



CROWNSTONE

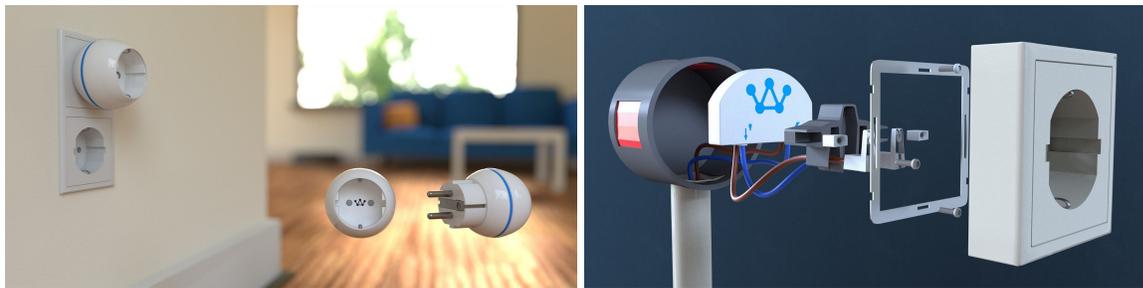
Passive Presence Detection

Internship Master Student

Topic

Crownstone is a startup that develops tech in power outlets. The Crownstone chip can be put on top or behind a power outlet and 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. It can turn off a fan when no one is around.

Normally a person needs to carry a smartphone or smartphone peripheral (a smart watch, bracelet, etc.) However, a Bluetooth radio can be used in a passive setup, just as a PIR sensor. By continuously monitoring the signal drops from other Crownstones it is possible to infer if there are objects that interfere with the Bluetooth signals. Crownstone already has [preliminary results](#) that demonstrate that this is indeed possible.



Function description

It is your task to work on the machine learning part of this problem. Your responsibility is to analyse the spectrum, see how drops in RSS can be robustly matched with the presence of people, and consider environmental conditions (with reflections, metal objects, and other real-world circumstances), running in real-time, and implemented on a smartphone.

The internship normally starts with an academic problem description together formulated with your supervisor, continues with a thorough literature study, defines the problem in a mathematical way and solve it using the programming language you master or will master. Almost all of our code is open source (github). Many other interns are working at Crownstone and we have a lot of experience with guiding you through the process. You won't be just getting the coffee at our place! We have high expectations w.r.t. your work! And... foosball skills are appreciated. :-)

The machine learning and signal processing techniques to be used are difficult to establish beforehand. The data at hand probably asks for sparse optimization methods. These are methods that go beyond Fourier transforms or wavelet transforms and respect the



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type of data at hand. For example image reconstruction becomes feasible way beyond Nyquist-Shannon's theoretical limit. For that reason sparse coding is currently a very hot research topic [1] [2] in image reconstruction, deblurring, MRI, EEG, etc.

[1] Compressed Sensing, Theory and Applications, 2012, Cambridge Press

[2] Sparse and Redundant Representations, 2010, Springer

Background

This internship is an initiative of Crownstone.

Crownstone (2016) is a startup in Rotterdam that brings technology to detect people and devices into every building. The Crownstones estimate a person's position through the smartphone. The Crownstones measure current and voltage to detect devices and examine their usage (<http://crownstone.rocks>).

Function requirements

A student in the master Mathematics, Artificial Intelligence, Computer Science, Knowledge Engineering, Machine Learning, 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:

- General machine learning methods (supervised, unsupervised, reinforcement learning);
- Signal processing;
- Programming skills.

For further information, see <https://crownstone.rocks>. Many master students have graduated at the Almende Group (of which Crownstone is a spin-off), see our hall of fame at <https://crownstone.rocks-hall-of-fame>. Your task is to find your own academic supervisor. We have worked with among others prof. Robert Babuska, prof. Pim Haselager, assist. prof. Rico Mockel, assist. prof. Kurt Driessen, assist. prof. Y (Wolf) Song, assist. prof. Dap Hartmann, assist. prof. Gerard Vreeswijk, prof. Bart de Schutter, assist. prof. Dimitri Jeltsema, prof. Nikolaus Correll, assist. prof. Marco Wiering, and are looking forward to collaboration with you and your supervisor!

Crownstone	University
Anne van Rossum anne@crownstone.rocks	Your academic supervisor(s)