Well System Monitor

Installation and User Manual

Version 1.0; date: 9/12/2018

Installation of the Well System Monitor

Concept

We highly recommend that you first read the Project Concept document included in this package. The project concept document explains the use cases we address with the well system monitor and discuss some of the limitations and future expansions.

The system consists of a microprocessor controlled system that monitors several sensors and reports their status to a cloud based storage facility. The project is based on the popular Water Leak Detector by Team Practical Projects as found on GitHub. The reader will need to build the Water Leak Detector hardware before continuing on this project.

This project uses the Particle.io Photon microprocessor and Google Docs Spreadsheet cloud storage. MIT App Inventor 2 is used to create a test app for an Android smartphone.

How the system works

The well monitor system connects over WiFi to the Particle.io cloud service. This is how it talks to the internet and how we can talk to it. The Android app can also connect to the Particle.io cloud and talk to the well monitor system for the purposes of testing and checking on system status. To provide long-term data logging we use the IFTTT service to gather data from the well monitor system and store it in a Google cloud spreadsheet.

Well Monitor ----> WiFi ----> Particle.io ---> IFTTT ----> Google Spreadsheet

|
‘---> Android app

Accounts

You will need accounts at the following websites:

1. Google (Google Drive app)
2. Particle.io
3. IFTTT

For the Santa Rosa installation account user names and passwords, see the document of that name.

Well Monitor Setup

WiFi Connection

Before continuing you will need to have know your WiFi network name and password. As you work through this list of actions you may want to check each step off as you go.

A. Install the Particle.io application on your phone and
   Claim the Particle Photon into your Particle.io account. For iPhone, see: https://itunes.apple.com/us/app/particle-build-photon-electron/id991459054?ls=1&mt=8.
   For Android, see: https://play.google.com/store/apps/details?id=io.particle.android.app.
   For Windows mobile, see:
   https://www.microsoft.com/en-us/p/particle/9nblggh4p55n?activetab=pivot%3aoverviewtab)
B. Get the Particle Photon onto your local WiFi. (see:
   https://docs.particle.io/guide/getting-started/start/photon/#step-1-power-on-your-device)
    a. Put Photon into WiFi configuration mode
        i. Connect the WSM to power. Wait about one minute.
            1. If the Photon is “flashing blue” about twice a second then go on to the next step.
            2. If the Photon is “breathing cyan” or “flashing green” then
                a. On the Photon find the Setup button (see photos below)
                b. Hold down the Setup button until the LED starts flashing blue. Now release the Setup button.
        ii. The LED should now be flashing blue. If not, repeat the process
    b. Start the Particle.io app on your phone.
        i. Log in using the Particle.io credentials above.
        ii. Find the + button to add a new device.
        iii. Select Photon

iv. Follow the directions in the app to provide your WiFi credentials to the Photon. IMPORTANT - if the app asks you to provide a new name for the device, just backspace to clear the name field and tap Done.

c. The Photon LED will turn colors, eventually turning green, then flashing green.
   i. Then the LED will turn cyan.
   ii. Then the LED will begin “breathing” cyan.
d. You are done. Your Photon is now connected to the Particle.io cloud.

Test your Well System Monitor

A. Install the WSM .apk file on your phone (see: https://github.com/TeamPracticalProjects/WellSystemMonitor/blob/master/TestApp/docs/Well_Monitor_App_Installation_and_User_Manual.pdf.
B. Start the WSM application.
C. Note the TEST: OFF indicator in the app.
D. Press and hold the test button on WSM system.
E. Tap the “UPDATE SYSTEM DATA” button in the phone app.
F. Note that the TEST switch indicator has changed to TEST: ON.
G. Ok, it’s all working

Hook it up

A. Mount the WSM in a convenient location within 6 feet of the well system relay box.
B. Mount the RJ11 box, near the pressure pump and the well pump relays.
C. From the RJ11 box, run two wires to a currently unused set of contacts on the relays. (shorting these wires will not hurt our system). If possible, the contacts should be normally closed and open when the pump turns on.
   a. Yellow and Green to the well pump
   b. Red and Black to the pressure pump
D. Use the telephone cord to connect the RJ11 box to the WSM.

Final Test

A. Cycle each of the pumps that the system is monitoring.
B. When a pump goes on or off, tap the UPDATE SYSTEM DATA button on the test app and make sure the app display correctly reflects the state of the pump.
C. You are done!

Logging with Google Docs and IFTTT

The WSM intends to log its sensor data to a Google Docs Spreadsheet for trend analysis.

