Implementation of a novel Spiking Neural Network on Neuromorphic Hardware

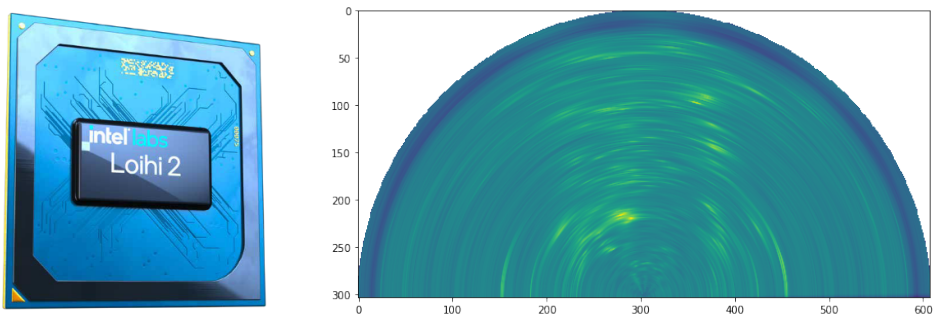

Figure 1: (Left) Latest neuromorphic chip of Intel, Loihi 2. [6] **(Right)** Range angle map taken from RaDICal dataset. [4]

Background

In the automotive domain, computational demands are steadily increasing to ensure a safe driving experience (e.g. Advanced Driver Assistance Systems (ADAS)). Especially for electrical vehicles, this is a big drawback since these functionalities reduce the driving range. The field of neuromorphic computation tries to tackle this task by building brain-inspired algorithms and hardware, that utilize the advantages of the brain; solving high demanding tasks with low power consumption. The brain benefits among others from sparse event based and asynchronous processing. The third generation of Neural Networks, Spiking Neural Networks (SNNs), naturally incorporate these benefits by using dynamic neuron models that transmit information via spikes. In recent years, hardware (e.g. SpiNNaker or Loihi) has been designed to efficiently run SNNs. Intel research teams pushed the development of neuromorphic hardware even further in the past years and published the successor of Loihi [2], Loihi 2 [6]. Combining the latest neurmorphic hardware and algorithms with energy efficient sensors as the FMCW radar sensor [5] might lead to efficient edge devices that reduce the overall power consumption of electrical vehicles.

Description

A novel SNN has been developed at the TUM, that consists of Resonate-and-Fire (RF) neurons [3, 1] to interpret the radar sensor data. RF neurons are selective for one specific frequency and hence can be used to analyze the frequency spectrum which is needed to extract distance, angle and velocity information of targets detected by the radar sensor.

The student will work on the implementation of this SNN on Loihi 2 and adapt the network to the needs of the novel neuromorphic chip. The final implementation will be evaluated on simulated and real data.

During this project the student will be

- working with dynamic neuron models, such as RF neurons [3, 1],
- understanding the theory of automotive FMCW radar sensors [5],
- having access to latest neuromorphic hardware (Intel's Loihi 2 [2, 6]),
- implementing SNN on Loihi 2.

Students eager enough to do a guided research AND master thesis on this topic will be preferred.

Technical University of Munich

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Advisor:
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Research project:
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Type:
Master Thesis, Guided Research

Research area:
Spiking Neural Networks, Signal Processing, Neuromorphic Hardware, Microcode

Programming language:
Python or Assembler

Required skills:
Python, Machine Learning, Signal Processing

Language:
Englisch/German

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August 2024

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References

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[2] Mike Davies et al. "Loihi: A Neuromorphic Manycore Processor with On-Chip Learning". In: *IEEE Micro* 38.1 (2018), pp. 82–99. DOI: 10.1109/MM.2018.112130359.

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[6] *Taking Neuromorphic Computing to the Next Level with Loihi 2*. 2021. URL: https://download.intel.com/newsroom/2021/new-technologies/neuromorphic-computing-loihi-2-brief.pdf.

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