Live Demonstration: spiking neural circuit based navigation inspired by *C. elegans* thermotaxis

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ISCAS track: 8.1 Spiking Neural Network circuits and systems

***Abstract*—We demonstrate a Spiking Neural Network(SNN) driven autonomous navigation implemented on a robotic car. The design of neural network is inspired by those present in the nematode *Caenorhabditis elegans*, used for thermotaxis. In our system we use light intensity as the sensor input for the network, instead of the temperature, as in the case of the worm. The network uses only local information to determine the gradations in the field and to make decisions in real time which enable the car to do tracking or finding its destination.**

I. Introduction

Several organisms in nature have the ability to identify and migrate to regions of specific temperature and chemical concentration. There are specific sensory neurons and neural circuits that control the probabilities of straight runs and turns to result in preferential movement towards desired region, solely based on the local information that they sense. Our experiment is a simple bio-mimetic system that demonstrates the possibility of using such purely spike based mechanisms to perform navigation. The robotic car is the counterpart of the worm and light sensors placed on it behave like the sensory neurons. The speed and direction of the robotic car are controlled solely by the outputs of the spiking neural network (SNN) designed in [1].

II. Demonstration Setup and Requirement

The block diagram of our system is shown in figure 1. The onboard circuit of the car has the sensor, the current to voltage converter, a microcontroller and an Xbee transceiver module. The sensor is a non-directional photo-diode mounted atop the car, whose output is converted to voltage and passed through an ADC. The final data, which represent local light intensity is communicated via wireless to the base-station using Xbee modules, through the serial port of the microcontroller. Spike based processing is done on the laptop, based on the real-time local information transmitted from the moving object. The light intensity information is translated into an equivalent current input for the first neuron in spiking neural circuit.

For the demonstration of our system, basic requirement is a relatively dark $4 \times 4\,\mathrm{m}^2$ area. With a series of light sources of variable intensities placed in this arena, we will create an illumination modulated field, where the car will navigate. Figure 2 shows the photograph of our autonomous navigation system.

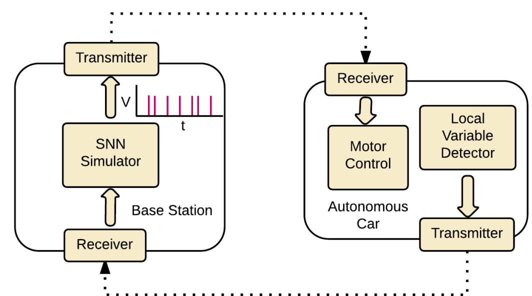

Fig. 1. Schematic block diagram of the SNN based navigation system - spikes computed in real-time in the laptop controls the motion of the robotic car.

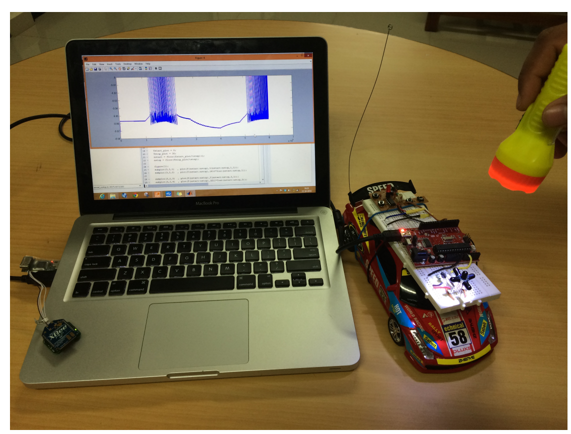

Fig. 2. Our demonstration set-up consists of a robotic car with a light intensity sensor. Sensor data is transmitted to the base station where spike based processing is used to determine and relay control signals to navigate the car in real-time.

III. Visitor Experience

We will create a setup where our robot would track a particular light intensity and avoid regions marked as obstacles, and finally reach the target location. There will be a real-time display of how the spikes emerge as the robot moves, giving the visitors a live demonstration of how biological systems use spikes to process information and make decisions in real-time.

References

[1] A. Bora, A. Rao and B. Rajendran. Mimicking the worm - an adaptive spiking neural circuit for contour tracking inspired by C. Elegans thermotaxis. International Joint Conference on Neural Networks, 2014