Source : www.thehindu.com Date : 2020-10-21

MOLECULAR COMPUTING: DNA-INSPIRED ADVANCED COMPUTERS

Relevant for: Science & Technology | Topic: Computer Technology incl. 3-D Printing

The small electronics are crucial to developing more advanced computers by replacing silicon chips with molecules. | Photo Credit: Special Arrangement

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Researchers at Yale University have developed a single-molecule switch, a device that could be key to the future of molecular or small computers.

Single-molecule-electret, the switching device could serve as a platform for small non-volatile storage devices such as Read-only-memory (ROM). These small electronics are crucial to developing more advanced computers by replacing silicon chips with molecules.

Most electrets are made of materials that produce the sound in speakers and the pairs of opposite electric charges line up in the same direction. By applying an electric field, their directions can be reversed. The attempt has always been to make these electrets as small as possible.

Mark Reed, the Harold Hodgkinson Professor of Electrical Engineering & Applied Physics at Yale University demonstrated a single-molecule electret with a functional memory. His work, along with research of colleagues at Nanjing University, Renmin University, Xiamen University, and Rensselaer Polytechnic Institute, were published in *Nature Nanotechnology*.

What is Molecular Computing?

Molecular computing is the science of using DNA, biochemistry and molecular biology hardware to build a computer. Instead of using silicon, scientists attempt running software with liquids, test tubes and living cells to reduce the size of circuits as much as possible.

Why replace Silicon?

Silicon microprocessors have been around in the computing world for more than four decades. But to build smaller computers, circuits need to be miniaturized. So, while reducing the size of the circuits, current flowing through the transistor starts leaking into other components, thereby, faulting the circuit and making it useless.

So, researchers are highlighting the idea of molecular computing due to its potential to pack more circuitry at cheaper cost onto a microchip than silicon. Few nanometres in size, molecules make it possible to manufacture chip sets that can hold trillions of switches and components in them.

What can replace Silicon?

Scientists are working on different possibilities, including DNA to replace silicon for molecular computing. It could be a breakthrough technology since a single copy of DNA sequence is large enough to print an entire encyclopaedia out of it.

DNA computing came into light in 1994 when American computer scientist Loenard Adleman used tools of molecular biology to solve a difficult computational problem. It was said that the method had the potential to outperform electronic computers.

DNA enables scientists to manipulate its solutions and work on millions of strands together in the laboratory. Just as computer stores information in the form of bits, DNA molecules are nothing but strings of Adenine, Guanine, Cytosine, and Thymine. These four bits together can hold large amount of data.

It could be interpreted as a software that builds a human being from a single cell. DNA holds no limit to power since more the number of molecules, greater is its strength. Unlike traditional computers, DNA computing can carry out million of operations at the same time.

For instance, a single cubic centimetre with 10 trillion DNA molecules could perform 10 trillion calculations at once while holding 10 terabytes of data. It is also viewed as a complement of quantum computing.

However, the number of possible solutions grow exponentially with the size of problems so even small problems would require large volumes of DNA to represent all possible answers.

There's a long way to go before it could be achieved but the degree of miniaturization offered by DNA could be key to the future of molecular computing.

Along with DNA computing, others biological computing methods include membrane calculation, evolutionary calculation and virus calculation.

Where will it be used?

The early DNA computers are unlikely to replace silicon soon, but it will be used for advanced calculations and powerful computing by national governments. In addition to this, it could also lead to better understanding of other biological processes.

Researchers tested the tool with an AI-based neural network on videos of former U.S. President Barack Obama. The neural network spotted over 90% of lip syncs involving Obama himself.

Bitcoin is the world's largest cryptocurrency in terms of market capitalisation and trading volume, according to cryptoassets tracking website CoinMarketCap.

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