Live Demonstration: neuromorphic robotics, from audio to locomotion through spiking CPG on SpiNNaker.

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***Abstract*— This live demonstration presents an audio-guided neuromorphic robot: from a Neuromorphic Auditory Sensor (NAS) to locomotion using Spiking Central Pattern Generators (sCPGs). Several gaits are generated by sCPGs implemented on a SpiNNaker board. The output of these sCPGs is sent in a real-time manner to an Field Programmable Gate Array (FPGA) board using an AER-to-SpiNN interface. The control of the hexapod robot joints is performed by the FPGA board. The robot behavior can be changed in real-time by means of the NAS. The audio information is sent to the SpiNNaker board which classifies it using a Spiking Neural Network (SNN). Thus, the input sound will activate a specific gait pattern which will eventually modify the behavior of the robot.**

***Index Terms*— Neuromorphic Auditory Sensor, Spiking Central Pattern Generator, Neurorobotics, SpiNNaker, Address-Event-Representation.**

I. Introduction

This document describes a live demonstration of an hexapod robot locomotion, driven by an sCPG, whose gaits can be changed in real-time using a neuromorphic audio classification system consisting on a set of pure tones. Both the sCPG and the classifier are implemented on a SpiNN-3 machine. The digital NAS [1] converts the pure tone signal to a spiking output which is sent in real-time to SpiNNaker using the Address Event Representation (AER) protocol. Then, a multilayer SNN (following the model from [2]) classifies the tone. The output of the classifier is used as a gait selector for the sCPG. The output of these sCPG, a set of neurons, generate the spike patterns to command the 18 servomotors of the hexapod. These spikes are later sent back to the FPGA, using the AER protocol. The FPGA board generates the Pulse-Width Modulation (PWM) signals to command the servomotors. In this demonstration the system will be tested using different musical tones, in order to select from the three available Central Pattern Generators (CPGs) implemented: walk, trot and run.

In a previous work [3], this setup was tested in an offline scenario, without the real-time pattern selection capabilities. Furthermore, they used an SpiNNaker-PC-Arduino setup instead of the FPGA-SpiNNaker closed loop setup that we present in this demonstration.

II. Demonstration setup

The setup includes three hardware devices described as it follows: 1) a 3D-printed hexapod robot with 18 servos. A multi-servo controller board is used to interface the robot with the FPGA board; 2) an FPGA board (Reference ZTEX 2.13 with an Artix-7 device from the Xilinx vendor) with a daughter board that provides the following external peripherals interfaces: audio line-in connector,PWM signals bus connector and AER-SpiNNaker hardware adapter; and 3) a SpiNNaker board (SpiNN-3 version) connected with the FPGA board using the spinnaker-link interface. Figure 1 shows the whole hardware setup.

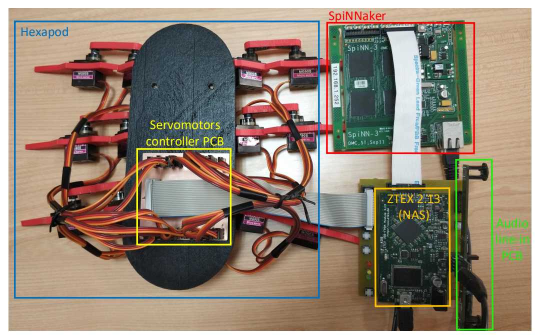

Fig. 1: Live demonstration full hardware setup.

III. Visitor experience

Interaction between visitors and the presented live demonstration will be enjoyable, since the user will play a sound and then the robot will start to act in consequence, responding to the user commands. This way, visitors can learn how the auditory information is processed and how it could interact with locomotive decisions using neuromorphic hardware applied to neurorobotics.

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