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Convolutional Neural Network を用いた Physics-Informed Neural Network の拡張

Extension of Physics-Informed Neural Network using Convolutional Neural Network

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In the manufacturing process of semiconductors and MEMS devise, a resist film consisting of resin and a solvent is coated onto a substrate, and it is known that various thickness undulations appear in the final resist films(1,2). Such thickness variations are required to be avoid or suppressed in industry. Although numerical simulations have been used to predict such thickness undulations, it is difficult to optimize the coating conditions from an inverse problem perspective because the time evolution of the governing equations takes a long calculation time. One of the solutions to this problem is to introduce machine learning. In this study, we focus on a method called Physics-Informed Neural Network (PINN) (3). The PINN learns the solutions of a partial differential equation (PDE) for given dataset of the input variables. Once a PINN has been trained, the solutions for any time instance can be directly calculated without time integration by forward calculations of the neural network (NN). The PINN has problem that it takes a long time for computational time. Therefore, it is necessary to improve the learning efficiency. Precious studies have shown that the learning efficiency of the PINN can be improved by incorporating the features of the governing equation into the training (4). The governing equation that the PINN uses as teachers are physical laws, and the interaction of solutions occurs locally. Therefore, in this study, we have extended Convolutional Neural Network (CNN), which learns using local features, to learn local solutions by combining it with the PINN. The results are reported verification using the liquid film flow problem.

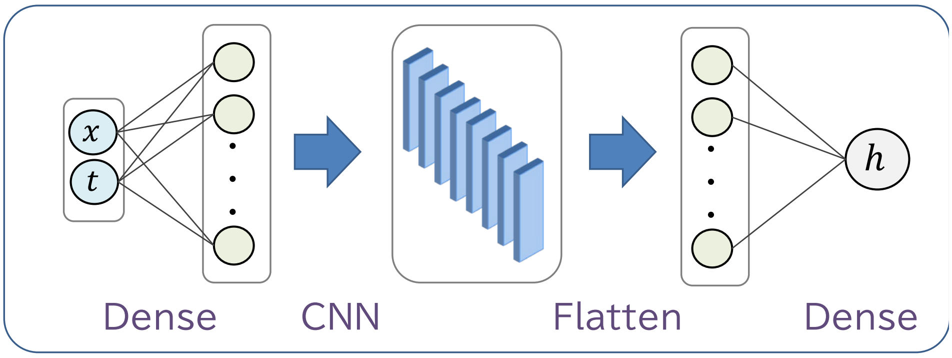

Fig. 1　Network structure of PINN using CNN.

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