Live Demonstration: Neuromorphic Sensory Integration for Combining Sound Source Localization and Collision Avoidance

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***Abstract*—The brain is able to solve complex tasks in real time by combining different sensory cues with previously acquired knowledge. Inspired by the brain, we designed a neuromorphic demonstrator which combines auditory and visual input to find an obstacle free direction closest to the sound source. The system consists of two event-based sensors (the eDVS for vision and the NAS for audition) mounted onto a pan-tilt unit and a spiking neural network implemented on the SpiNNaker platform. By combining the different sensory information, the demonstrator is able to point at a sound source direction while avoiding obstacles in real time.**

I. Introduction

This live demonstrator comprises a neuromorphic system which points into the direction of a sound source while avoiding obstacles (for detailed information see [1]). The main component of the demonstrator is a spiking neural network (SNN) implemented onto the SpiNNaker board. It consists of an Optical Flow (OF) encoder network and a sound source direction network which receive sensory input from the embedded Dynamic Vision Sensor (eDVS) [2] and the Neuromorphic Auditory Sensor (NAS) [3] respectively. The two networks feed into the sensory integration network which chooses the system's heading direction. This heading direction information controls the position of a pan-tilt unit through a head direction cell network, as proposed in [4]. The system has already been tested in an offline scenario on a wheeled robot [1]. In this context, we demonstrated the ability of the network to select the shorter path around obstacles toward the sound source. In this demonstrator we improve the system by closing the loop and present a neuromorphic agent able to effectively fuse visual and auditory information.

II. Demonstration setup

The live demonstration setup includes three neuromorphic devices: 1) the 128x128 pixels resolution eDVS [2]; 2) a 64-channel binaural NAS [3] implemented on FPGA (based on a Xilinx Artix-7 family); 3) a SpiNNaker board (SpiNN-3) connected to both neuromorphic sensors through the spinnaker-link interfaces. An ears-like binaural microphone is used to provide auditory input to the NAS. Figure 1 shows the whole hardware setup.

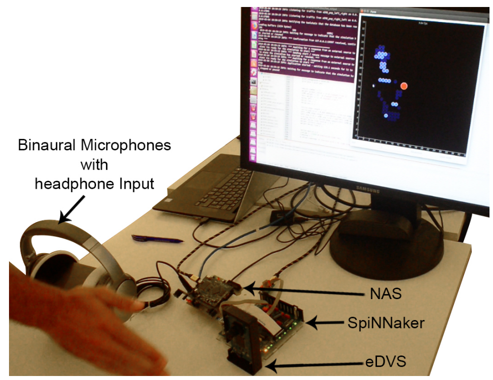

Fig. 1. Live demonstration hardware setup without pan-tilt unit. The screen shows the response of the system. Red dot: Heading direction, blue dots: Optical Flow (OF).

III. Visitor experience

Visitors will be able to interact with the system presented in this live demonstration by changing the sound source position and by waving their hands or moving an object in front of the retina to simulate an obstacle. The system will react to these stimuli in real time, being able to find the closest direction to the sound source while avoiding obstacles. The heading direction will be presented to the visitors in a real-time graph along with the obstacle's position. A pan-tilt unit will move accordingly to the heading direction calculated in the SNN, avoiding the obstacles that the visitor presents to the retina.

References

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