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Application of Nanotechnology in Computer Application

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Abstract
Nanotechnology is now firmly entrenched in the field of computer science, assisting in the development of more efficient computing components. It's a technology with an undiscovered future, capable of advancing science and technology to realms we've never dreamed. It is an interdisciplinary field with applications and development in a variety of fields including applied science, mechanical engineering, and electrical engineering, among others. Nanotechnology has evolved in the modern era of numerous applications in recent years. In this paper, we highlight the relevance of nanotechnology in computer science, as well as recent developments and potential.
keywords: *Carbon nanocomputer, computational nanotechnology, Time crystal in quantum computer, top down approach ,bottom up approach*

Introduction

In computer science, nanotechnology is a sort of engineering aimed at creating electronic components and devices that are measured in nanometers, which are exceedingly small in size and structure. It combines ideas from physics, engineering, and other fields. Today, anyone can carry a computer in one hand – A computer (hundreds of times slower) was the size of a room 40 years ago. Miniaturization of microprocessors is currently in process at nanometre-scales . The style of our modern technology is still the same as ancient technology that constructed a refined product from bulk materials. This style is referred to as bulkor top-down technology.
As conventionalmethods to miniaturize the size of transistors in silicon microprocessor chips will soonreach its limit and the modification of today's top-down technology to produce nano scale structures is difficult and expensive , a new generation of computer components will be required. Feynman and Drexler proposed a new style of technology, which assembles individual atoms or molecules into a refined product .This Drexler terms *molecular technology* or *bottom-up technology*. This bottom-up technology could be the answer for the computer industry. Though top-down technology currently remains the choice for constructing mass-produced devices, nanotechnologists are having increasing success in developing bottom-up technology.
The CPU's performance is likewise doubled every 18 months, according to Moors law. Every one and a half years, the feature size for a semiconductor chip shrinks by a factor of two. The number of transistors the industry would be able to place on a computer chip would double every 1.5 years Cost of constructing a new Fabs will double every3 years. Now the challenge is how the overcome from this problem, the answer is nanotechnology. Nanotechnology plays a vital part in computer science nowadays.

Literature Review

In 1959, future Nobel Laureate Richard Feynman gave a visionary discussion on nanoscale miniaturisation titled "There's Plenty of Room at the Bottom". Drexler's work later provided futuristic nanotechnology concepts. Many researchers in physics, material science, chemistry, and biology were inspired by Feynman and Drexler's views. The microprocessor is the computer's CPU (central processing unit), which handles the memory, input/output devices, and overall functionality. OR It is the central processing unit, which is made up of a single integrated circuit. Microprocessor Evolution In 1959, Fairchild Semiconductor (established in 1957) created the first integrated circuit. 4004 INTEL .It is INTEL's first microprocessor. It was introduced in 1971. it was a 4 bit microprocessor,

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after that the number of transistors in increases according to the moors law and today we have processors like I 5 and I 7which are much more efficient. With the development of efficient computer technology in the 1940s, the solutions of elaborate wave equations for complex atomic systems began to be a realizable objective**.**

Various methodologies began to be seen as part of a new growing science of computational chemistry in the 1970s. The inaugural issue of the Journal of Computational Chemistry appeared in 1980. We focused on how nanotechnology can be applied in computer science and the benefits of nanotechnology, as well as current and future nanotechnology computer science research**.**

Development in Nano Technology in computers

A nanocomputer is a computer with extremely small physical dimensions. Nano computing is a subfield of nanotechnology, which is a rapidly developing field. Researchers and futurists have proposed a number of different forms of nanocomputers. Nano computing falls into a few categories.,

1.Chemical Nano computers

Chemical nanocomputers would be able to store and process data based on chemical structures and interactions. Nature already has biochemical nanocomputers; they can be found in all living organisms. The creation of a genuine chemical nanocomputer will most likely follow a similar path to that of genetic engineering. Engineers must figure out how to make individual atoms and molecules execute programmable calculations and data storage.

2. Electronic Nano computer

Advances in nanocomputing technology are anticipated to occur in this route in the late 1940s, making the electrical nano computer appear to be the most straightforward and likely direction for Nano computer development in the near future. Electronic nanocomputers would work similarly to microcomputers today. The most significant distinction is one of scale. With each passing year, more transistors are crammed into silicon chips, resulting in integrated circuits (ICs) with ever-increasing storage and computing power. The atomic structure of matter imposes the ultimate limit on the number of transistors per unit volume. Most engineers agree that technology has yet to approach this limit. The phrase "nano computer" is relative in the electronic sense. Ordinary microprocessors today may be classified as nanodevices by 1970s criteria.

