Live Demonstration - Multilayer spiking neural network for audio samples classification using SpiNNaker

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Abstract— **In this demonstration we present a spiking neural network architecture for audio samples classification using SpiNNaker. The network consists of different leaky integrate-and-fire neuron layers. The connections between them are trained using firing rate based algorithms. Tests use sets of pure tones with frequencies that range from 130.813 to 1396.91 Hz. Audio signals coming from the computer are converted to spikes using a Neuromorphic Auditory Sensor and, after that, this information is sent to the SpiNNaker board through a PCB that translates from AER to 2-of-7 protocol. The classification output obtained in the spiking neural network deployed on SpiNNaker is then shown in the computer screen. Different levels of random noise are added to the original audio signals in order to test the robustness of the classification system.**

I. Introduction

This document describes the live demonstration of a classification system using a multilayer spiking neural network that is deployed on the SpiNNaker 102 machine for audio samples classification. A Neuromorphic Auditory Sensor (NAS) [1] is used to convert the audio signal information to spikes using the Address Event Representation (AER) protocol, which is later translated to the appropriate format for the SpiNNaker chips (2-of-7 protocol) and adapted to the right logic levels. In this demonstration, the system will be tested using pure tone signals with frequencies that range from 130.813 to 1396.91 Hz.

In a previous work [2], this setup was tested in an offline scenario with eight different pure tones and trained using a firing rate based algorithm, achieving a 99.8% accuracy result when no random noise is added to the original signals. A 95% average accuracy is achieved even when the signal-to-noise ratio (SNR) value is 3 dB (the amplitude of the pure tone is the same as the amplitude of the noise signal), proving that the system is very noise-tolerant.

NAS designing is very flexible and fully customizable, allowing neuromorphic engineers to build application-specific NASs, with diverse features and number of channels. In this case, we have used a 64-channel mono NAS, with a frequency response between 20Hz and 22kHz, and a dynamic range of +75dB, synthesized for a Spartan-6 FPGA.

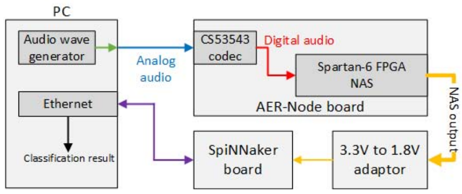
Leaky Integrate-and-Fire (LIF) neurons have been used in a 3-layer SNN architecture for audio samples classification. The training phase is performed offline and supervised. The main objective of this training is to obtain the weight values of the connections between the input and the hidden layer and between the hidden and the output layers for further audio samples classification.

II. Demonstration Setup

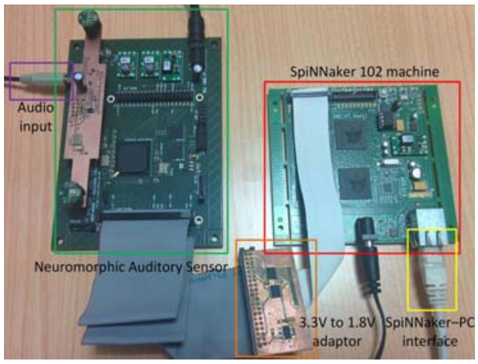
This demonstration will use an AER-Node board, which contains a Spartan 6 FPGA implementing a 64 channels mono NAS. NAS output AER events will be sent to the SpiNNaker board and used as input for the classification system. The computer will be running an audio wave generator to play different pure tone signals. The results of the classification will be sent to the computer via Ethernet directly from SpiNNaker.

III. Visitor Experience

Visitors will be able to test the system with diverse kinds of pure tone signals and noise levels and visualize the classification results of the SNN deployed on the SpiNNaker machine. A graphic user interface will let the visitor select and modify the input data features (frequency and SNR) and see the output of the classifier system inside SpiNNaker 102.



(a)



(b)

Fig. 1. a) Block diagram of the demonstration. b) Picture of the setup.

IV. References

[1] A. Jiménez-Fernández; E. Cerezuela-Escudero; L. Miró-Amarante; M. J. Domínguez-Morales; F. d. A. Gómez-Rodríguez; A. Linares-Barranco; G. Jiménez-Moreno, "A Binaural Neuromorphic Auditory Sensor for FPGA: A Spike Signal Processing Approach," in IEEE Transactions on Neural Networks and Learning Systems , vol.PP, no.99, pp.1-15.

[2] Dominguez-Morales, J. P., Jimenez-Fernandez, A., Rios-Navarro, A., Cerezuela-Escudero, E., Gutierrez-Galan, D., Dominguez-Morales, M. J., & Jimenez-Moreno, G. (2016, September). Multilayer Spiking Neural Network for Audio Samples Classification Using SpiNNaker. In International Conference on Artificial Neural Networks (pp. 45-53). Springer International Publishing.