IFTTT

Log in to IFTTT and create a new applet. For the trigger select Particle.io. It may prompt you to log in to your Particle.io account. Select your Photon that is running your WSM. Set the trigger to New Event Published with a name of “WSM”.

For the action select Google Sheets. It may prompt you to log in to your Google Drive account. Make the spreadsheet name EventName and have it append a row with the following ingredients: EventName|||EventContents|||DeviceName|||CreatedAt

We used a Photon named P7_WSM and a Google account of “WSM Santa Rosa”. The summary of our applet is:

Output

Spreadsheet

IFTTT will create a Google Docs Spreadsheet and then append events to it as they happen. This logging can lag 10 minutes or more from the time the event happens.

This is a sample of the spreadsheet. The columns are: Event Name, Event Value, Device, IFTTT Time. The first row was a WSM event from device p7_WSM, recorded by IFTTT at 06:53 (no time zone specified).

The second column is the value of a WSM event. Note that it contains three pieces of data: Photon Time when the event was posted by the device, Sensor Name, Sensor Value. For example, the first entry is a post made by the device at 13:53 GMT. The event was reporting the smoothed humidity, current value of 62.99%.

WSM	2018-09-12 13:53:41 | Humidity Smoothed (%): 62.999985	P7_WSM	September 12, 2018 at 06:53AM
WSM	2018-09-12 13:53:41 | Temperature Smoothed (oF): 68.000031	P7_WSM	September 12, 2018 at 06:53AM
WSM	2018-09-12 14:01:48 | System Restart	P7_WSM	September 12, 2018 at 07:01AM
WSM	2018-09-12 14:01:48 | pushbutton state: 1	P7_WSM	September 12, 2018 at 07:01AM
WSM	2018-09-12 14:02:10 | pressure pump state: 1	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:21 | pressure pump state: 0	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:42 | pressure pump state: 1	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:49 | pressure pump state: 0	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:03:15 | pressure pump state: 1	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:25 | pressure pump state: 0	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:41 | Humidity Smoothed (%): 62.999985	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:41 | Temperature Smoothed (oF): 68.000031	P7_WSM	September 12, 2018 at 07:33AM
WSM	2018-09-12 14:13:41 | Humidity Smoothed (%): 62.999985	P7_WSM	September 12, 2018 at 07:13AM
WSM	2018-09-12 14:13:41 | Temperature Smoothed (oF): 68.000031	P7_WSM	September 12, 2018 at 07:13AM

Pivot Table

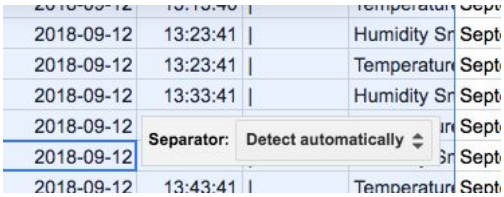
The raw data table is great for knowing details, but it can be hard to scan the spreadsheet to see what's happening over time. A Pivot Table helps.

We need to prepare the data for analysis by parsing the second column and adding column titles. First step is to select the second column. The right click and choose to add a column to the right. Do this again so you have two blank columns.

WSM	2018-09-12 13:53:41 | Humidity Smoothed (%): 62.999985			P7_WSM	September 12, 2018 at 06:53AM
WSM	2018-09-12 13:53:41 | Temperature Smoothed (oF): 68.000031			P7_WSM	September 12, 2018 at 06:53AM
WSM	2018-09-12 14:01:48 | System Restart			P7_WSM	September 12, 2018 at 07:01AM
WSM	2018-09-12 14:01:48 | pushbutton state: 1			P7_WSM	September 12, 2018 at 07:01AM
WSM	2018-09-12 14:02:10 | pressure pump state: 1			P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:21 | pressure pump state: 0			P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:42 | pressure pump state: 1			P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:49 | pressure pump state: 0			P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:03:15 | pressure pump state: 1			P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:25 | pressure pump state: 0			P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:41 | Humidity Smoothed (%): 62.999985			P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:41 | Temperature Smoothed (oF): 68.000031			P7_WSM	September 12, 2018 at 07:33AM
WSM	2018-09-12 14:13:41 | Humidity Smoothed (%): 62.999985			P7_WSM	September 12, 2018 at 07:13AM
WSM	2018-09-12 14:13:41 | Temperature Smoothed (oF): 68.000031			P7_WSM	September 12, 2018 at 07:13AM

Now select the second column. Go to the menu and select Data -> Split Text To Columns… Google will probably select the wrong separator. Click the pop up, choose Custom, and type a vertical bar | in the text box. Press Enter.

