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Optical Computers: A New Era of High Speed Computing Based On Photons

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Abstract: ***In the present era of science, technology and engineering computers have facilitated our life up to the great extent. The computation speeds of computers have increased to astonish level. Research says speed of electron has attained their maximum speed and we reached at a stage that nothing could be further expected from electrons. According to Moore's Law states law in which the number of transistors on a computer chip doubles every eighteen months and speed will be increase with 2 times in every six months. We can easily see the fact about speed and number of transistor in today's computers. The Traditional transistors which are the building block of modern computers can no longer keep up, because too many transistors will slow down processor speeds and also transistors have physical size limits. Again metallic copper wires have their speed of transmission also resistance per unit length in the chip increased, causing more power usage and excess heating. An optical computer (also called a photonic computer) is a device that uses the photons in visible light or infrared (IR) beams, rather than electric current, to perform digital computations. They can perform operations 10 or more times faster than any conventional electronic computer. We can easily track electrons and also we can easily copy it but in optical computer exact location and speed can be calculated due to Heisenberg's Uncertainty Principle.***

Keywords: Photons, computing, high speed computing, optical computing, optical computers

1. Introduction

During the period of last 60 years many researchers have done to speed the computation power or computation speed. An electric current flows from one point to other point only about 10 percent of the speed of light, that's why there is limitation of speed in traditional computers There is also the limitation of rate at which data can be exchanged from one point to another point over long distances, and this is one of the factors that led to the evolution and concept of optical fiber. Using the advantages of IR (infrared) and/or visible networks at the device and component scale, a computer can be developed that can perform operations 10 or more times faster than a conventional digital electronic computer. Visible-light and IR beams pass through each other without interacting.

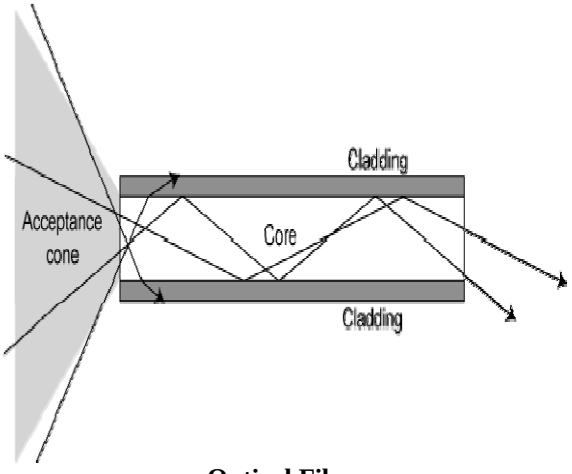
The term optical computing can be used for many different technologies, but basically it refers to computers that use light waves or more precisely photons rather that electricity or electron for computation. There are two different types of optical computers Electro-Optical Hybrid computers and Pure Optical computers. In Electro-Optical Hybrid computers optical fibers and electronics parts are used to read and direct data from the microprocessor processor. Light pulses are used instead of voltage. Processors change from binary code to light pulses using lasers and information is then detected and decoded electronically back into binary. Pure Optical Computers use multiple frequency of light wave. We know that light wave behaves like both electromagnetic waves and also particle which is photons, in optical computing we use particle property of light which is photons. Basic components of optical computers are:

- Optical Processor
- Optical Fiber
- Optical Transistor
- Constructive Transistor
- Destructive Transistor
- Optical Logic Gates
- Optical Switches
- Holographic Memory

Optical processor: - The first optical processor built is Lenslet's optical processor. It is combination of optics, silicon, communications and tools in standard board, software tools are allowed to smooth development path.

Optical processor

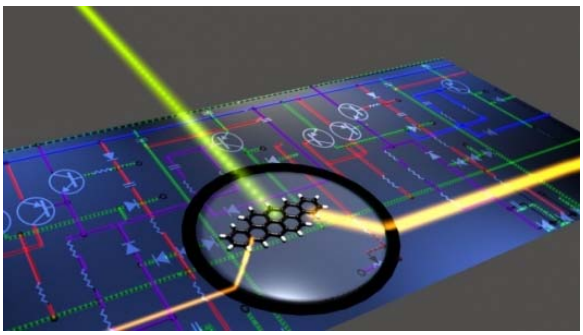
Optical fiber: - Optical fibers are used to send data from one point to another point with the help of photons. They work on the principle of total internal reflation.



