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DNA Computing and Recent Developments

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Abstract:-DNA computing is a type of computational technology that uses DNA, biochemistry and molecular biology, in place of the fixed silicon-based chips. The emphasis of DNA computing lies in the fact that DNA molecules can store huge information than any existing conventional computer chip. DNA computing use different techniques for computational analysis. Research and growth in this area concerns theory, practicals, and applications of DNA computing. This paper reviews DNA computing, also known as molecular computing is a new approach to especially parallel computation and recent developments in DNA computing.

Index Term- DNA Computing, Encryption, Security, Quantum Computing

I. INTRODUCTION

DNA is a small molecule that encodes genetic information which is very essential for execution and growth of all organisms. DNA stands for Deoxyribo Nucleic Acid. DNA is a polymer made of monomers called deoxyribo nucleotides. every nucleotide consists of three main parts: deoxyribose sugar, phosphate group and a nitrogenous base. The nitrogenous bases are Adenine, Guanine, Cytosine and Thymine(AGCT). DNA seems as a double helix which is formed by base pairs attached to a sugar-phosphate backbone.

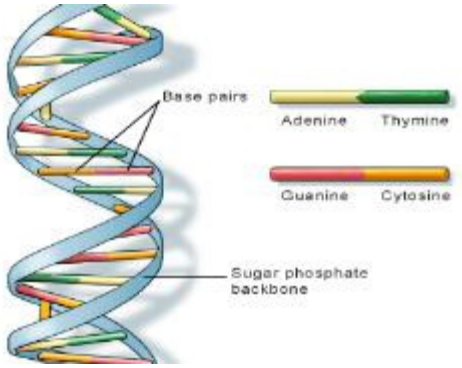

Figure 1: Molecular structure of DNA[11].

ADVANTAGES OF DNA COMPUTING

Preventability: Adleman realized that strands of DNA behave much like mathematical equations. DNA's chemical bases-adenine, thymine, and cystosine, and guanine hook up in a conventional manner. Adenine always links with thymine and guanine with cytosine. As regularity of pattern Adleman hypothesized that he can use molecules to process data the same way PCs use microprocessors.

DNA directions: Adleman performed a series of biochemical experiments to remove the wrong answers—strands encoding routes that either started or ended in the wrong town those that visited a town more than once, and so on. When almost all the wrong answers had been destroyed, Adleman looked under the microscope and found only strands that carried the right answers.

Very Cheap and Clean: DNA is an amazing technique to store information. A single gram of genetic material, which can reside in about one cubic centimeter, has potential to hold as much information as 1 trillion CDs, according to Adleman. It is also clean because people do not use any dangerous material to produce it and also no pollution generates.

Parallelism: Adleman proves that DNA has many strands and each one can work paralley without creating disturbance with each other. The speed of any computer can be find out by two ways: (i) how many parallel processes it has; (ii) how many steps can perform per unit time. Thus, biological computations have very much parallelism than conventional ones."

Half-hour test **:**The first practical applications are also emerging. In 2002 Olympus optical company and the university, TOKYO claims to have jointly develop a fast way identifying genes linked with diseases. Researchers there developed a method that can synthesize around 10,000 different DNA strands which are known to bond with genes related to specific diseases such as cancer. The strands are

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numbered and mixed with fluid containing genes extracted from the patient.

Low Power Dissipation: The potential of DNA-based computation lies in the fact that DNA has a gigantic memory capacity and also in the fact that the biochemical operations dissipate so little energy.

DISADVANTAGES OF DNA COMPUTING

Occasionally Slow: The speed of each process in DNA Computing is still an open issue until now. Adleman took 7 days of lab work to perform his experiment . Adleman asserts that the time required for an entire computation should grow linearly with the size of the input graph. Which remains is true as long as the creation of each edge does not require a separate process.

Hydrolysis: The DNA molecules can fracture. DNA molecules can break – meaning a DNA molecule, which was a part of the computer, is fracture by time. DNA can get worse. As time goes by, your DNA computer may start to dissolve. DNA can possibly get damaged while it waits around in solutions and the manipulations of DNA are prone to error.

Information Untransmittable: DNA computer is concerned as a highly parallel computer, because each DNA molecule act as a separate process. Standard multiprocessor has connection buses that transmit information from one processor to the next. However the problem of transmitting information from one molecule to another in a DNA computer has yet to be solved by the research community. Recent DNA algorithms compute effectively without passing any information, but this process limits their flexibility.

APPLICATIONS OF DNA COMPUTER

Massively Parallel Processing: The most important advantage offered by most proposed models of DNA computation is the ability to handle millions of operations in parallel. The parallel processing capabilities of DNA computers can be designed to offer the potential to find tractable solutions to intractable problems which are impossible to solve by the traditional systems, as well as potentially speeding up large polynomial time problems(NP-Complete) requiring relatively few operations.

DNA2DNA: Another area of DNA computation exists where conventional computers clearly have no current capacity to compete. DNA2DNA computations use the DNA computers for performing massive parallel operations on unidentified pieces of DNA without having to sequence them first. It is achieve by re-coding and amplifying unknown strands into a redundant form so that they can be operated on according to techniques similar to those used in the sticker model of DNA computation.

