*** 北米連携センター情報***

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●脳機能をシミュレートするマイクロチップを発表

【Wall Street Journal, 2014/08/07】

IBM は、脳内の神経活動をシミュレートして演算処理を行うマイクロチップを開発したことを発表。

同社によると、従来のチップと根本的に異なるデザインを持つこのチップは、パターン認識やオブジェクト分類などに優れているとのこと。

また、学術誌「Science」に掲載された論文では、これまでの脳を模したチップよりもサイズが大きく、特異な素材や製造プロセスを用いる代わりに、標準的なデジタル技術を使用しているといった新規性も有している。チップの発売時期についての詳細は明らかにされていないものの、IBM は既に潜在的なパートナーと販売に向けての話し合いを始めているという。

「TrueNorth」と名付けられたチップの製造を担当したのはサムソン。チップの基盤となるデザインは、国防省高等研究計画局（DARPA）から、2008 年以降 5300 万ドルの資金提供を受けているプロジェクトで、コーネル大学とともに共同開発したものが採用されている。この「TrueNorth」は、100 万本のニューロン、2 億 5600 万個のシナプスに相当する 54 億のトランジスタを搭載し、「ニューロシナプティック・コア」と呼ばれる構造体を 4096 構築。この構造体のそれぞれがデータの保管や処理、クロスバーと呼ばれる通信スキームを使った他の構造体とのデータのやり取りを行える。

IBM アルマデン・リサーチセンターの研究員、ダルメンドラ・モダ氏によると、チップは「イベント・ドリブン」型のデザインで、各コアは常時駆動しているのではなく、必要時のみ駆動。このため省電力性にも優れており、通常のマイクロプロセッサが 1 平方 cm 当たり 50-100W の電力を消費するところ、「TrueNorth」は 20mW しか消費しないという。

「ニューロモーフィック（神経形態学的)」チップと呼ばれる製品は、インテルやクアルコムも開発を進めているが、実用化に至った後は、プログラマに新たなソフトウェア作成方法を学ばせるという大きな課題が立ちはだかる。

IBM は、プログラム言語やチップをシミュレートするツールの開発でこの問題に取り組み始めており、他のニューロモーフィックチップに比べると使いやすくなっているとの声もあるが、現時点でこの分野の先進者を判断するのは時期尚早という専門家もいる。

脳研究を基にしたハードウェアやソフトウェアを開発する新興企業、ニューメン

タの創設者で、モバイル機器開発分野で著名なジェフ・ホーキンス氏は、「TrueNorth」のような 2 次元的な回路構造を持つチップは、チップを重ねるといった方法で脳の膨大な接続をより近くシミュレートするアプローチに取って代わられるだろうと予想している。

（参考）本件報道記事

IBM Unveils Chip Simulating Brain Functions Tech Giant Claims Microchip Is a Sharp Break From Traditional Chip Design

By DON CLARK

SAN JOSE, Calif.— International Business Machines Corp. IBM is claiming a major advance in emulating the brain in silicon.

The technology company has developed a microchip that simulates functions of neurons, synapses and other features of the brain to perform calculations. IBM says the chip, a sharp break from the fundamental design used in most computers, excels at chores like recognizing patterns and classifying objects while using much less electrical power than conventional hardware.

IBM's new chip is the latest in a series of efforts by the company and others to design brain-like chips as traditional chip manufacturing yields fewer breakthroughs. But its latest offering, described in a paper in the journal Science, has novel features that include its large size and the use of standard digital technology rather than esoteric materials or production processes.

Though it is providing few details on timing, IBM says it is already talking to potential partners about ways to bring the chip to market. The company has connected multiple chips together to test potential system designs, and sees applications of the technology ranging from room-size supercomputers to floating jellyfish-shaped devices that could sense tsunamis or other aquatic conditions.

"We have huge commercial ambitions," said Dharmendra Modha, a researcher at IBM's Almaden Research Center here whose titles include chief scientist for brain-inspired computing.

