Title	数理ニューロンモデルを使った下オリーブ核における情報伝達効率向上に関する基礎研究
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Study on efficient information transmission inferior olive using mathematical neuron model

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1 Introduction

The internal model hypothesis was proposed by Kawato which have been extensively investigated by physiological experiment. This feedback error learning is typical of Internal model and IO is the main organ to inform error signal by the feedback error learning. But low firing rate of inferior olive is one of the well-known outstanding problems. There was doubt concerning the enough signal transmission. Schweighofer make physiological inferior olive networks model in order to investigate the computer simulations. Schweighofer proposed that inferior olive moderate electrical coupling produced allow rich error signals reach cerebellum and chaos may be useful in the nervous system. This study examines hypothesis of Schweighofer.

2 neuron model

We used a simple neuron model called a μ -model. The IO neuron is low firing rate for 1-2 [Hz]. The model is added that time constant τ in order to agree IO firing rate. The neuron coupling is 1-dimensional periodic boundary condition.

3 Estimation of error signal transmission

Inferior olive is assumed an organ to error signal plopagation. We evaluate the coupling area which is effective to error signal propagation for the correlation between input and average firing rate of output. And, we calculate lyapunov exponent in order to study the level of chaos in coupling area. In addition, we judge the coupling aria by the correlation of neuron to each other in order to indicate asynchronous. From these results, we are consistent with the proposed result on Schweighofer. However, from the same studies results, we found different effective coupling area to signal transmission from Schweighofer's hypothesis. The Lyapunov exponent of this coupling area was low since it differs from hypothesis of Schweighofer. Therefore, we investigate the difference between the hypothesis of coupling area from Schweighofer and the hypothesis of it not from Schweighofer.

4 Estimation of uniformless neuron model

The real neuron is not uniformle. We evaluate the transmission of signals in the case that each of neuron has uniformless firing. The firing of constant μ is decided by random from $\mu \pm 5\,\%$ and $\mu \pm 1\ 0\,\%$ in order to make uniformless firing the each of neuron. For this result, We show effective to error signal propagation, and besides high Lyapunov exponent. And, We show effective to error signal propagation, yet low Lyapunov exponent.

5 Estimation of robust

IO should propagate an accurate error signal. It is important that the neuron is strong in the noise. We add a noise into each neuron of μ-model and evaluated the coupling area. As a result, the coupling area of hypothesis not from Schweighofer has stronger robust than coupling area Schweighofer's one.

6 Examination of spike timing

We compare and contrast surrogate data about the timing of firing of coupling area, which is not from Schweighofer. Surrogate data is the spike data which change the timing of firing of simulation spike data by μ-model. As a result, the coupling area relate with the influence of the timing of firing.

7 summary

In this paper, we report the analysis of the hypothesis of Schweighofer by μ-model. Therefore, We confirmed the Schweighofer's hypothesis but we found an another effective coupling area for transmission of signal in different type of coupling area. We investigated the case that the neuron has the characteristic of firing, evaluated the robust, considered the uniformless timing firing of coupling area which is different idea of Schweighofer's hypothesis. Through the four results, we could suggest the effectiveness of coupling area that is not same as Schweighofer's idea in signal transmission. For next step, we need to study whether the signal transmission of coupling area that different idea as Schweighofer ' s is just for μ-model or not. In addition, by the add it into feedback error learning as a model of cerebellum learning, and then, we can study about signal transmission and cerebellum learning coupling area.

References

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