This will fill in the first blank column you created. Now select that column and Data -> Split Text To Columns… again. This time use the colon : as a separator.

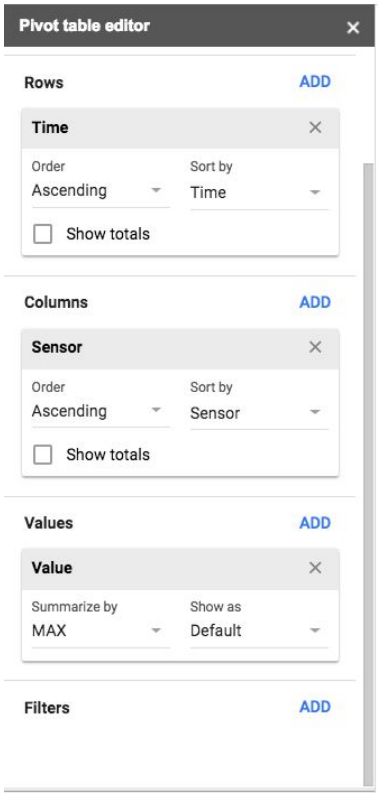


Insert a row at the top of the sheet and give each column a name. Your sheet should now be formatted like this:

System	Time	Sensor	Value	Device	IFTTT Time
WSM	2018-09-12 13:53:41	Humidity Smoothed (%)	63.00	P7_WSM	September 12, 2018 at 06:53AM
WSM	2018-09-12 13:53:41	Temperature Smoothed (oF)	68.00	P7_WSM	September 12, 2018 at 06:53AM
WSM	2018-09-12 14:01:48	System Restart		P7_WSM	September 12, 2018 at 07:01AM
WSM	2018-09-12 14:01:48	pushbutton state	1.00	P7_WSM	September 12, 2018 at 07:01AM
WSM	2018-09-12 14:02:10	pressure pump state	1.00	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:21	pressure pump state	0.00	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:42	pressure pump state	1.00	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:02:49	pressure pump state	0.00	P7_WSM	September 12, 2018 at 07:02AM
WSM	2018-09-12 14:03:15	pressure pump state	1.00	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:20	well pump state	1.00	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:25	pressure pump state	0.00	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:30	well pump state	0.00	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:41	Humidity Smoothed (%)	63.00	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:03:41	Temperature Smoothed (oF)	68.00	P7_WSM	September 12, 2018 at 07:03AM
WSM	2018-09-12 14:13:41	Humidity Smoothed (%)	63.00	P7_WSM	September 12, 2018 at 07:13AM
WSM	2018-09-12 14:13:41	Temperature Smoothed (oF)	68.00	P7_WSM	September 12, 2018 at 07:13AM

Select the entire sheet and then Data -> Pivot Table. This will open a new sheet with a blank pivot table. The pivot table editor should open. Make this your configuration and your pivot table should look like the one below.

	A	B	C	D	E	F	G	H
1	Time		Humidity Smoothed (%)	pressure pump state	pushbutton state	System Restart	Temperature Smoothed (oF)	well pump state
2		0.00						
3	2018-09-12 13:53:41		63.00				68.00	
4	2018-09-12 14:01:48				1.00	0.00		
5	2018-09-12 14:02:10			1.00				
6	2018-09-12 14:02:21			0.00				
7	2018-09-12 14:02:42			1.00				
8	2018-09-12 14:02:49			0.00				
9	2018-09-12 14:03:15			1.00				
10	2018-09-12 14:03:20							1.00
11	2018-09-12 14:03:25			0.00				
12	2018-09-12 14:03:30							0.00
13	2018-09-12 14:03:41		63.00				68.00	
14	2018-09-12 14:13:41		63.00				68.00	

