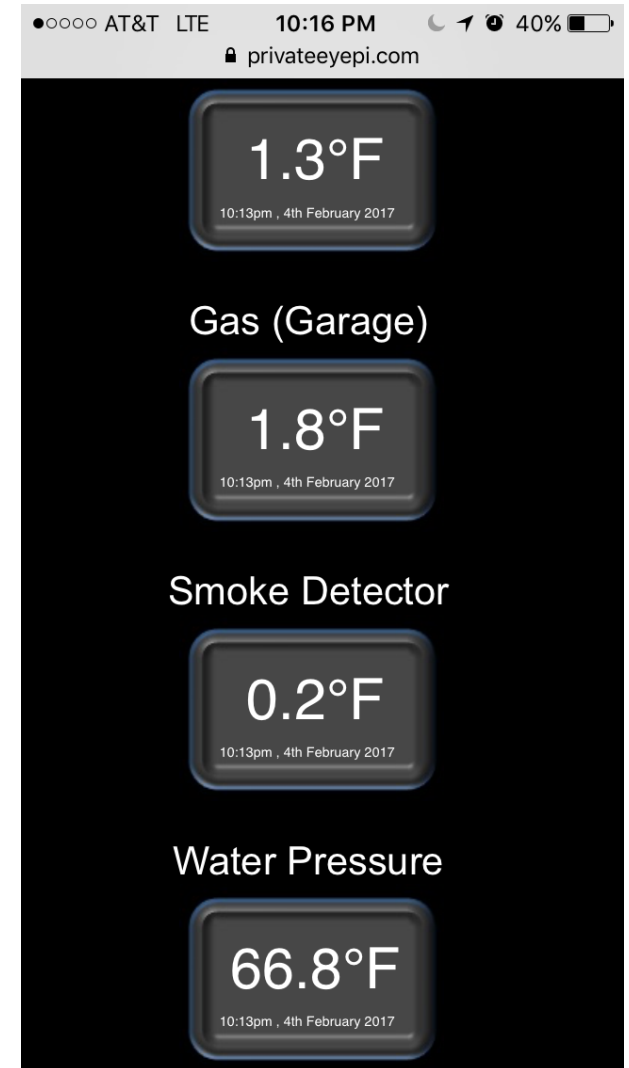
```
    PSI_range = 100
```

```
    ticks = data - min_wps_tick
```

```
    water_pressure_PSI = ticks * PSI_range / tick_range
```



```
    water_pressure_PSI = round(water_pressure_PSI,places)
```

```
    return (water_pressure_PSI - 6.8) # offset = 6.8 PSI
```



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Configuration

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User

GPIO

Location

Zone

Zonelink






Email

Rules

Config

Add

Description	GPIO Port:	Type	Edit	Delete
Temperature (Upstairs)	GPIO 4	Temperature	Edit	Delete
Temperature (Downstairs)	GPIO 20	Temperature	Edit	Delete
Temperature (Garage)	GPIO 5	Temperature	Edit	Delete
Gas (Upstairs)	GPIO 2	Temperature	Edit	Delete
Gas (Downstairs)	GPIO 26	Temperature	Edit	Delete
Gas (Garage)	GPIO 3	Temperature	Edit	Delete
Smoke Detector	GPIO 21	Temperature	Edit	Delete
Water Pressure	GPIO 19	Temperature	Edit	Delete



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Threshold Setup

GPIO	Location	Zone	Zonelink	Email	Rules
------	----------	------	----------	-------	-------