The chip, dubbed TrueNorth, was built for IBM by Samsung Electronics Co. using the same manufacturing technology the South Korean company uses to make microprocessors for smartphones and other mobile devices. IBM collaborated on the underlying design with researchers at the New York City campus of Cornell University in a project that has received $53 million in funding since 2008 from the Pentagon's Defense Advanced Research Projects Agency.

IBM's announcement comes as both scientists and engineers are pondering the prospect of slowing improvements of conventional microprocessors. Historically, manufacturers steadily have shrunk chip circuitry, reducing costs while improving calculating speed and reducing power consumption.

But chip manufacturers can no longer rely on traditional processes to produce dramatic improvements, particularly for scientists grappling with supercomputers that have power needs already approaching those of small cities. Radically different chip architectures like TrueNorth may help.

"Power is the fundamental constraint as we move forward," says Horst Simon, deputy director of Lawrence Berkeley National Laboratory, a major supercomputer user. "This chip is an indication that we are really at the threshold of a fundamental change in architecture."

The underlying design used in most computers and microprocessors since the 1940s—named after mathematician John von Neumann —separates components that carry out calculations from memory circuity that stores data. Bits are shuttled between those components through a conduit called a bus, with activity synchronized by an internal clock. The scheme works well for tasks like adding repeated sets of numbers, Mr. Modha says. And chips have become much faster for such jobs as manufacturers have increased the frequency of the clock's timing pulses.

But that trend also tends to boost a chip's power consumption. Moving data back and forth over a bus, meanwhile, tends to slow calculations, he said.

Brains, by contrast, are compact and particularly efficient at chores like recognizing a person's face or distinguishing one sound from another, Mr.

Modha says. Cells called neurons process and transmit information that is stored nearby, connected by structures called synapses.

TrueNorth, IBM says, uses 5.4 billion transistors—four times more than a typical PC processor—to yield the equivalent of one million neurons and 256 million synapses. They are organized into 4,096 structures called "neurosynaptic cores," each able to store, process and transmit data to any other using a communications scheme called a crossbar.

The design is "event-driven," Mr. Modha says. That means that individual cores fire up only when they are needed, rather than running all the time.

This scheme makes the chips more power efficient. Where a comparable standard microprocessor draws 50 to 100 watts per square centimeter, TrueNorth draws just 20 milliwatts, or thousandths of a watt, IBM says.

In a demonstration, Mr. Modha showed how the technology used with a video camera atop a building can pick out and track people walking below. Besides daisy-chaining TrueNorth chips to make large systems, IBM expects to distribute a smaller, simpler chip for applications where space is paramount or humans can't easily go. Potential applications described by the company include ball-size rolling robots with cameras to inspect disaster sites and leaf-size sensing devices that could be scattered during a forest fire.

"It's not going to replace conventional computers," Mr. Modha says. "It is a complementary relationship."

Other companies, including chip giants Intel Corp. and Qualcomm Inc., QCOM have their own designs for what engineers call "neuromorphic" chips. Once working devices have been created, engineers face the equally daunting task of persuading programmers to learn new methods for creating useful software.

IBM has tried to address the obstacles, developing a special programming language and tools to simulate such chips. The technology "is much closer to being usable than a lot of other neuromorphic systems others have developed," says Rajit Manohar, a longtime collaborator who is professor of electrical and computer engineering at Cornell Tech.

But other experts say it is too early to identify front-runners in the field. One is Jeff Hawkins, a mobile-device pioneer and co-founder of Numenta, a startup that has been building hardware and software based on a lengthy study of the brain.

Mr. Hawkins believes that largely two-dimensional chips like TrueNorth will give way to stacks of chips or other approaches that more closely emulate the brain's many connections. It's "a many-year process to find out what the right neural architecture is," he says.

Source:
http://online.wsj.com/articles/ibm-unveils-chip-simulating-brain-functions-1407434402?mod=ST1

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