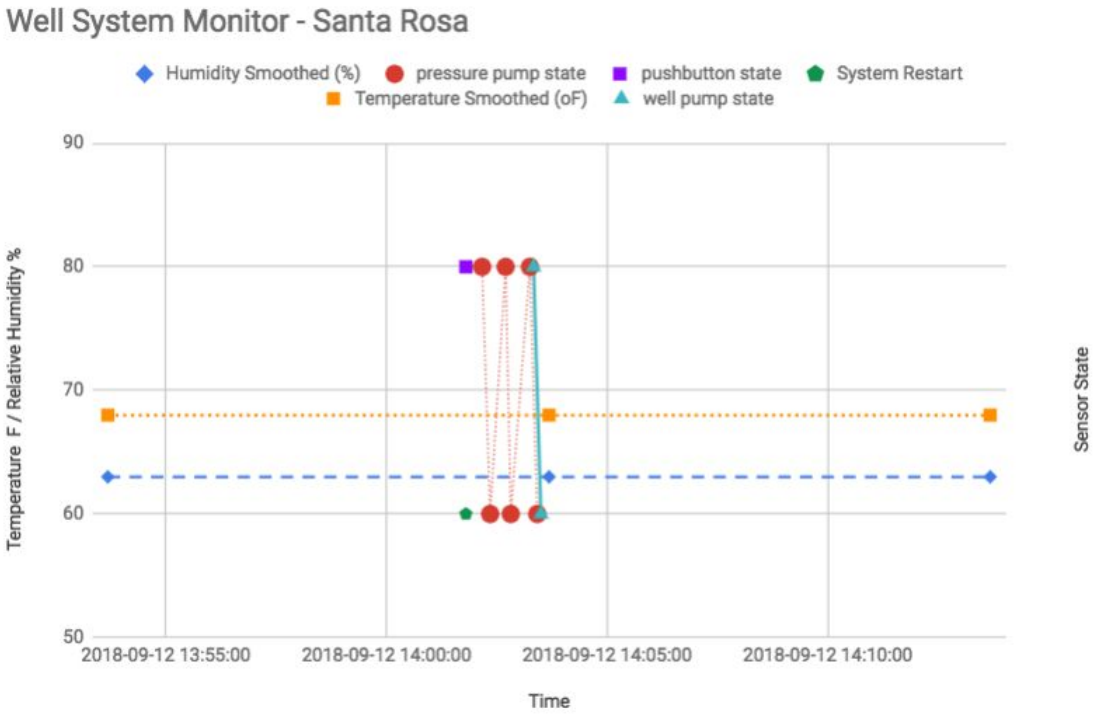


Graph

Finally we get to the graph. Select the entire pivot table and the Insert -> Graph.

In the graph below we see all the information from the sample data used above. Temperature has held at about 69 oF. Relative Humidity is at 62%. Both these values are plotted to the left y-axis. The sensors are plotted to the right y-axis. When the sensor is at the top line the sensor reports true; bottom line, false. When the sensor is high, that pump is ON.

In the sequence plotted below we see that the pressure pump turned on three different times. While the pressure pump was running for the third time, the well pump came on. The well pump remained on until after the pressure pump stopped.



The graph can be a bit tricky to format, and there are so many config choices. We will outline the choices we made to get the graph shown above.

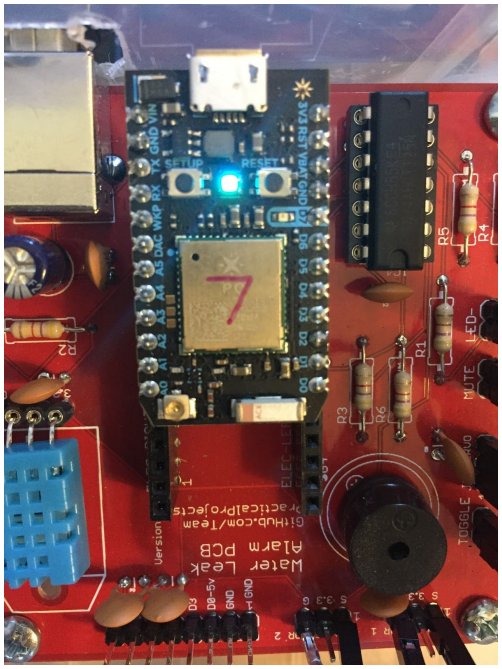
1. DATA:
    a. Use row 1 as headers
    b. Use column A as labels.
2. CUSTOMIZE
    a. Chart Format: Plot null values
    b. Series
        i. Humidity and Temperature to the left axis
        ii. All the other sensors to the right axis.
        iii. Sensors each get a different Point Shape and Color. Point Size, 10px.
    c. Right Vertical Axis limits -0.5 and 1.5

Helpful Photos

The Particle.io Photon processor

1. There is an LED in the center of the board. When the device is initializing this LED will turn many colors. If something goes wrong the color will help diagnose the issue. When it finally starts “breathing cyan” then the device is connected to the Particle.io cloud service.

2. Note the two little buttons on either side of the LED. The one on the left is labeled SETUP and the one on the right is RESET.



There is another LED on the right side of the board. When working properly the blue LED will blink on/off every five seconds.

This is NOT the LED that is controlled by the Reset and Setup buttons.