Networked Embedded Systems Lab
Prof. Marco Zimmerling

Design and Implementation of a Vision-based Environmental Monitoring System

Master Thesis / Master Project Proposal

Environmental monitoring is key to understanding and protecting vulnerable ecosystems. Traditional battery-powered camera traps trigger on passing wildlife and store resulting images locally. The data is manually retrieved and evaluated offline to identify species or individuals. The high cost for battery replacement and data retrieval severely limits the scale of this type of vision-based monitoring. Battery-free devices instead have low environmental impact and can be operated maintenance free for decades, facilitating unprecedented insights into these environments.

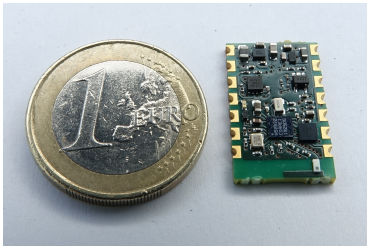
For example, automated analysis of the images from hundreds of battery-free cameras could yield insights into behavior and habitats of wildlife. Another important application is the detection of wildfires, illegal woodcutting or poaching. The capabilities and processing power of state-of-the-art microcontrollers have enabled acquisition, processing and on-device classification of images. However, signal acquisition and classification on intermittently powered, battery-free devices remain largely unsolved.

The goal of this project is to develop and implement a software solution to acquire an image signal from a low-power CMOS sensor on a low-power microcontroller and to process and classify this signal, taking into account the intermittent execution of a battery-free device. The first milestone is an activity detection algorithm that executes intermittently on a development board and detects a significant change of the scene as compared to the previous image. The next step is a classification algorithm to detect a specific object (e.g. presence of an animal) in the image. Finally, the implemented solution can be ported from the development board to a real battery-free device provided to the student. The exact scope and requirements of the project can be adjusted according to the student's interest and the type of work (thesis or study project).

The student will be provided with all necessary hardware and tools to develop and debug the software for the microcontroller. They will be supported with setting up the development environment and provided with example code as a starting point. They will receive feedback and guidance in weekly meetings with their advisor. In addition to the written 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.
- Basic knowledge of microcontrollers.
- Motivation to learn new embedded machine learning concepts.



Contact

- Kai Geissdoerfer, kai.geissdoerfer@tu-dresden.de
- Prof. Marco Zimmerling, zimmerling@cs.uni-freiburg.de