Efficient and Robust Spiking Neural Circuit for Navigation Inspired by Echolocating Bats

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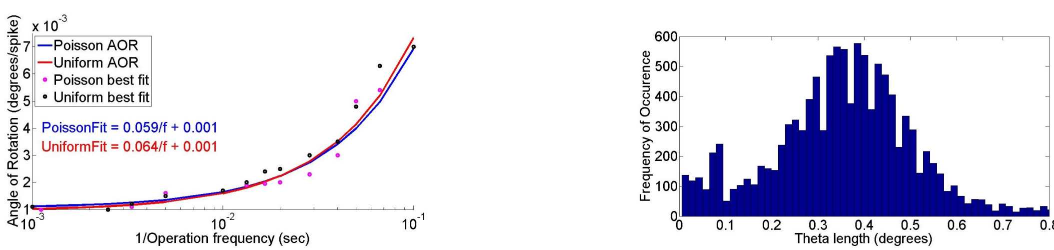
Supplementary Material

Angle of Rotation

Figure 1(a) shows the dependence of Angle of Rotation (AoR) on the operating frequency for Uniform and Poisson sources. This figure indicate one particular value which gives low RMS error for a particular frequency when subjected to step function response. Hence, using this interpolation relation, our SNN can be engineered to work at a desired average spike frequency of the network. Figure 1(b) shows a histogram of theta length (calculated analogous to the run length in a coin toss). It shows that theta-length has a mode of 0.39° and thus AoR could be realized using commercial motors without significant error even though the AoR is small.



(a) (b)

Figure 1: a) In our model, the Angle of Rotation (AoR) per spike is chosen to be inversely proportional to the operating frequency. b) The distribution of theta length in our simulations (similar to the run length in a coin toss) has a mode value 0.39° for an exemplary 1 kHz Poisson network.

Matching PID system to SNN characteristics

The values of k_1 and k_2 in equation (7) in text were determined by matching peak time (T_p) and percent-overshoot (η) with the observed values for artificial bat. Thus, using standard notation for second-order systems,

$$T_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} = 0.75 \qquad \eta = 100\exp\left(\frac{-\zeta}{\sqrt{1-\zeta^2}}\pi\right) = 10$$

and hence values of k_1 and k_2 are given by

$$k_1 = 2\zeta\omega_n = 6.12 \qquad k_2 = \omega_n^2 = 26.9.$$

Simulation parameters

The following tables specifies parameter values used in our simulation model:

Table 1: AEIF Neuronal Parameters used in Simulation for neuron types RS and CH

Parameter	**RS**	**CH**	**Parameter**	**RS**	**CH**
C	200pF	200pF	τ_w	30ms	120ms
g_L	10ns	10ns	a	2ns	2ns
E_L	-70mV	-58mV	b	0pA	100pA
Δ_T	2mV	2mV	V_r	-58mV	-46mV
V_T	-50mV	-50mV			

Table 2: Values of synaptic strengths for sub network n, where n is an integer from 1 to 16. $W_{i,j}$ denotes the synapse from neuron i to neuron j.

Synapse	**Value**	**Synapse**	**Value**	**Synapse**	**Value**
$W_{1,3}$	$80 + 2n$	$W_{1,4}$	-80	$W_{2,3}$	-80
$W_{2,4}$	$80 + 2n$	$W_{3,5}$	-20	$W_{3,6}$	55
$W_{3,7}$	-8	$W_{3,8}$	65	$W_{4,5}$	65
$W_{4,6}$	-8	$W_{4,7}$	65	$W_{4,8}$	-8
$W_{5,7}$	-7	$W_{5,8}$	-7	$W_{6,7}$	-7
$W_{6,8}$	-7	$W_{7,8}$	-10	$W_{8,7}$	-10

Table 3: Other simulation parameters

k (10 Hz)	1	k_1	6.12
k (100 Hz)	10	k_2	26.9
k (1 kHz)	100	v	6.8 m/s