Optical Fiber

They are small in size, there will be low transmission losses, there is no interference from radio frequencies, electromagnetic components, and crosstalk they are safe they are more secure and Environmental immunity

Optical Transistor: It is basically based on Fabry-Perot Interferometer. Constructive interference yields a high intensity (a 1 in binary). Destructive interference yields an intensity close to zero (a 0 in binary).

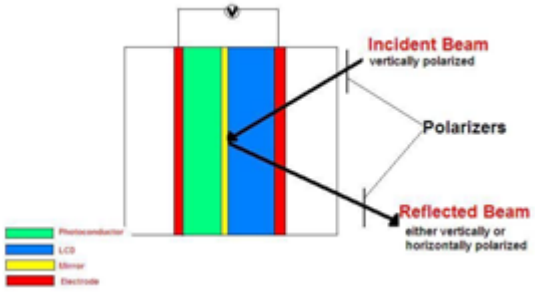


Optical Transistor

Constructive transistor – it construct the light beam which equivalent to 1.

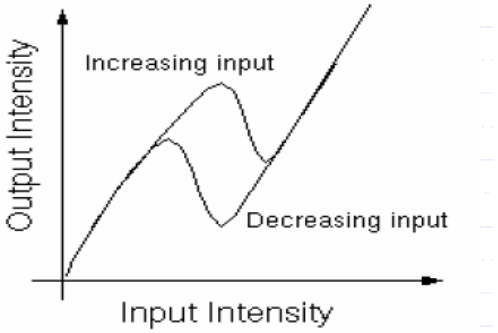
Destructive transistor- it destruct the light beam and it is equivalent to 0.

Digital Optical logic gates – it uses the principle of liquid crystal light valve (LCLV), and also uses liquid crystal device and photoconductor. They are programmable through application of write beam, causing the polarization of the reflected beam to change.



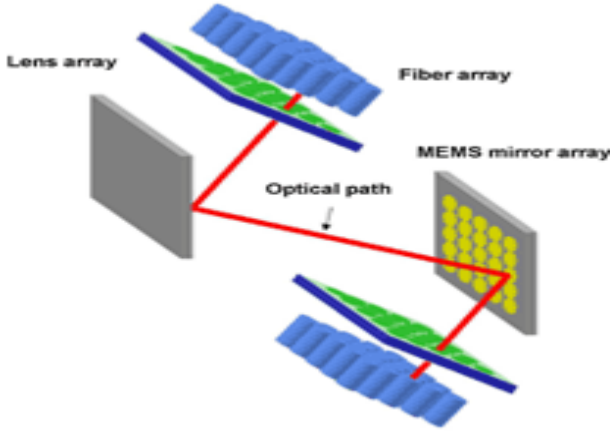
Electro-Opticall logic gates

Pure optical logic gates –they are Self-Electro-Optic Effect Device (SEED) by changing in voltage changes absorption properties in quantum well layers. They are Stackable, Small size, Low power, easily made Compatible with standard fabrication techniques for current logic gates.



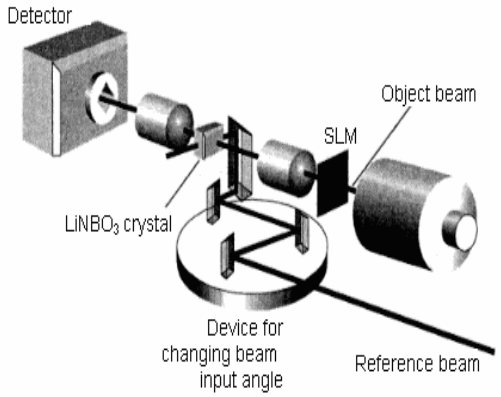
Graph of input photon intensity and output photon intensity

Optical switches - All optical logic gate based on Interference fringes, which the detector reads, and then sends the information through to the correct program. One of the switch made is Analog Gimbal-Mirror Switch they transmit direct light into higher number of ports without much loss of information. There will be no need to waste time converting from optical to digital. There is a problems include; tightly packed mirrors, mirror-control algorithm, fiber and lens arrays and mechanical packaging.



