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Marseille, February 10, 2023

Dear editor,

Please find enclosed the revised manuscript entitled “Learning heterogeneous delays in a layer of spiking neurons for fast motion detection” for your consideration as an article in *Biological Cybernetics*. All the authors have been involved with the work, have approved the manuscript and agreed to its revision. The original submission ID is a7f45f8e-87d6-4a30-ac7f-9f0c94e2592a.

Our manuscript describes a novel method inspired by neuroscience to overcome some challenges faced in computer vision, notably when dealing with large amounts of data. By using heterogeneous delays on different synapses, this novel spiking neuron method is able to detect spiking motifs and we validate the method on synthetic event-based data. Results show that this method could provide a path for future spiking neural network algorithms using less energy for a similar performance as their analog counterparts. This work is the extension of a previous study on a simpler event-based dataset. Our contribution here is to offer a better formal description of the model, an application on a more ecological task and testing of the influence of various parameters of the validation dataset.

Given the substantial modifications we did to the original manuscript to reduce and clarify the different sections we do not provide a tracked changes version of the revision (such a document can be provided if needed). We provide a point by point response to the reviewers with references to the manuscript.

Sincerely yours,

Antoine Grimaldi

REVIEWER REPORTS

Reviewer 1

1.There is a lack of an intuitive figure to show the HD-SNN model used in this paper.

blabla

2.The MLR model used in the experimental part was presented in authors' another work. Therefore, the changes on the MLR model are suggested to be highlighted and contrasted graphically.

3.The title of section 2.2.1 is "a generative model for rater plots", but actually this section introduces basic terms and symbols. Section 2.2.2 is named "detecting spiking motifs", but most of the content seems to introduce the generation process of raster plots, while only the last paragraph introduces the detection of motif. It is recommended that the content of these two sections be reorganized and that references to Figure 1(b)(c)(d) be added where appropriate during the description.

4.The adjustment of weights and delays needs more detailed elaboration, preferably given in mathematical formulas.

5.In Figure 4, it is claimed that the kernels are very similar for the ON polarities, and different kernels are selective to the different motion directions. However, in terms of these two observations, I think they are not very significant, so I suggest a more intuitive way to reflect them, such as quantifying the similarity between the ON kernels, and the angle between the kernels and the vector of the standard motion directions.

6.There are few experiments and lack of comparative experiments. Since the model has an improvement based on MLR model, it is suggested to increase the comparison with MLR model and HOTS model on other datasets, such as N-MNIST and other neuromorphic datasets, so as to show the advantages of the proposed model in computational consumption.

7.Some sections are verbose, such as the discussion.

8.There are some minor errors in the text, and it is recommended to check the full text: 1)In the first paragraph on page 8, "a presynaptic address b_s" should be "a postsynaptic address b_s"; 2)Whether W_b in the first formula should be K_b? And d in it lacks description. 3)"PGs" should be given in its full name when it first appears. 4)There is no subgraph label of (a), (b) and (c) in Fig. 3, but the expression of Fig. 3-(a)/(b)/(c) appears many times. 5)The content of paragraph 1 on page 13 is repeated.

Reviewer 2

Key results: Please summarize what you consider to be the outstanding features of the work. Using a single layer of spiking neurons with heterogeneous delays to learn spatio-temporal spiking motifs

Validity: Does the manuscript have flaws which should prohibit its publication? If so, please provide details.

The work presented here is very similar to the author's other work, "Learning hetero-synaptic delays for motion detection in a single layer of spiking neurons" 10.1109/ICIP46576.2022.9897394. This must be addressed and cited with an explanation of how this work presented is an extension of this previous publication. Abstract, Fig 6 and the main result is presented in the previous work. Arguably some of the figures from the previous publication would be nice to see in this publication as it helps with the visualisation of the problem. One suggestion for the extension to make the work unique would be to extend with some event-camera data, as it is mentioned multiple times within the publication. There are also a number of citations that could have been added that did appear in the other publication, while also including other motion detection/ segmentation or previous work on event-based optical flow, which is a very similar problem.

Originality and significance: If the conclusions are not original, please provide relevant references.

See above...