Development of Automated Sensors for Households

Tony Bui, Sharyar Khalid, Sheng Li, Kevin Wong
Department of Electrical Engineering, University of Washington, Seattle

INTRODUCTION

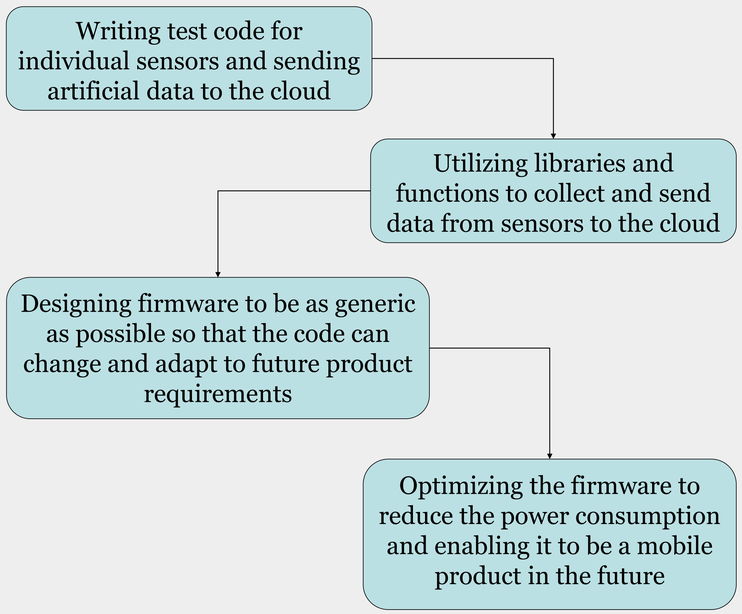
We live in a world driven by efficiency, optimized by technology. With the industry's unprecedented growth over the past several years, we believe that smart home technology will quickly become a cornerstone of today's automation paradigm. In this project, our team is developing specialized commercial smart home products as we investigate their efficacy. As such, the first product we are developing is a sensor that detects various gas leaks. The second product we are developing measures flow rate of water throughout a house. Both sensors will connect to a cloud infrastructure where users will be alerted in real-time and can view analytics. Additionally, both sensors will interface with other automated products such as shutoff valves.

MOTIVATION

With recent developments in smart home technology, we believe we have found a niche in the market: utilitarian applications of automated sensors. Carbon monoxide detectors are quite common, and general air quality monitors exist, but our research shows that many premium monitors cost upwards of $200, so we set out to design one that is smaller, more efficient, and cheaper to manufacture.

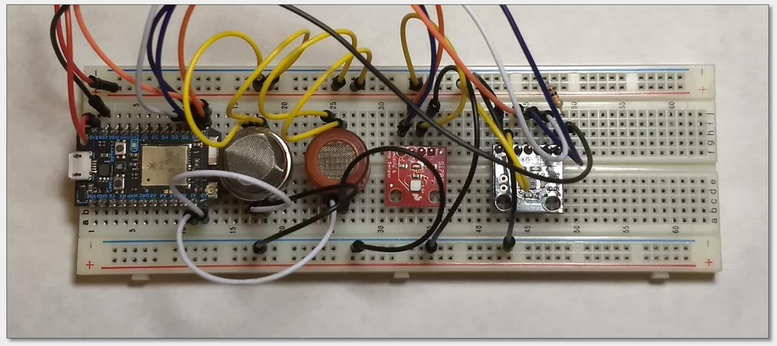
Wally, the company we are working with, already has certain products in place, so we wanted to interface with the technology they have developed. Specifically, their shutoff valve can trigger when their sensors detect a local water leak. However, their system doesn't account for leaks away from their sensors. A water flow meter solves this issue; abnormally low water flow can often indicate a leak or malfunction and should prompt the owner with shutoff options.

