

Nano Technology for Computer Science: Scope and Opportunities

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Abstract

Nanotechnology is now a days strengthening its roots in the field of computer science by contributing in the creation of more efficient computing components .Nanotechnology has been developed in several fields of studies including, material science, engineering , chemistry, physics, biology and computer science as well .Novel nano materials and nano devices are fabricated and controlled by nanotechnology tools and techniques, This paper shows how these nanotechnology tools and devices can be used to benefit Information technology Industry and we look for the needs and chances of nanotechnology research in computer science. Nano technology in computer science is named as Nano computing .which is divided into categories- Electronic Nano computing, Mechanical Nano computing, Chemical Nano computing, Quantum Nano computing etc. The application and use of nano materials in electronic devices, in optical and magnetic components are the economically most important parts of the nanotechnology permeate the design of artefacts at nowadays and likely in the near future . Advances in technology repeatedly allow software to lower and lower levels. This occurred long ago with microprogramming, when computers were stand-alone; more recently it occurred with programmable networks (e.g. routers); it is now occurring with wireless networks. Nanotechnology will lead to a new dramatic step of this kind. Although it will include applications that require little computational input, it will also provide opportunities for exploitation that involve complex computational interactions among structured populations of nanoscopic agents. The more sophisticated

these structures and interactions, the more computer science (CS) research will be involved. 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. A new style of technology is introduced, which assembles individual atoms or molecules into a refined product. This technology is termed as *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. Such research is wide ranging and includes: software engineering, networking, internet security, image processing, virtual reality, human machine interface, artificial intelligence, and intelligent systems. Most work focuses on the development of fast computing components. The nanometer level new devices, methods of assembly, and architectures are being investigated. The crossbar, an old idea, is expected to play a prominent role in these new developments; its regular structure is well suited to nanotechnology-based assembly. . It is not an attempt to violate any laws; it is something, in principle, that can be done.

1. Introduction

Today a computer can be carried with one hand – 40 years ago a computer (hundreds of times slower) was the size of a room. Miniaturization of microprocessors is currently in process at nanometre-scales [3]. Yet, 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 *bulk or top-down technology* [1]. As conventional methods to miniaturise the size of transistors in silicon microprocessor chips will soon reach its limit² and the modification of today's top-down technology to produce nano scale structures is difficult and expensive [3], 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 [1]. This Drexler terms *molecular technology* or *bottom-up technology*[1]. 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. Moors law also states that CPU is doubled in performance every 18 months The feature size for device in a semiconductor chip is decreasing by a factor of 2 every one and a half year . 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 to overcome from this problem, the answer is nanotechnology. Today Nanotechnology in computer science has an important role.

2. Literature Review

In 1959, Richard Feynman, a future Nobel Laureate, gave a visionary talk entitled "There's Plenty of Room at the Bottom"¹ on miniaturization to nanometre-scales. Later, the work of Drexler [1,2] also gave futuristic visions of nanotechnology. Feynman and Drexler's visions inspired many researchers in physics, material science, chemistry, biology. Microprocessor is the CPU (Central processing unit) of the computer which controls the memory, input/output devices, and overall operation in the computer. OR It is the central processing unit built on single IC. Evolution of Microprocessor Fairchild Semiconductor (founded in 1957) invented the first IC in 1959. INTEL 4004 It is the first microprocessor of INTEL. It was introduced in 1971. it was a 4 bit microprocessor, after that the number of transistors in increases according to the moors law and today we have processors like I 5 and I 7 which 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. During the 1970s, widely different methods began to be seen as part of a new emerging discipline of *computational chemistry*.¹ The *Journal of Computational Chemistry* was first published in 1980. Computational chemistry has featured in a number of Nobel Prize awards, most notably in 1998 and 2013.

