Peiliang Du

EC 601

Project 1

The development of the electronic chip has reached its bottleneck due to the physical limitations. Chips are getting smaller with more transistors in them, and this raises a significant problem with heat dissipation. Because of the relatively high latency and energy loss, scientists are eager to find new methods to support the next generation computation-hungry applications. In the recent years, researchers had found that the high clock frequency, low latency, and low energy loss make the photonic chip an ideal replacement for its electrical counterparts. The photonic chip can make a huge impact on our society, it can be used in many places that require huge computing power, such as autonomous vehicles and data centers.

Tradition neural networks are getting more complex, and they consume a large amount of power during computation. Portions of the power were loss at the transistors when using electronic integrated circuits, and the delay at the gates hinder the communication speed. These days, researchers had found that photonics can outperform electronics in these areas. According to the MIT researchers, their photonic chip simulations could run optical neural networks 10 million times more efficient than the electrical chip. Right now, the electronic accelerators are measured in picojoules, while the photonic accelerators could be operated with sub-attojoule efficiency based on the MIT simulations, which is a million times more efficient. Nowadays, many large tech companies such as Google, Apple, and Intel are investing and researching in photonic chip. The common approach by these companies is using a hybrid design, which combine silicon and optical circuits on the same PCB, such that the processing unit runs optically, and the activation and storage unit runs electronically.

Currently, there are two well-known startup companies working on the photonic chip, the Lightmatter and the Lightelligence, both are in Boston area. At the Hot Chips conference 2020, the Lightmatter reveals it first photonic processing platform Mars that runs at higher clock frequencies, consumes less energy, and has lower latency, which can also run standard machine learning frameworks including PyTorch and TensorFlow. Like many other semiconductor

companies that design their chip with RAM close to the processing unit, Lightmatter uses 3D integration technology to make the routing less than 1mm, which lower the latency and saves energy. The platform is designed to be plugged into standard server or workstation, so that it can be compatible with a wide range of devices.

Although photonic chip is still at its beginning stage, many companies and laboratories see the potential ability of the photonics that could move data faster with less energy spent. Hopefully, we could see the photonic chip replacing electronic chip in computation-hungry applications soon.

WORK CITED

1. Rob Matheson, "*Chip design drastically reduces energy needed to compute with light*", June 5, 2019, MIT News Office.
2. Patrick Kennedy, "*Lightmatter Mars SoC AI Inference Using Light*", August 18, 2020, ServeThe Home.
3. DAVID SCHNEIDER, "*Lightmatter's Mars Chip Performs Neural-Network Calculations at the Speed of Light*", 29 AUG 2020, IEEE Spectrum.
4. Kyle Wiggers, "*Photonics startup Lightmatter details its AI optical accelerator chip*", August 17, 2020, The Machine.
5. RITIKA SAGAR, "*MIT Researchers Make New Chips That Work On Light*", 14/06/2021.