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Recent Advancements in DNA Computing

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Abstract - Generally,the computer systems are made up of silicon-based computer technologies. In DNA computing, it is based on the computing techniques of DNA, biochemistry and molecular biology, instead of traditional silicon-based computer technology. Initially,Adleman computed an experiment which instances the Hamiltonian path problem with DNA test tubes in 1994. Then he computed further research on computation with molecular means in theoretical computer science. DNA computing has vast parallelism and high-density storage to solve many problems. Also, DNA has explored as an excellent material and a fundamental building block for developing large scale nanostructures, constructing individual nanomechanical devices, and performing computations. The input and output information will be in the molecular form which is demonstrated by molecular-scale autonomous programmable computers. This paper deals with the review of future advancements in DNA computing and challenges for researchers in future.

Keywords: DNA Computing, Hamiltonian Path Problem, Evolutionary Computing, Nanostructure, Nanomechanical Devices.

I. INTRODUCTION

The conventional silicon based computers are having upper limit in terms of speed. In this type of computers, the necessary information was encoded binaurally and the code words generated were carried by a sequence of high voltage and low voltage. This was the phenomenal beginning of the expansion of computers.

The revolution of these computers supports lot of innovation. But there was no change in the idea of storing and modifying data by electric means in practice. So, there is a need for an alternative media instead of electric means to store, modify and to solve computational problems. The search for the alternative media led to DNA.DNA computing is a technique for solving computational problems with biological and chemical operations on DNA strand by Adleman [1]. Since then more researchers are persuaded by the promising future of this area.

II.THE PROCESS OF DNA

For all living things, DNA is a fundamental storage medium. Hence, it is considered as one of the main building block of the living things. The role of DNA is to absorb or transmit data of life for billion years. A size of marble could fit for approximately 10 trillion DNA molecules. Since all this molecules can process data simultaneously, a small space is enough for 10 trillion calculations at once [5]. Assume DNA as a software and enzyme as hardware, and put it into a test tube together. These molecules undergo with certain chemical reaction in which it allows simple operations to be performed as a byproduct of the reactions. The composition of the DNA software molecules can be controlled and device functionalities can be explained by the scientists [5]. In a conventional computer, there will be pushing of electron in dry circuit which is completely different approach. No mechanical devices are used. To a naked eye, the DNA computer can be seen as like a clear water solution in a test tube. A single drop of water could hold a trillion bio-molecular devices. Based on the length of the DNA output molecule, the results are analyzed by using the techniques of the scientist. There will be no computer screen for showing up the result.

III.SILICON BASED TECHNOLOGY LIMITATIONS

The computer processing power [2] will be doubled after every 12 months which follows a rule of Moore's law. By decreasing the size of transistor and increasing the number of processor, the processing power will be achieved. But in coming years the size is reduced and constructs them with atoms. The transmission of information will have effect in their size. So the silicon based computer is limited in the lower size. Also, silicon based computer chips are made of toxic components. These types of computers waste lots energy in the form of heat they generate and energy they consume.

IV.DNA COMPUTING

DNA molecule consists of double helix structure which is composed of two sugar phosphate backbones formed by polymerization of deoxy-ribose sugar. The two backbones are placed as pairs of nucleotides such as Adenine, Cytosine, Guanine and Thymine. To performcomputing operations the DNA computers using single strands of DNA [3].

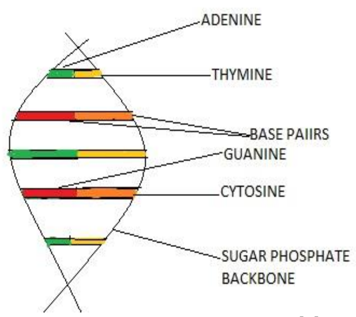

Figure 1: DNA Model

The main focus of DNA computing is to use massive parallelism, and the allocation of tiny portion of a computer task to many different processing elements. DNA structure allows the problem of elements to be represented in the analogous to the binary code structure form [1]. All the possible solution to a problem can be represented by trillions of unique strands of DNA. Some scientists predicted that in future, our bodies are patrolled by tiny DNA computers that monitor our well being and release the right drugs to repair damages or unhealthy tissue.

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V.HAMILTONIAN PATH PROBLEM

The first breakthrough in DNA computing occurred in 1994, when Adleman use DNA computing to solve the travelling salesman problem [1] which is also known as Hamiltonian path problem. In this Hamiltonian path problem, a fixed number of bridges are connected each other to a series of town. A salesman have to find a shortest path to reach his destination along with he have to visit all the towns between the source to destination. When the number of town is small, the problem can be easily solved by figuring out all the possible combinations. If the number of town value is increased, then there will be too many possible paths will be generated. So the need of computer will arise. Anyway, even with a computer a Hamiltonian path problem can easily become too complicated to solve [2].

