Water Leak Detector
Concept Document

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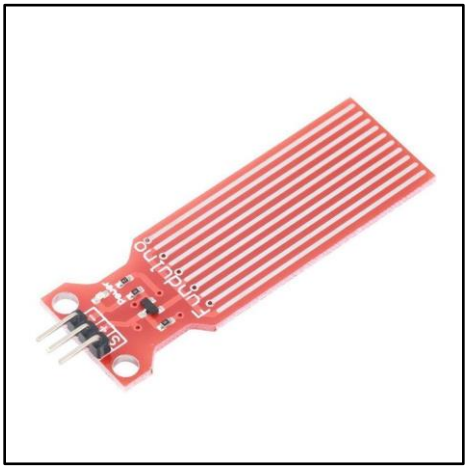
Problem.

A leaking washing machine, overflowing tub or sink, or leaky pipes or toilet can cause considerable damage to a home if not detected and shut off early. Years ago, a washing machine water valve stuck open while washing clothes late at night. One of us awoke in the middle of the night to find a flood in the washer/dryer vestibule resulting in $12,000 in water damage. Since that time, we have been reluctant to run the washing machine at night or at any time when someone is not home to watch over it. This is not always convenient and it would help to have a solution that can detect a water leak and signal us via a local alarm (for when we are at home) and/or a smartphone notification (for when we are out).

Leaky or humid basements and leaking water heaters present similar problems. Adding a second water leak detection sensor, as well as temperature and humidity measurement to the project, can cover all of these bases.

Proposed Solution.

There are inexpensive, analog water detection sensors, such as:
https://www.amazon.com/Solu-Detection-Arduino-Sensitivity-Surface/dp/B00UJ0DVN4/ref=sr_1_5?ie=UTF8&qid=1484328763&sr=8-5&keywords=water+level+sensor+arduino
This sensor looks as follows:



Water Leak Sensor.

The sensor consists of a bunch of parallel conductors that have a very high DC resistance when the sensor is dry. However, when water shorts out adjacent conductors, the resistance falls.

This project uses a Particle Photon (e.g. https://www.adafruit.com/products/2721) to sense the presence and amount of water via an analog input from this sensor. Based upon our analysis and test results for this water level sensor, the sensor's analog output should be thresholded to produce an alarm condition when the voltage output goes from 0 volts (dry) to a relatively low

value (e.g. 0.5 volts). Tests of the sensor have determined that a pool of water of as little as 2 mm deep will cause this level of change.

Whenever water is sensed, the project will sound a loud, pulsing, audible alarm made from an inexpensive piezo buzzer (e.g. https://www.adafruit.com/products/1536). An LED will also flash when the water level threshold is exceeded. A backlit push button switch (e.g. https://www.adafruit.com/products/1440) provides both the LED indicator and a means to mute the audible alarm when pressed.

Temperature and humidity are measured by one, inexpensive (DHT11) sensor (e.g. https://www.adafruit.com/products/386). An inexpensive servo (e.g. https://www.adafruit.com/products/169) is used to provide a visual "meter" for temperature or humidity, based upon a toggle switch selection (e.g. https://www.adafruit.com/products/3221).

The WiFi capability of the Photon is used to provide a smartphone notification of an alarm condition. Alarms are generated for: Water leak detection by either of the two sensors, low temperature detection, and high temperature detection. Publications to the Particle Cloud from the Photon firmware trigger a webhook which, in turn, runs a Google Apps Script that is deployed as a web app. The script sends an e-mail to the user's mobile carrier's SMS gateway, producing an alarm text message on the user's mobile phone.