FIRMWARE DEVELOPMENT

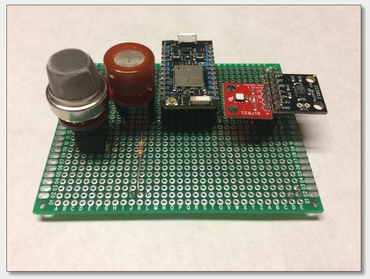


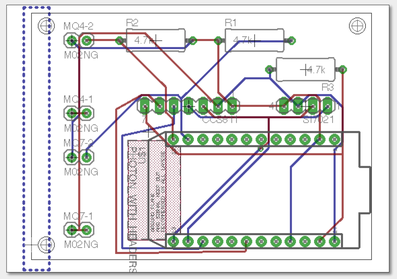
HARDWARE DEVELOPMENT

The first step was designing a breadboard for integrating all four sensors that simultaneously collect and send data to the cloud. The sensors are placed and connected to a Particle Photon microcontroller that handles cloud communication.



Protoboard and PCB designs were then made for a more portable solution. These designs easily fit into enclosures and are better suited to be turned into consumer products.

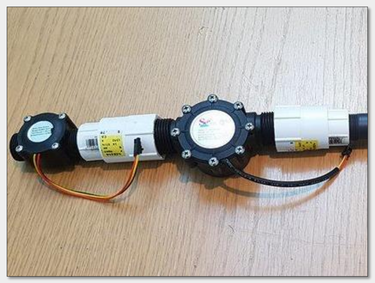


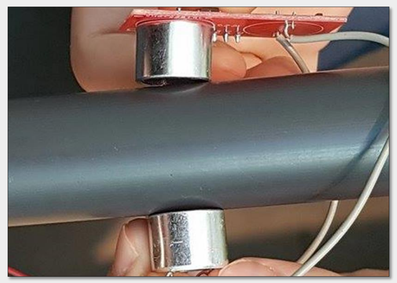


Two methods are used to measure flow rate:

1. Mechanical capture from a rotor and hall-effect sensor
2. Acoustic capture from ultrasonic sensors

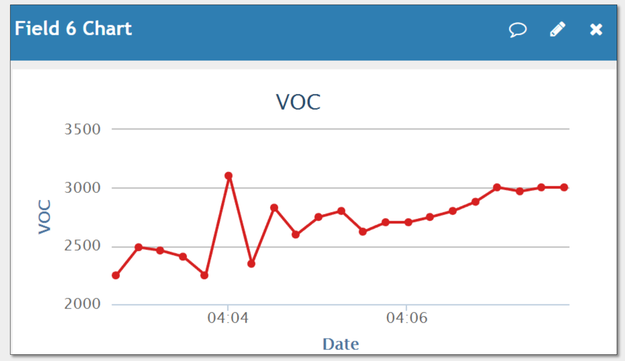
The rotor sensor works by having water drive a rotor, and using a hall-effect sensor to output a corresponding pulse signal. The ultrasonic sensor takes into consideration various shifts and Doppler effects, and measures flow rate without ever touching the water. The rotor sensor is more robust, but it requires a plumber to install because they are connected in-line to pipes. The ultrasonic solution only requires sensors to be attached externally, and are easier to install.



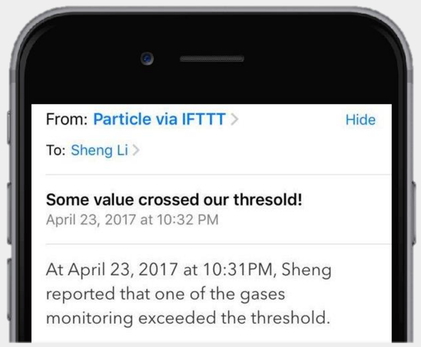


RESULTS

We are able to visualize and monitor sensor data in real-time. Data is published to the cloud based on whether certain criteria are met. Large variations in values and crossing thresholds can result in data being instantly published, while periods of consistent readings publish more sparsely to reduce power consumption.



We also receive automated email and text alerts when sensors pass certain thresholds. These alerts can be changed and adjusted.



FUTURE DEVELOPMENT

Moving forward, our devices are advanced prototypes that will be the basis for developing a consumer product. We have designed our prototypes so that they can easily be added to Wally's existing package. Future development includes rigorously testing sensors for accuracy and consistency, developing a battery-powered solution, and seamlessly interfacing with Wally's shutoff valve. If all of these can be achieved, we believe that this product will be smaller, more efficient, and cheaper to manufacture than any existing product on the market.

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