Optical switches

Holographic Memory- A holographic memory can store data in the form of a hologram within a crystal. A laser is split into a reference beam and a signal beam. Signal beam goes through the logic gate and receives information. The two beams then meet up again and interference pattern creates a hologram in the crystal.



Holographic Memory

2. Work Done Till Now

An English technology company dubbed Optalysys says that in January 2015, it will demonstrate prototype optical computers that perform calculation at high speed of light.

First germanium laser: - MIT researchers have demonstrated the first laser from germanium that can produce light waves for optical communication it is also the first germanium laser to operate at room temperature.

Researchers at MIT, Harvard and the Vienna University of Technology have developed a proof of concept optical switch that can be controlled by a single photon and is the

equivalent of a transistor in standard computers and have important repercussions for the development of an effective quantum computer.

Advantages f Optical Computers

- Higher performance
- Higher parallelism
- Less consumption
- Less heat is released
- Less noise
- More flexibility in layout
- Less loss in communication
- Less wear

Disadvantages of Optical Computers

- Optical components and their production is still expensive.
- Optical components are not miniaturized enough yet.
- Problems of exact manufacturing.
- New expensive high-tech factories have to be built.
- Incompatibility.

3. Application Areas

Photonics applications are in every aspect of our life of this modernized world. In every field of life we observe a vital contribution of photonic to make our life more comfort and reliable in our everyday used products, this was made possible by attributes of photons that yield efficiency, reliability and perfection at low cost, high speed and safety. [9].

In our everyday life, we interact with each other by using telecommunication techniques, we interact with hospitals their laser surgery endoscopy and a lot for, in military applications infrared sensors, command & control systems, navigation, search & rescue range and lot more in the fields of metrology, spectrometry all these things are blessing of photonics field. [9].

In short photonics could be regarded as booster for information and communication, data storage, Industrial manufacturing and ability, life science and lead it lightening and displays, security, metrology and sense, security and safety, transport, space, aeronautics rather every field of life have been boosted exponentially just due to photonics and those fields indexes its absent photonics would be soon redefining them as well, so that they could become more reliable .provides higher productivity and efficiency so that they could provide the need of upcoming times. [9].

Photonics is no longer an emerging field but a present reality with multiple products readily on the market. The progress in the field of communication was possible because of its optical interconnects other fields including optical data recording, optical fibers xerography based laser printing all such wonders of present time are the practical photonics.[6][9].

Photonics benefits also motivated NASA to replace electric components by photonic counter parts in spacecraft's due to their greater performance, high reliability and all the above quick delivery. Though same issues are face but are expected to be resolved as photonic research is progress. [11].

The Intel cooperation is also working on photonics; they have worked on silicon photonics and as aresult have produced the world fastest opto-integrated chip having a speed of encoding at the rate of 200 GB/sec. [10]. Infinera cooperation has also introduced new wave length division multiplexing wonder by photonics by making a 100GB/Sec WDM system which is first of its type in industry. It's a wonder which was achieved after integration over 50discrete optics devices capable of performing distinguishes operation. Infinera is also intended to launch 100GB Ethernet on the near future. [6]

If issue of application of photonics is there it everywhere where computers are or every place where computation is taking place in short our entire life. [9].

4. Conclusion

Although optical communication technology is very expensive, but it is fastest ever in entire invention. Our today's technology says it is not possible or feasible but in coming years it will dominate. The main reason behind development of optical computation is its high speed computation and transmission power. Also our traditional computer system has several limitations. It will stop at certain speed and processing, to go beyond it we have to use optical communication.

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