Echo state network with nanomagnets

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Recurrent neural network (RNN)[1] is one of the most promising devices for an artificial intelligent. In RNNs, information is calculated and stored in multiple nodes with closed feedback loops. Recently, computer based RNNs show excellent performance to solve multiple tasks such as voice recognition, game of Go, etc. However, an energy consumption of the computer based RNN is increasing associate with improvement of a RNN performance. To reduce the energy consumption, echo state networks also called as reservoir computing have been introduced. In echo state network, the feedback loops between the nodes can be replaced with a physical phenomenon. [2-4].

In this study we demonstrate echo state network based on nanomagnet array with macrospin simulations. The nanomagnet neural network (NM-NN) is composed of 20 nanomagnets. A state of the NM-NN is defined as a direction of static magnetization of the nanomagnets. To update the state, we change uniaxial anisotropies of the nanomagnets. To check a performance of the NM-NN, we use binary task of AND, OR and XOR functions. As a result, the NM-NN can be trained to perform the AND, OR and XOR tasks with up to an input delay of three steps.

In this study we ignore the temperature effect. However, a stochastic behavior according to an ambient temperature could be used to enhance the performance of the NM-NN. We expect that devices derived from NM-NN will be widely used as neural network hardware based on spintronics in the near future. This research and development work was supported by the Ministry of Internal Affairs and Communications,JAPAN.

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