

Master Project: Embedded AI with μ Brain on MCUs

Supervisors: Lin Wang (VU Amsterdam) and Federico Corradi (IMEC)

Description

Spiking neural networks (SNNs) mimic the way the central nervous systems of biological organisms work. Based on the von Neumann architecture, traditional artificial neural networks exchange information between neurons in every propagation cycle. In contrast, SNNs adopt a neuromorphic architecture which allows the exchange of information between neurons via sparse spikes. As a result, SNNs can achieve much lower latency and are more energy-efficient in general, making them especially suitable for embedded scenarios where energy efficiency is of critical concern.

This project aims to enable embedded AI by bringing SNNs to embedded IoT devices. More specifically, we will employ an SNN chip provided by IMEC (called μ Brain [1]) and integrate it with a microcontroller (MCU). MCUs are low-power computing devices which can be programmed to execute instructions and have been widely used in various embedded environments such as home appliances and toys. Due to their limited computing resources, MCUs are typically not suitable for running complex AI inference (e.g., based on deep learning) over continuous sensor data streams, which can be gracefully handled by μ Brain. This project thus proposes to combine μ Brain with an MCU and validate the properties of such a hybrid design. Using the integrated platform, we will develop an IoT application based on voice recognition and quantify the performance and energy efficiency of the new platform.

Tentative Tasks

- Porting the μ Brain chip to MSP430 [2] microcontroller
- Training a spiking neural network for voice recognition for μ Brain
- Developing a voice recognition application with μ Brain on MSP430
- Quantifying the accuracy and energy efficiency of the application

Requirements

- You are familiar with low-level C programming and are comfortable working with C
- Experience with embedded systems (e.g., MCU) programming is a big plus
- Experience with deep learning is not required but would be helpful

References

[1] μ Brain - <https://www.frontiersin.org/articles/10.3389/fnins.2021.664208/full>

[2] MSP430 - <https://www.ti.com/microcontrollers-mcus-processors/microcontrollers/msp430-microcontrollers/overview.html>