Networked Embedded Systems Lab
Prof. Marco Zimmerling

Dynamic Maximum Power Point Tracking for Battery-free IoT Devices

Master Thesis / Master Project Proposal

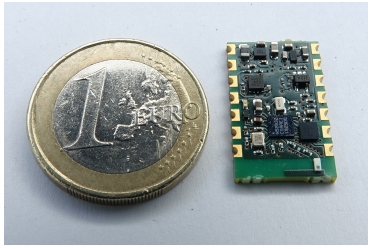
Replacing batteries of IoT devices with energy harvesters allows building tiny, cheap and sustainable devices that can be operated maintenance-free for decades. In order to maximize the amount of harvested energy, an attached load must match the harvester's impedance. This impedance changes with changes of the energy environment, requiring continuous load adjustments - known as maximum power point tracking (MPPT). State-of-the-art MPPT solutions for IoT devices rely on simple transducer models and are only able to track slowly-changing harvesting conditions.

The goal of this project is to improve the efficiency of MPPT on battery-free IoT devices under dynamically changing harvesting conditions. To this end, the student will first collect energy harvesting traces from a wrist-worn solar harvesting device. They will use the collected traces to analyze the efficiency of the state-of-the art MPPT technique and compare it to the theoretical optimum. Next, they will implement alternative approaches exploiting the advanced current and voltage sensing capabilities of a battery-free device recently developed by our research group, resulting in an in-depth comparison of the requirements, overhead and efficiency. The analysis may also yield a novel MPPT technique that combines features of existing approaches. As a final step, the most promising solutions are implemented on a real battery-free device and evaluated in experiments under realistic, controlled light conditions. The exact scope and requirements of the project can be adjusted according to the type of project (master thesis or master project).

The student will be provided with all necessary hardware and tools to record the energy harvesting traces and to develop and debug the software for the battery-free device. They will be supported with setting up the development environment and provided with drivers and example code to interact with the energy harvesting hardware. They will receive feedback and guidance in weekly meetings with their advisor. In addition to a final report, the deliverables include a git-managed repository with well-written and sufficiently documented code and a live demonstration of the implementation. Supervision will be possible in German or English.

Requirements

- Good coding skills in C and Python.
- Practical experience with microcontrollers.
- Basic understanding of electronics.



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