DNA BASED CRYPTOGRAPHY

Cryptography is the technique that deals with all the aspects of privacy, confidentiality, key exchange, authentication and non-reputation for the safe and secured communication over an unsafe channel. As stated before, DNA enables a good base to protect data and the method is called as DNA cryptography. In this technique, by utilizing one of the bases of nucleotides sequences(ATCG), the plain text is encoded into the form of DNA strands. Pure DNA acquired from the biological theory can be rearranged using different unusual bases which would enable consecutive processing.

II. RELATED WORK

Grasha Jascob, et. al[1], The Internet is a universal and inexpensive communications network suited for e-commerce and medical image communications. Security has become a major issue as data communication channels can be intruded by intruders during transmission. Though, different methods have been proposed and used to protect the transmission of data from illegal and unauthorized access, code breakers have come up with various methods to crack them.
Based on their research work, they concludes that the DNA based encryption helps in the secure transmission of such confidential images.

Grasha Jacob, et. al[2] With the growth of technological advancements, the threats deal by a user exponentially. Hence security has become a critical issue in data storage and transmission. The author conclude that the DNA binary strands support feasibility and applicability of DNA-based Cryptography. The security and the performance of the DNA based cryptographic algorithms are satisfactory for multi-level security applications of today's network. Certain DNA algorithms can resist exhaustive attack, statistical attack and differential attack. DNA Cipher is the beneficial supplement to the existing mathematical cipher.
Amish S Desai, et al[5], As XML becomes a standard for disseminating data on the internet, applications disseminating XML data on the internet are rapidly increasing, so flow of XML data on the internet could breach the privacy of data providers unless access to the disseminated XML data is carefullycontrolled. The methods using encryption have been proposed for such access control. Based upon their research work they conclude that DNA in

connection to cryptography is a fast developing interdisciplinary area. The Proposed method adds some artificial features to make the resulting cipher texts difficult to break. The theoretical analysis shows that this method is powerful against certain attacks, especially against flooding and men-in-middle attacks.

Asha Cherian, et al[6], The relevance of information security in the modern days has increased manifold as online threats are affecting millions of users. The traditional methods of cryptography are now defenseless to attacks. The idea of DNA based Cryptography has been identified as a feasible and effective methodology to create nonintrusive algorithms. Encoding or encrypting information using DNA sequences can be performed by DNA Cryptography. This can be implemented using DNA technologies with the help of different biochemical processes. Conventionally DNA Cryptography is realized using biological implements.
Komal Kumbharkar, et. al[7], The biological research in the field of information technology paves the exploitation of storing capabilities, parallelism and also in conservative cryptography which enhances the security features for data transmission. DNA is the gene information which encodes information of all living beings.Based upon their research work they conclude that in this paper, a review on DNA computing and DNA based Cryptography is presented. DNA encryption techniques are also described. This technology is far away from the actual realization because biological problems related to DNA cryptography can be performed only in lab with biological tools and methods.

Kritika Gupta, et. al[8], Today, information has become very important resource and so is its security. Many traditional mathematical algorithms have been developed for encrypting the information or data for security purposes but they have limitations. DNA encryption, on the other hand, is much more effective as it has got much more storage and computing capabilities. DNA encryption comes from DNA computing, initiated with the idea of "computing using DNA not on DNA".
Based upon their research work they conclude that Encryption can be applied before or after authentication to maintain data confidentiality and data integrity so that no one other than the intended receiver can read or modify the data.

Er.Ranu Soni, et. al[3], DNA cryptography is a new instinctive cryptographic field emerged with the research of DNAcomputing, in which DNA is used as information shipper and the modern biological technology is used as accomplishment tool. The speculative study and implementation shows method to beefficient in computation, storage and transmission and it is very powerful against certain attacks. The contemporary main difficulty of DNA cryptography is the lack of effective protected theoryand simple achievable method.
An author concludes that the symmetric OTP DNA algorithm based on Java Cryptography Architecture was first tested. The purpose is to compare the time required to complete the encryption/ decryption in the case of the DNA Cipher with the time required by other classical encryption algorithms.

III. CONCLUSIONS

The 21st century is a period of information explosion in which information has become a very important strategic resource. The task of information security, in this century, has become increasingly important. Cryptography is the most important component part of the infrastructure of communication security and computer security. However, there are many latent defects in some of the classical cryptography technology of modern cryptography - such as RSA and DES algorithms - which have been broken by some attack programs. Some encryption technology can implement a trap door, helping attackers who understand this trap door the ability to decrypt this kind of encryption technology. This information demonstrates that modern cryptography encryption technology based on mathematical problems is not so reliable as before.

IV. FUTURE WORK

DNA computing, also known as molecular computing is a new approach to massively parallel computation. A DNA computer is basically a collection of specially selected DNA strands whose combinations will result in the solution to some problem, depending on the problem at hand. Technology is currently available to select the initial strands and even to filter the concluding solution. DNA chains have a very large scale of parallelism, and its computing speed can potentially reach about a billion times per second; second, the DNA molecule - as a carrier of data - has a large capacity. It seems that one trillion bits of binary data can be stored in one cubic decimeter of a DNA solution; third, a DNA molecular computer has low power consumption, only equal to one-billionth of a traditional computer. In future our research work is to create a DNA based XOR encryption method, the proposed encryption algorithm.

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