3. Quantum nanocomupting

Quantum computing is a cutting-edge method of computing that is based on quantum mechanics and its incredible phenomena. Physics, mathematics, computer science, and information theory are all combined in this field.

To explain what are quantum computers, we begin by having a closer look at a basic chunk of information, namely one bit. From a physical point of view a bit is a physicalsystem which can be prepared in one of the two different states representing two logical values — no or yes, false or true, or simply 0 or 1. One bit of information can be also encoded using two different polarizations of light or two different electronic states of an atom. However, if we choose an atom as a physical bit then quantum mechanics tells us that apart from the two distinct electronic states the atom can be also prepared in a coherent superposition of the two states. This means that the atom is bothin state 0 and state 1.Now we push the idea of superposition of numbers a bit further. Consider a register composed of three physical bits. Any classical register of that type can store in a given moment of time only one out of eight different numbers i.e. the register can be in only one out of eight possible configurations such as 000, 001, 010,

... 111. A quantum register composed of three cubits can store in a given moment of time all eight numbers in a quantum superposition.

4. Mechanical nanocompting

Instead of solid-state transistors and other components, mechanical computers rely on millions of minuscule moving parts to push electrons to conduct calculations. The binary switches, which compute the ones and zeroes that drive modern computers, are made up of gates, pillars, levers, and pistons. Because they are more rugged and can perform at much higher temperatures than

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conventional silicon chips, scientists say, nano mechanical chips will have a wide range of uses in "extreme environments such as space, car engines, battlefields, and children's toys." Another benefit: they require less power to operate, meaning they don't need the energy- sucking cooling systems required by conventional computers.

Current Scenarios of Nanotechnology and Computer Science

1.Carbon Nanotube Computer

Carbon nanotubes (CNTs) are hollow cylinders made up of a single carbon atom sheet. CNTs have been found to have the same properties as Silicon transistors, and hence act as semiconductors, making them suitable for usage as transistors in computer chips. A group of Stanford researchers has created a basic computer using carbon nanotubes, which might pave the way for a new generation of electronic gadgets that are faster and use less energy than silicon chips. This nanotube processor is made up of 178 transistors, each of which contains carbon nanotubes that are about 10 to 200 nanometer long. It has been reported by the they have made six versions of carbon nanotube computers, out of which one them can be connected to external hardware, and a numerical keypad that can be used to input numbers for addition.

2.Computational Nanotechnology

Nanoscale systems are made up of thousands, if not hundreds of thousands, of atoms, despite their insignificance. As a result, characterising their electrical structures and dynamics necessitates a high level of theoretical expertise as well as a lot of computing capacity. It is a technique for studying nanoparticles by utilising computer models to predict their behaviour and to guide real-world nanoparticle physics and chemistry. Computational nanotechnology is a powerful tool for understanding nanoparticle physics and chemistry. After carrying out a simulated experiment, theory is developed to explain the observed results, which is then validated by conducting a lab experiment. If the predicted results and the theoreticalresults agree, then the theory is accepted. Unexpected results from laboratory work can also be examined with theoretical methods, which often lead to the developmentof new theory. One of the example of Computational Nanotechnology is development of ***NanoDesign***, A research group at NASA has been developing this software system, for investigating fullerene nanotechnology and designing molecular machines. The software architecture of NanoDesign is designed to support and enable their group to develop complex simulated molecular machines.

3.Time crystal in quantum computer

Today's quantum computers are far from perfect—they only have a few dozen quantum bits, and these "qubits" are noisy and prone to uncorrectable random errors. However, a group of researchers has now demonstrated that such "noisy intermediate-scale quantum" (NISQ) devices may be utilised to imitate complicated quantum activity. They show theoretically that an NISQ device like Google's Sycamore quantum computer can be used to simulate an object called a discrete time crystal, whose components undergo spontaneous collective oscillations.

Time crystals, first hypothesised in 2012, are systems that return to a precise configuration on a regular basis—they're crystals that repeat in time rather than space. For example, some systems made of many interacting quantum components are predicted to act as time crystals when driven by a periodically varying force. A classical pendulum also oscillates in response to a periodic driving force, but a periodically driven time crystal resonates at an integer multiple of the drive's period (a lower frequency than that of the driving force). Such a system is called a discrete time crystal (DTC). Making a real DTC that oscillates endlessly, on the other hand, is difficult because the driving force injects energy into the system, causing it to heat up, eventually overwhelming the periodic dynamics. Certain quantum systems that contain disorder can, in theory, avoid such heating through a mechanism called many-body localization (MBL), which prevents energy from spreading through the whole system and thus stabilizes a DTC. Although quantum experiments have previously reported DTC-like oscillations, no one has yet been able to employ MBL (or any other method) to stabilise a DTC and allow it to cycle endlessly.