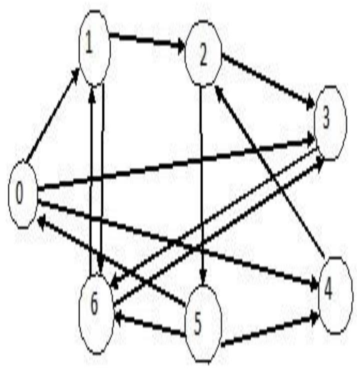

Figure 2: Hamiltonian Path Problem

Even though Adleman's seven city Hamiltonian path problem solution was relatively straight forward whereas all the possible routes amount of time were written by hand, his experiment showed that DNA could be useful as a computational tool.

VI.DNA BENEFITS IN COMPUTING

Massive Parallelism: The small amount of water consists of 1022 molecules. Therefore, there will be more parallel processes and there will many operation steps can be performed in a single unit time. Hence, biological computation could have vast parallelism than computational ones [6]. Storage capacity: DNA computers provide extremely large and dense information storage. For example, one gram of DNA can approximately occupy the volume of one cubic centimeter which is fit for the information stored in one trillion CDs.

Extremely low power squandering: DNA computers can perform 2*1019 (irreversible) operations per joule. But existing latest supercomputers can execute maximum of 109 operations per joule. Clean, cheap and available: DNA computer performance can easily found by its characteristics like clean, cheap and available. It does not produce any harmful material and no pollution will be generated by DNA computer. Therefore it is clean. DNA can be easily found in nature while it is not necessary to exploit mines. S. it is very cheap and available.

VII.FUTURE ENHANCEMENT ANALYSIS AND CHALLENGES FOR RESEARCHERS IN DNA COMPUTING

Research in DNA computing currently does not suggest that DNA computer will provide a successor to silicon within the next few decades. Another form of DNA chip is used by scientists in their research for self treatment of diseases. DNA computing technology can take some more time for the traditional sense may be for pipedream, and application areas to be covered. It is possible to be integrated with traditional approaches to create DNA/silicon hybrid architecture or within software.

DNA computers can produce a result of output with minimum human interference which reduces the time. Currently, researchers developing genetic "Computer Program" through which it could be introduced and replicated by living cells in order to control their processing [4]. DNA computing area is extremely at the beginning stage of the development. For example, Georgia Tech researchers have been used leech neurons to perform mathematical operations. Besides, other researchers managed to establish a link for the brain of the lamprey eel to robot for the purpose of controlling it. The ability of a brain is already shown to process information from the surrounding environment and direct the movements robot's in response to the stimuli [7].

VIII. CONCLUSION

In this paper, the current technology available in DNA computing research field is reviewed. It is very new research area which brings the attention from both biologists and computer scientists. DNA computing possibilities were proved by some biological experiments. DNA operations are highly parallel in characteristics, the corresponding DNA algorithms scale well in the sizeof the problem. Therefore, DNA computing proves the advantages potentially in solving hard problems. Also, the characteristics of DNA computing satisfy the "Green Revolution" concept in which it saves lots of energy, low power squandering and so on. It creates more opportunities for expanding, manipulating operations and to solve real applications exclusively in industrial engineering and management engineering. As a conclusion, DNA computing is one of the newest and exciting platforms to be explored by the researchers.

REFERENCES

[1] Adleman, L.M. 1994, "Molecular computation of solution to combinatorial problems. Science 266(11):1021-1024.
[2] A.Narayanan and S.Zorbalas, 1998, "DNA algorithm for computing shortest paths, Proc.of the Genetic Programming", Morgan Kaufman, p p. 718-723.
[3] Adleman.L.M. 1996, "On constructing a Molecular computer".
[4] Will Ryu, 2002, "DNA Computing: A Primer", ArsTechnica,
[5] Seeman NC, 2003, "DNA in a material world", Nature 427-431.
[6] Olympus TechnoZone, Nanotechnology will drive the evolution of the DNA molecule as functional components", http://www. olypus.co.ip/en /magazine/TechZone /Vol54e/page5.htmlZingel, T. 2000. Formal Models of DNA Computing: A survey. Proc. Estonian Acad. Science, Physics, Maths., 49, 2,90-99.