3. Development in Nano Technology

A nano computer is a computer whose physical dimensions are microscopic. The field of nano computing is part of the emerging field of nano technology . Several types of nano computers have been suggested or proposed by researchers and futurists Computers. Following are the 4 categories of nano computing –

3.1. Electronic Nanocomputers

Electronic nano computers would operate in a manner similar to the way present-day microcomputers work. The main difference is one of physical scale. More and more transistor s are squeezed into silicon chips with each passing year; witness the evolution of integrated circuits (IC s) capable of ever-increasing storage capacity and processing power. The ultimate limit to the number of transistors per unit volume is imposed by the atomic structure of matter. Most engineers agree that technology has not yet come close to pushing this limit. In the electronic sense, the term nano computer is relative. By 1970s standards, today's ordinary microprocessors might be called nano devices.

3.2. Chemical Nanocomputers

Chemical nano computers would store and process information in terms of chemical structures and interactions. Biochemical nano computers already exist in nature; they are manifest in all living things. The development of a true chemical nano computer will likely proceed along lines similar to genetic engineering. Engineers must figure out how to get individual atoms and molecules to perform controllable calculations and data storage tasks.

3.3. Quantum Nanocomputing

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 physical system 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 polarisations 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 *both* in 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 qubits can store in a given moment of time all eight numbers in a quantum superposition.

3.4. Mechanical Nanocomputing

Mechanical computers depend on millions of microscopic moving parts instead of solid-state transistors and other components to push the electrons to perform calculations. Gates, pillars, levers, and pistons create the binary switches, which compute the ones and zeroes that drive modern computers. Because they are more rugged and can perform at much higher temperatures than 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.

3.5. Nanorobots

One vision of a nano assembler or nano robot is a device with robotic arms, motors, sensors and computer to control the behavior, all at the scale of nano meters. In 1992, the book called “Nanosystem” by Drexler gives an analysis of the feasibility of machine components for such nano robots [24]. However, even to build a molecular motor, researchers have to consider laws of thermodynamics when motors are actually in operation [25]. Just building a miniature version of an ordinary motor is not adequate. Recently, a controversy arose surrounding Feynman’s vision of nano robots. In 2003, an open debate through letters between K. E. Drexler and R. E. Smalley (who was awarded a Nobel Prize for the discovery of fullerenes) was presented to public²². Smalley was not convinced that such molecular assemblers envisioned by Drexler are physically possible, while Drexler insists on his previous findings. Certainly, the study of similarly-sized biological machines – organic cells – suggests there may be more effective alternatives to Drexler’s nano robots. Even if nano robots can be realised, they will not be available in the near future.

4. Benefits of nanotechnology for computer science

Nanotechnology has benefited computer science in many ways such as by increasing the efficiency of computer processors, by ensuring the continuity of MOORE'S LAW etc. A billion (or trillion) tiny particles, whether complex molecules or miniature machines, must all cooperate and collaborate in order to produce the desired end result. 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 and its 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 applications to provide faster, smaller, and more portable systems that can manage and store larger and larger amounts of information. These continuously evolving applications include:

- Nano scale transistors that are faster, more powerful, and increasingly energy-efficient; soon your computer's entire memory may be stored on a single tiny chip.
- Magnetic random access memory (MRAM) enabled by nanometer-scale magnetic tunnel junctions that can quickly and effectively save even encrypted data during a system shutdown or crash, enable resume-play features, and gather vehicle accident data.
- 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.

5. Conclusion

The emerging fields of nano science and nano engineering are leading to unprecedented understanding and control over the fundamental building blocks of all physical things. Mechanical devices allowed us to reach beyond our physical strength and advance into technical civilization. Nanoscience and nanoscale manufacturing will allow us to reach beyond our natural size limitation, 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] T. Rueckes, K. Kim, E. Joselevich, G. Y. Tseng, C.-L. Cheung, and C.M. Lieber, "Carbon nanotube based nonvolatile random access memory for molecular computing," *Science*, vol. 289, pp. 94–97, 2000.
- [4] C. Dekker, "Carbon nanotubes as molecular quantum wires," *Phys.Today*, pp. 22–28, May 1999
- [5] Y. Cui, L. J. Lauhon, M. S. Gudiksen, J. Wang, and C. M. Lieber, "Di-iameter-controlled synthesis of single crystal silicon nanowires," *Appl.Phys. Lett.*, vol. 78, no. 15, pp. 2214–2216, 2001