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Professors Sung-Min Hong and Jonghyun Choi's joint research team develops technology to accelerate semiconductor device simulation using an artificial neural network

□ GIST (Gwangju Institute of Science and Technology) School of Electrical Engineering and Computer Science Professor Sung-Min Hong and AI Graduate School Professor Jonghyun Choi's research team developed technology to accelerate semiconductor device simulation * using an artificial neural network.

* semiconductor device simulation: a technology that predicts the performance of semiconductor devices using computer programs, which is used to save enormous time and money for developing semiconductor devices

◦ The team succeeded in reducing simulation time by nearly 10 times by generating excellent approximate solutions with the artificial neural network based as most of the time spent performing semiconductor device simulations is spent on calculating unnecessary intermediate-course answers.

□ Recently, semiconductor shortages have appeared around the world, and semiconductor manufacturing technology is attracting great attention. Semiconductor device technology is particularly important to complete the

development within a short time, so the expectation for semiconductor device simulation is high.

- However, because it usually takes a lot of time to perform a semiconductor device simulation program, this itself is becoming a bottleneck in technology development. To solve this problem, there are techniques such as using parallel computing, but there is a disadvantage in that enormous computing resources are required to handle all of the numerous device design candidates.

□ The research team shortened the simulation execution time by immediately finding the answer to the voltage condition that the user wanted to know.

- Semiconductor device simulation solves nonlinear equations, and it requires guessing an approximation that is close to the answer. However, it is difficult to know in advance a good approximation to the voltage condition (approximately 0.7 V) that the user wants to know, which inevitably starts at 0 V and gradually increases the voltage.

□ The research team introduced an artificial neural network to immediately find the answer to the desired voltage condition. This artificial neural network supervises the existing simulation results and generates a potential profile * inside the semiconductor devices corresponding to the desired situation. Using this predicted potential distribution as an approximate guess, the correct answer can be found in a short time.

* potential profile: Potential is the electrical position energy that a unit charge has. Because voltage is applied to the semiconductor device, the potential value is different for each position inside the device. This potential profile affects the movement of electrons inside the semiconductor device, so the potential profile is the most important physical quantity in the semiconductor device simulation.

- To verify the proposed method, a speed comparison with the existing method was performed. Compared to the result of setting the simulation control parameters of the conventional method to the optimum values, the speed improvement of more than 8.4 times was obtained. Because the optimum values of the simulation control parameters are not known until the

simulation is performed directly, the expected speed improvement for actual applications is 10 times or more.

- Professor Sung-Min Hong said, "The results of this study are meaningful in that it was the first to confirm that the execution time of semiconductor device simulation can be greatly reduced by using an artificial neural network. This is expected to be actively used in the development of next-generation semiconductor devices through follow-up research."

- This research was led by GIST School of Electrical Engineering and Computer Science Professor Sung-Min Hong and AI Graduate School Professor Jonghyun Choi and conducted by master's student Seung-Cheol Han with support from the National Research Foundation of Korea and the Institute for Information and Communications Technology Promotion (IITP) and was published online on May 7, 2021, in *IEEE Transactions on Electron Devices*, a world-class academic journal in the field of semiconductor devices.

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