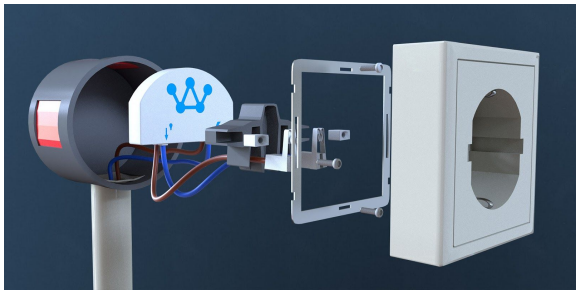
Low-level ADC

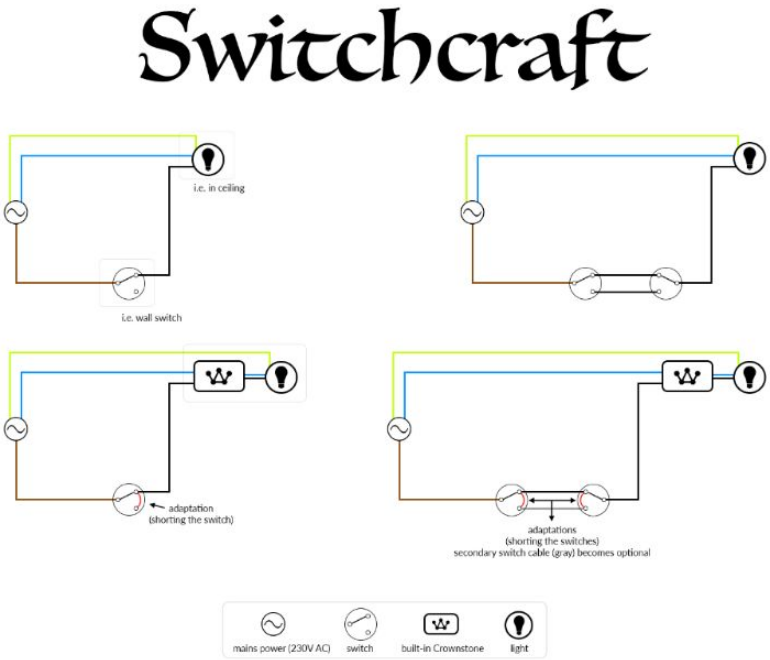
Internship Master Student

Topic

Crownstone, an innovative company based in Rotterdam, builds smart home solutions. The company develops tiny form-factor modules which can be put behind a power outlet. Those modules obtain information about current and voltage patterns from devices that are plugged into it. Moreover, it is able to react to the presence of people by the use of signal strength information emitted by Bluetooth Low-Energy smartphones, smartwatches and fitness devices.

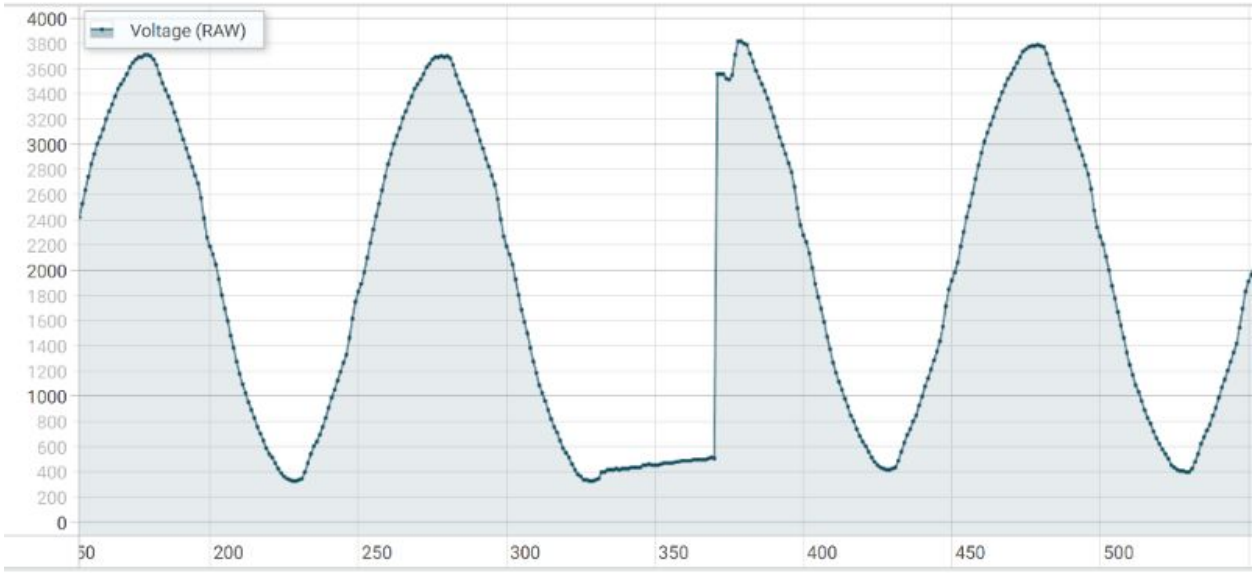


One of the key differentiators compared to our abilities is the ability to use a conventional light switch in parallel with the Crownstone hardware module.



The switch is altered slightly by adding a physical wire from one pole to the other. In this manner

it will always power on the Crownstone module. When someone presses the light switch there will be very short moment that the switch mechanically travels from one pole to the other. During this period of a couple of milliseconds there is a disruption to the power supply of the Crownstone. Thanks to a large capacitor the chip will still have power to continue its operation and keep measuring voltage at a high frequency.



The voltage disruption is shown in the figure. The challenges are:

- to accurately measure such a disruption so the state of the Crownstone can be flipped from ON to OFF or the other way around;
- to have very few false positives and false negatives and a setting where we can shift from false positives to false negatives;
- to have this recognition running also when dimming.

There are two subproblems that will improve the above classification. One of them is the quality of the dimming functionality, the other the quality of the measurement of voltage, current, and power.

The dimming functionality can be improved:

- provide leading edge dimming and phase section dimming besides trailing edge dimming;
- get dimming very stable, it's possible to get very slow fluctuations due to drift;

The measurements themselves can be improved:

- replace current moving average filter by something more suited to the particular noise encountered;
- consider frequency domain to filter as well;

There are a variety of other considerations. For example, currently dimming is set to 10% and up due to the fact that devices that are not dimmable might get broken. However, we might safely enable lower levels of dimming for resistive loads. A low-level classifier that recognizes resistive loads would improve the dimming functionality for those lights. There might also be classification techniques that can recognize an LED or other light types without full-blown device identification. In particular it would be useful if the Crownstone would be able to adjust its phase cutting to the particular light type.

Plan of Approach

In brief, the plan of approach:

- Analyse the problem in detail theoretically;
- Develop the necessary tools to understand the problem practically;
- Implement a stand-alone proof of concept on the Crownstone board;
- Implement and integrate with the open-source Crownstone firmware (http://github.com/crownstone/bluenet/);
- Test with a variety of lamps.

Background

This internship is an initiative of Crownstone (http://crownstone.rocks).

Function requirements

A student in the master Electrical Engineering, Computer Science, or related disciplines. For us, personal motivation is just as important as experience. Fluent English is essential. It is *not* required to speak Dutch, but appreciated of course. :-)

Knowledge about the following topics is desired:

- C/C++
- Embedded development
- Signal processing