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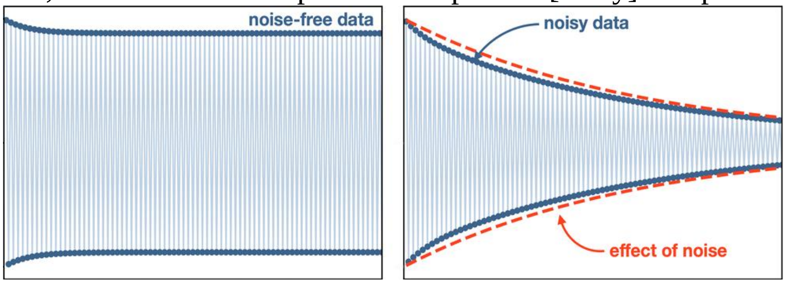
Quantum computers provide a unique opportunity for making a time crystal because they are precisely controllable quantum systems. In principle, any quantum object that can change its state can form a quantum DTC, so when implementing one on a quantum computer, the boundary between simulation and real experiment is blurred. "it is best viewed as an experiment on a many-body system, rather than the output of an imperfect [noisy] computer simulation



[Crystal clear time crystal: Oscillations appear in the quantum circuit at twice the period of the driving force, a clear signature of a discrete time crystal. In theory, the oscillatory signal (the correlations between the qubits' values at different]

They've now demonstrated that Google's Sycamore quantum processor, which uses superconducting devices as qubits, can simulate an eternally stable DTC. According to the Stanford team, their algorithm for creating a DTC on Sycamore can yield genuine MBL, which means that the periodic behaviour can theoretically be perpetuated indefinitely. They lay out a blueprint for the first realization and detection of an MBL DTC, and the Sycamore circuit indeed meets all the desired conditions," says Ippoliti. In their scheme, the qubits work as a chain of interacting spins that can point "up" or "down." By controlling their orientation with a periodically varying force, the spins can be made to flip back and forth along the chain at a lower frequency than that of the driving force.

The key MBL DTC signature, according to the researchers, is that an oscillatory signal with a period that is a multiple of the driving force emerges from any initial state of the system—a feature that is difficult to test in other experiments but is simple to investigate using this quantum-computational algorithm.

In collaboration with Google researchers, the team has also shown that their scheme works in practice, using 20 of the 53 qubits in the Sycamore circuit However, in those experimental runs, the DTC behaviour could only be watched for less than a millisecond (about a hundred oscillations). That's because, as with any quantum computation, the qubits can only be kept in the quantum-coherent state needed for the computation for a short time before interactions with their environment induce decoherence that breaks the simulation. Nevertheless, the strategy outlined by Ippoliti and colleagues describes how to distinguish the fingerprint of true (in principle, indefinitely sustained) DTC behavior from dynamics that might mimic it for short times, as seen in previous experiments. That approach—which the team used in their analysis of the Sycamore data—involves looking at the detailed statistics of fluctuations in the oscillation amplitudes.

The researchers stress that this DTC behavior can also, in principle, be simulated on a classical computer. But in that case, "the bits in the computer evolve in a way that looks nothing like the physics we're interested in but nevertheless output numbers that replicate the outcomes of a hypothetical experiment," Ippoliti says. In contrast, on a quantum computer, the qubits themselves exhibit the DTC behavior.

Their work shows the great potential of NISQ devices for exploring nonequilibrium phases of matter. Quantum physicist John Preskill of the California Institute of Technology concurs.

Technology

Nanotechnology employs the Nanofabrication technique, which allows for atomic-level manipulation and integration, and is of special interest to computer engineers because it paves the way for super-high-density microprocessors and memory chips. It is the design and fabrication of devices with nanometer-scale dimensions. Various nanofabrication processes can be largely divided into two

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categories:

1.TOP-DOWN APPROACH:

The top-down technique aims to develop smaller devices by directing the assembly of larger ones. Traditional micro manufacturing processes, in which materials are cut, milled, and shaped into the required shape and order using externally controlled tools, are frequently utilised in the top down approach .The most common top down fabrication technique is nano lithography. In this process required material is protected by a mask and the exposed material is etched away. Depending upon the level of resolution required for features in the final product etching of the base material can be donechemically using acids or mechanically using ultra violet light, x-rays or electron beams. This is the technique applied to manufacture computer chips.

