Non-linearity in reservoir computing with nanomagnet array

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Recurrent neural network (RNN) is a mathematical model for machine learning, which emulates the nerve system in human brain. RNN consists of many nodes which keep information as a state of the nodes, and the nodes interact with each other. Fig. 1 shows a concept of the RNN. Each node in the middle layer shows a non-linear response via the interaction between the nodes. The state of the nodes is recursively updated, i.e. the state is determined by the present input and the previous state. Therefore this property can be used for computing a time series datum. Recently, to improve a performance of the RNN, reservoir computers (RCs) [1] with physical system have been reported [2 - 4]. The RC is one of the RNN and have simple architecture. In this research, we introduce a RC with nanomagnet array which calculate a state via magnetostatic interaction between the nanomagnets, and evaluate a non-linearity in the nanomagnet-RC (NM-RC).

Figure 2 shows a schematic illustration of the NM-RC. In this system, the nanomagnets are used as nodes, and magnetization directions of the nodes are used as a state. To update the state of the node, we change uniaxial anisotropies of the nanomagnets. The magnetization directions are simulated by using a macro-spin simulator. In the presentation, we report the non-linearity in the NM-RC. This research was supported by the Ministry of Internal Affairs and Communications.

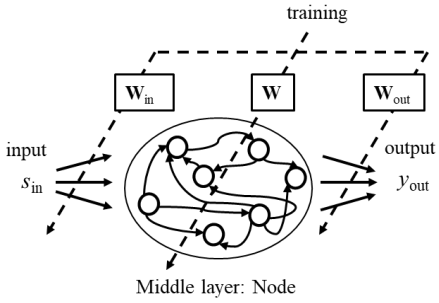
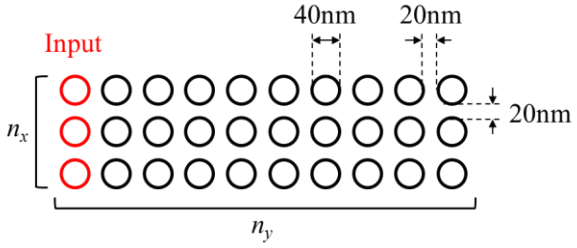


Fig. 1 Schematic illustration of recurrent neural network.



ig. 2 Schematic of typical $n_x \times n_y$ nanomagnets for recurrent neural network

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