Add			
GPIO	IF Day AND Hour of day (0-23) is between 7.00 AND 16.00	Activate Zone	Delete
GPIO 6	IF Zone is armed AND Sensor open	Email	Delete
GPIO 13	IF Day of week is from Monday TO Friday AND Hour of day (0-23) is between 7.00 AND 16.00	Activate Zone	Delete
GPIO 13	IF Zone is armed AND Sensor open	Email	Delete
GPIO 13	IF Day of week is from Monday TO Friday AND Hour of day (0-23) is between 16.00 AND 23.00	Deactivate Zone	Delete
GPIO 6	IF Day of week is from Monday TO Friday AND Hour of day (0-23) is between 16.00 AND 23.00	Deactivate Zone	Delete
GPIO 19	IF Zone is armed AND Sensor value is between 0.00 AND 65.00	Email	Delete

Regular email and/or
email-to-text
(10-digit-of-smart-
phone@text.att.net)

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Data Analysis

- Alert pattern
 - Frequent->water issue (?)
 - Infrequent->normal use of water
 - Someone just comes home (?)
 - Someone uses your garden hose (?)
- Water pressure fluctuation in your area

AT&T 6:46 PM 56%

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Water Pressure

Hour	Sensor	Temperature
12 AM	Water Pressure	70.37F to 72.81F
1 AM	Water Pressure	70.98F to 73.42F
2 AM	Water Pressure	72.32F to 73.18F
3 AM	Water Pressure	70.86F to 72.32F
4 AM	Water Pressure	67.19F to 70.73F
5 AM	Water Pressure	72.20F to 79.89F
6 AM	Water Pressure	67.44F to 75.86F
7 AM	Water Pressure	71.95F to 77.08F
8 AM	Water Pressure	77.57F to 79.40F
9 AM	Water Pressure	78.79F to 80.87F
10 AM	Water Pressure	79.65F to 81.48F
11 AM	Water Pressure	67.07F to 80.14F
12 PM	Water Pressure	67.56F to 70.61F
1 PM	Water Pressure	68.29F to 71.47F
2 PM	Water Pressure	69.15F to 71.34F
3 PM	Water Pressure	57.06F to 70.49F
4 PM	Water Pressure	68.41F to 71.83F
5 PM	Water Pressure	76.72F to 82.09F
6 PM	Water Pressure	75.50F to 80.38F
7 PM	Water Pressure	76.35F to 78.06F
8 PM	Water Pressure	74.52F to 79.04F
9 PM	Water Pressure	78.30F to 80.87F
10 PM	Water Pressure	68.05F to 71.34F
11 PM	Water Pressure	70.00F to 72.93F

AT&T 7:16 PM 51%

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back Temperature Log - W

Date/Time	Temperature
2017-02-01 03:02:35 pm	69.63F
2017-02-01 03:10:56 pm	70.00F
2017-02-01 03:19:15 pm	67.19F
2017-02-01 03:27:36 pm	66.09F
2017-02-01 03:35:56 pm	57.06F
2017-02-01 03:44:16 pm	69.63F
2017-02-01 03:52:37 pm	70.49F

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System Uptime and Security

- Cron job on RP
 - `sudo crontab -e */1 * * * * sudo python /home/restarter.py >/dev/null 2>&1`
 - `sudo python restarter.py`
 - `sudo service cron start`
- 24/7 internet connection
 - Battery backup and surge protection for RP and modem/router
 - Remotely pinging modem for internet provider's status
 - A Python script is run by Windows Task Scheduler
- RP files/image backup with SD card cloning
- Firewall on RP
 - `sudo apt-get install ufw`
 - SSH

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Links

- <http://www.projects.privateeyepi.com>
- <https://learn.adafruit.com/raspberry-pi-analog-to-digital-converters/mcp3008>
- <https://www.adafruit.com/datasheets/MCP3008.pdf>
- <http://www.mouser.com/ProductDetail/Honeywell/PX2AS2XX100PAAAX/?qs=7J0fLV8%2FqQITxpIKtBDIJw%3D%3D>
- <http://computers.tutsplus.com/articles/how-to-clone-your-raspberry-pi-sd-cards-with-windows--mac-59294>
- <https://learn.sparkfun.com/tutorials/raspberry-pi-spi-and-i2c-tutorial>