2.BOTTOM-UP APPROACH:

To make nanostructures out of smaller building blocks, it uses molecular recognition and self-assembly (molecules, colloids, and clusters). It is based on fundamentally different ideas and has a more chemical engineering and material science character.. A good example of this kind of approach is found in nature; all cells use enzymes to produce DNA by taking the component molecules and binding them together to make the final structure. Chemical synthesis, self-assembly, and molecular fabrication are all examples of bottom-up techniques. Self-assembly occurs when little manipulation occurs, but components spontaneously come together to form ordered nanoscale structures, for instancein the formation of nanotubes and some monolayers

Advantage of nanotechnology for computer science

Nanotechnology is already being used in a variety of computing, communication, and other electronic applications to produce quicker, smaller, and more portable systems capable of managing and storing ever-increasing amounts of data. Nanotechnology has aided computer science in a variety of ways, including enhancing the efficiency of computer processors and insuring the continuation of MOORE'S LAW, among other things. In order to generate the intended final result, a billion (or trillion) tiny particles, whether complicated molecules or miniature machinery, must all cooperate and collaborate. None will have, individually, sufficient computing power to enable complex programming. Like the growth of crystals, the development of embryos, or the intelligent behaviour of ants, bottom-up nanotechnology must be achieved through collective, emergent behaviours, arising through simple interactions amongst itself andits environment. Computer science, and especially fields of research such as swarm intelligence, will be critical for the future of bottom-up nanotech. Nanotechnology is already in use in many computing, communications, and other electronics applicationsto provide faster, smaller, and more portable systems that can manage and store larger and larger amounts of information. These continuously evolving applications include:

1. Nanoscale transistors that are quicker, more powerful, and more energy-efficient; your computer's whole memory could be stored on a single tiny chip in the near future.

2.Magnetic random access memory (MRAM) enabled by nanometer-scale magnetic tunnel junctions that can quickly and effectively save even encrypteddata during a system shutdown or crash, enable resume-play features, and gather vehicle accident data.

3.Displays for many new TVs, laptop computers, cell phones, digital cameras, and other devices incorporate nanostructured polymer films known as organic light-emitting diodes, or OLEDs. OLED screens offer brighter images in a flat format, as well as wider viewing angles, lighter weight, better picture density, lower power consumption, and longer lifetimes.

Conclusion

The emerging fields of nano science and nano engineering are enabling unprecedented comprehension and control over the fundamental building blocks of all physical things.

Because nanotechnology is so small, it will be able to vastly improve scientific exploration. The current trends and future development will result in massive contribution in the field of computing. Nanoscience and nanoscale manufacturing will enable us to go beyond our natural size limitations

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and work directly at the building blocks of matter, where properties are defined and can be changed. Combining the present technology with the staggering potential of nanotechnology to forge devices from the smallest building blocks we are certainly on the verge of a revolution in the way we sense and control the physical world around us. This is likely to change the way almost everything –from vaccines to computers to automobiles tyres to objects not yet imagined –is designed and made.

References

1. K. E. Drexler, 1986. Engines of Creation: the coming era of nanotechnology. Anchor Press.
2. K.E. Drexler, C. Peterson and G. Pergamit, 1991. Unbounding the Future: the Nanotechnology Revolution
3. Y. Cui, L. J. Lauhon, M. S. Gudiksen, J. Wang, and C. M. Lieber, "Di-ameter-controlled synthesis of single crystal silicon nanowires,"Appl.Phys. Lett., vol. 78, no. 15, pp. 2214–2216, 2001
4. www.nano.gov
5. Alexander Coronado,"Review of quantum wires and dots in nanotechnology", 2605672 EEE-5425, Introduction to Nanotechnology Spring 2013.
6. International Journal of Emerging Sciences ISSN: 2222-4254 1(1) April 2011
7. M. Ippoliti *et al.*, "Many-body physics in the NISQ era: Quantum programming a discrete time crystal," **PRX Quantum 2, 030346 (2021)**.
8. X. Mi *et al.*, "Observation of time-crystalline Eigenstate order on a quantum processor,"
9. J. Randall *et al.*, "Observation of a many-body-localized discrete time crystal with a programmable spin-based quantum simulator,"