SCNMC

Sensorless Closed-Loop Neuromorphic Motor Control

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1 SotA of Neural Motor Control

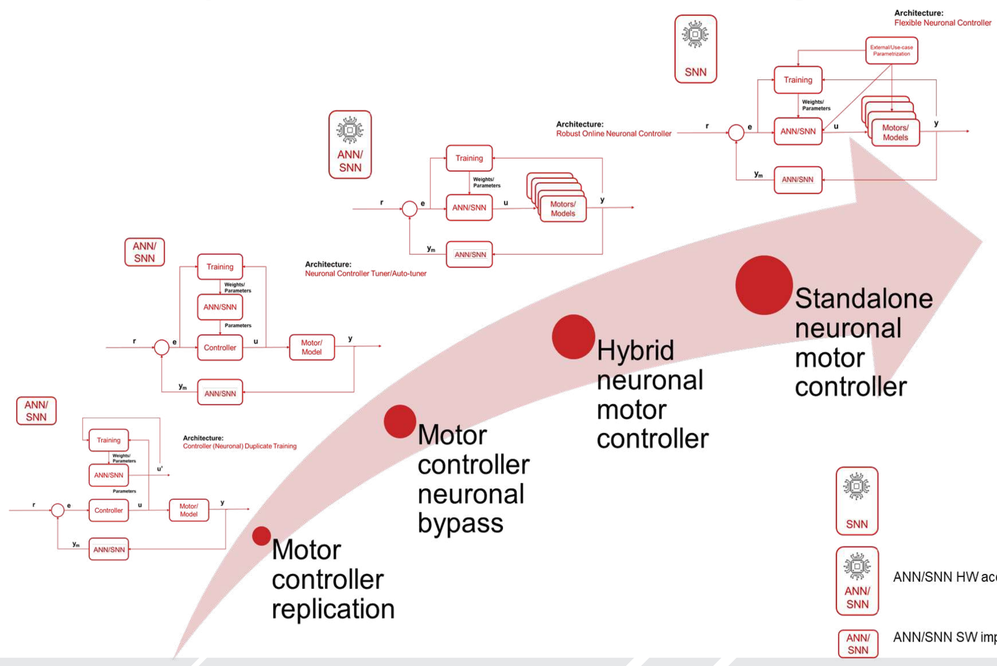
Sensor-based and sensorless neuronal control

- **Motor control** applications require precise position and speed measurements, which are typically obtained with sensors.
  - **Sensors** increase the cost and size of the motors and suffer from stressful motor operating conditions.
  - **Sensorless methods** leverage the estimation of electrical signals in the motor to predict rotor position and speed information.
- **Neural networks** offer a very versatile learning system that enables a data-driven estimation and control for motors. Yet, they do not consider time in their operation missing transients which are crucial in motor control.
- **Spiking neural networks** are biologically plausible neural networks which can exploit time and enable adaptive, robust, and versatile control.
- **Neuromorphic systems** enable the execution of spiking neural network controllers on specialized hardware to achieve efficient motor controllers.

2 Innovation

Core innovation

- **Sensorless** motor control is both **functionally** and **economically more efficient**
- The **neuromorphic implementation** of **spiking control systems** can not only improve the **energy efficiency**, **real-time capabilities**, and **robustness** of the system through **learning** and **adaptation** capabilities in face of **uncertainty**
- To **achieve the specification**, we are following an **incremental approach** which enables us to **explore** and **evaluate** the **innovation** through **test benches**



3 Future performance profile & skills of the project partners

Fraunhofer IIS & EMFT

- Validation of IIS and EMFT's own neuromorphic hardware accelerator in industry-relevant use case
- Expertise in design & deployment of neuromorphic closed-loop controllers
- Consolidation and expansion of cooperations with companies in the fields of motor control & robotics

SPICES Lab, Technische Hochschule Nürnberg

- Experience in designing algorithms for cutting-edge neuromorphic hardware accelerators
- Roadmap for the development, integration and use of neuromorphic motor controllers
- Development of application-specific motor test systems for/with industry partners
- Strong interaction and collaboration with local electrical drives companies, including proof-of-concept designs and schooling for deployments

Application potential
Agri-Tech

Source: https://lynx-engineering.co.uk/

4 Prospects

- Offering the industry a **significant reduction** of **costs** (up to 50€ by removing the integrated sensor(s) from the motor)
- Improved **sensorless closed-loop** control of **electric motors** in applications of **industrial cooperation partners**
- Unprecedented **processing power** to **analyse** & **integrate** the **feedback** of **closed-loop control** systems in **real time**
- New possibilities for an **interaction** between **system-level** and **component-level control**
- More **intelligent and robust control** in challenging conditions & situations of **uncertainty**
- Strong **contact** and **support** from **local electrical drives manufacturers** which support the project: **Metronix Meßgeräte und Elektronik GmbH** and **BURGER ENGINEERING GmbH & Co. KG**

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