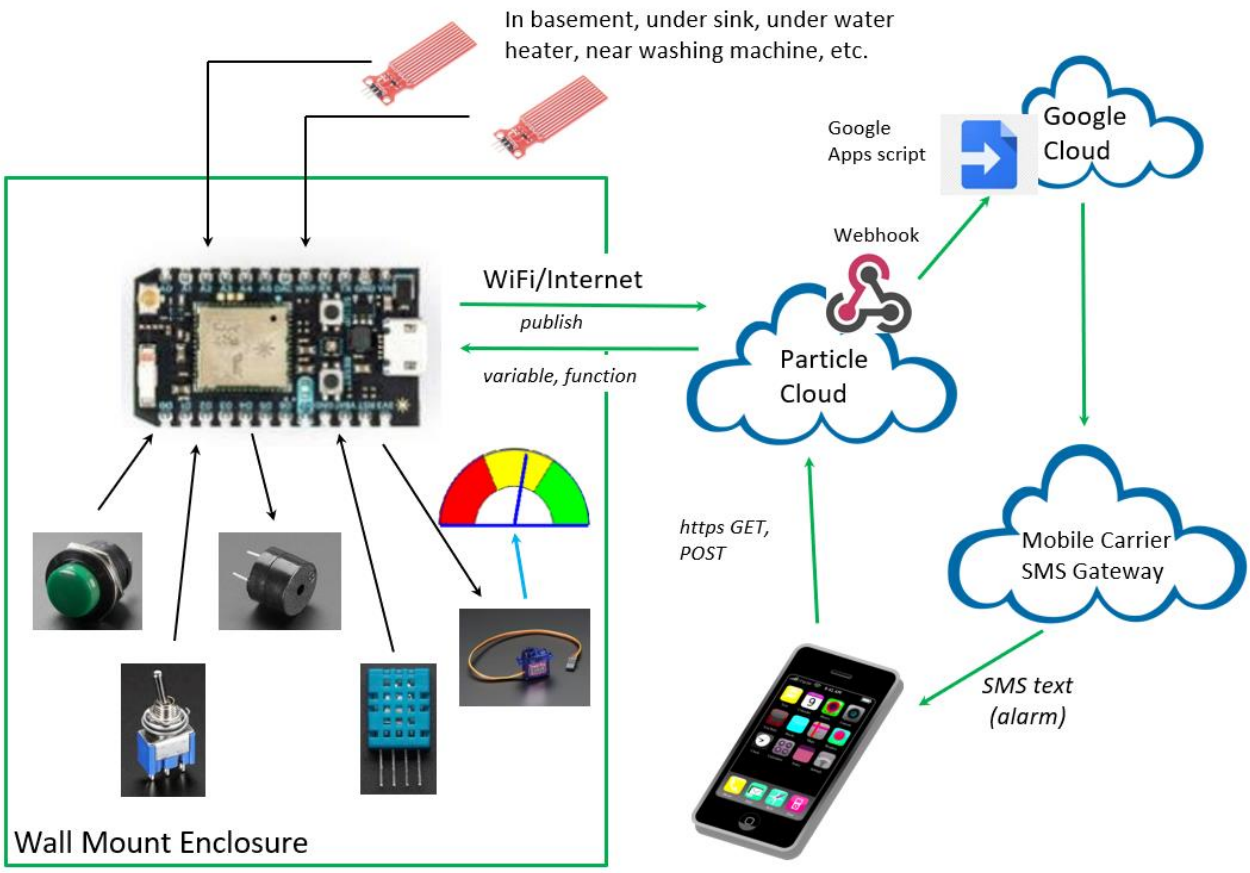
A smartphone app is provided as part of this project. The app is written in MIT App Inventor 2 and currently supports Android smartphones (iOS support is in beta testing by MIT as of this writing). The app allows the user to:

- Display the current temperature and relative humidity from the device, over the Internet.
- Display the current status of the alarms (temperature and leak).
- Set and display the low and high temperature alarm limits.

Communication between the Photon, the Particle Cloud and other necessary cloud services follow the Team Practical Projects now-standard approach, as described in the document:

https://github.com/TeamPracticalProjects/Connectivity_Tools_with_Particle_Devices/blob/main/TPP_Connectivity_Tools_Technical_Description.pdf

The concept is shown, schematically, below:



Water Leak Alarm Concept.

Operational Details.

The project supports two water level sensors. Each water level sensor may be placed under or near a sink, toilet, washing machine, water heater, or basement wall to be monitored. The sensors should be positioned vertically so that the maximum number of conductors are shorted when the water level rises to the bottom of the sensor and above.

The two sensors are cabled to the Photon which, along with the DHT11, toggle switch, pushbutton switch, piezo buzzer and servo, should be wall mounted in a plastic box. The location of the plastic box should be somewhere visible, so that the temperature/humidity indication can clearly be seen and the LED/mute button accessed. Analysis of the water level sensor has determined that it has an output impedance of about 100 ohms; thus, a relatively long cable (e.g. 25 feet) can be used between the sensors and the electronics enclosure, particularly if several threshold readings are required to trigger an alarm.

The firmware in the Photon continuously monitors the amount of water on the sensors, based upon their analog signal value. When a predetermined “flood alert” threshold is exceeded for

five measurements, the piezo buzzer is pulsed to create an easily heard audible alarm and the backlit push button LED flashes. The alarm sounds continuously until someone presses the pushbutton to silence it or until the alarm condition is cleared. The LED continues to flash until the alarm condition is cleared. The alarm also publishes an alarm event to the Particle Cloud, which, in turn, results in an SMS alarm notification to the user's mobile phone. The alarm resets and rearms automatically when five measurements fall below the threshold value.

The Photon reads out temperature and humidity values from the DHT11 sensor every few seconds. The servo "meter" displays either temperature or humidity, based upon the toggle switch selection. The Photon firmware tests to see if the temperature exceeds a low or high reading threshold and publishes an alarm accordingly. Low and high temperature alarms result in an appropriate SMS alarm notification to the user's mobile phone.

The current temperature and humidity readings and the status of all of the alarms may be read, at any time, using a smartphone app that is part of this project. The app also provides a means for the user to set the high and low temperature alarm limits. The Particle Console may be used in lieu of the smartphone app or for testing purposes.