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The Future of Quantum World with Optical Computers

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ABSTRACT :-

In this era of paced technology, there is huge need to shift from this electronic era to the quantum era.

From the beginning of the century, SUN is the ultimate source of energy and computers are the indispensable part of the life in the technological world. The combination of these ultimate tools can create a magic to the whole world . Nowadays, computers deal with the electrical current on their functioning which can flow with the speed of only 10% the speed of the light. But in this technical era there is a strong need to increase the efficiency of the computers and them to be as fast as the speed of the light , and this need paves a way towards – OPTICAL COMPUTERS (THE FUTURE COMPUTERS).

INTRODUCTION :

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. The speed of light is only 10 percent of that of light. This limits the data flow over long distances and hence this led to the evolution of optical fibers. By applying some of the advantages of visible and/or IR networks at the device and component scale, a computer might someday be developed that can perform operations 10 or more times faster than a conventional electronic computer. Optical computing has been one of the most important areas of research for the past sixty years. The interest towards this started in the sixties with major ideas and discoveries opening a large number of opportunists. The period after 1980's could be called the golden age as various new inventions and applications of optical computing. Even today the optical computing is an important area of research.
So here in this paper we discuss the benefits and applications of optical computers.

KEYWORDS :

Optical computers, dynamic allocations, best efficiency.

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BACKGROUND:

The period 1980 to 2004 could be called the golden era of optical computing. There was a lot of interest in the field, there was sponsors for the programs on this topic and the research effort was very intensive worldwide. Many international societies organized several conferences on the subject related to optical computing. The journals had frequently a special issue on the topics and Applied Optics had every 10th of month an issue entitled “Information Processing”. The research was very fruitful in all the domains of optical information processing including theoretical work on algorithms, analog and digital computing, linear and nonlinear computing. Optical correlators for real applications were even commercialized. However, around 2000, we could feel that the interest for the subject started to decline. The reasons are many, but the evolution of digital computers in term of performance, power and also flexibility can be remarkable. They are also very easy to use even for a non-specialist.
It is impossible to list here all the progress carried out in this area from 1980 to 2004. Several books give the state of optical computers at the time of their publication.
In the following, we will describe only some aspects of optical computers. The purpose is to give to reader an idea of the evolution of the domain.

THE NEED FOR OPTICAL COMPUTERS:

The world has experienced a huge development in the field of computers since the last few decades. According to a research, the number of transistors in a computer doubles every year. But, the evolution of digital computing has almost reached its zenith as simply adding more numbers of transistors is not much improvements in the speed as data processing as the data handling process becomes much more complex.

The concept of optical computing can easily be used to solve this problem.

Optical computers, as the name suggests, can work at the speed of light.

In a typical digital computers , in a single processor , the given data is processed one by one ,i.e , in a serial mode. The common approach to increase the overall data processing speed is to add more number of processors in parallel so that the data can be given in parts to divide the work among all the processors . But this approach also increases the complexity in data handling. The collection of processed data from all the processors and then putting together all the pieces increase the time taken.[6]

But in case of optical computing methods such as Optalysys Optical Computing , the data processing is achieved in a single step.[7]

Photons , which are the main carriers in optical computing have an almost no-loss transmission and they can provide huge bandwidths , which greatly enhances multiplexing capacity for parallel communication channels without interference.

WHAT ARE OPTICAL COMPUTERS?

Optical computers are the device that uses the photons of the visible or infrared light, instead of electric current, to perform algorithmic calculations and digital computing. An optical computer can be able of processing the data up to 10,000 time faster than the current models because multiple operation can be performed simultaneously.

Optical computers where the way of processing of electrical energy can be replaced by the quantum packets of light is the very attractive future technology. The replacement of wires by optical fiber cable pathway is of special interest because light can cross without interference and thus, the complex wiring of the modern computers can be easily simplified. In addition to these things, optical computers can operate at very high rates as problems such as inductivities of wire will not be there.

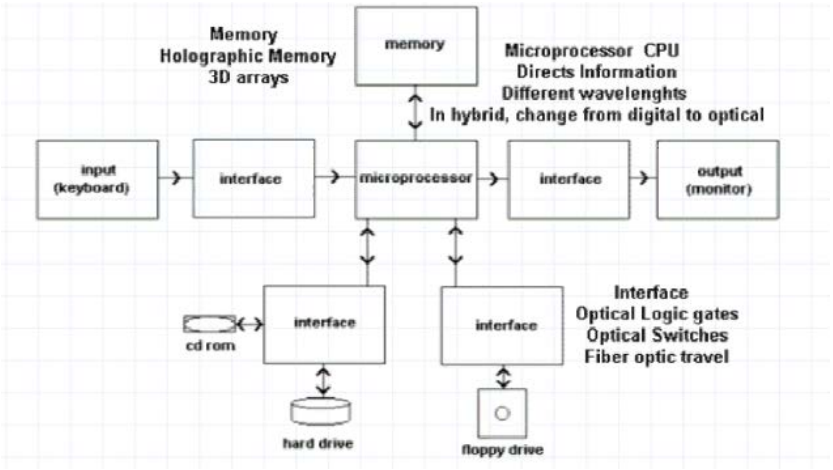
Optical computing paves a way towards the newer technological approach for developing new computer's processors and other components. Optical computing basically refers to do algorithmic calculations, performing computation, operations, storage and transmission of data using light. Silicon photonics use laser light for computation work Instead of the current approach of the electrically transmitting data along the tiny wires etched into silicon.

Visible and Infrared beams, can pass each other without any interaction unlike electric current. Electric current must be guided around each other, and this makes three dimensional wiring necessary. Thus, an optical computer , besides being much faster than an electronic one , might also be smaller.

Both analog as well as digital signals can be transmitted by the fiber optic system over the light waves. This system consists of a signal generator, an encoder, a fiber optic cable and a receiving device. Fiber optics have many advantages over copper cable. They have become a desired standard for networking backbones and hubs because of the advantages they have over copper to achieve the speed and bandwidth capacity. A single fiber optical cable can transmit the same amount of data as approximately 600 pair traditional copper telecommunications wire, an transmit data further with less boosting of the signal, it is not affected by electrical anomalies such as lightning, it is small, light weight and easy to install.

WORKING:

BLOCK DIAGRAM OF THE WORKING OF OPTICAL FIBER:--



OPTICAL COMPUTER BUS WITH DYNAMIC BANDWIDTH ALLOCATION:--

A signal communication device for use within a computer includes a set of optical fibers configured to form an optical computer bus between a set of computer sub-system elements of a computer. A set of optical input connector cards and set of optical fibers are connected to each other. Each of the input optical connector cards includes a transmitting dynamic bandwidth allocator responsive to an optical bus clock signal operating at a multiple of a computer system clock signal cycle. By dynamically assigning the bus time slot, the transmitting dynamic bandwidth allocator allows a light signal to be applied to the optical computer bus. In this way, the optical computer bus bandwidth can be dynamically allocated to the system.

WHY DON'T WE HAVE OPTICAL COMPUTERS YET?

In spite having a ton of advantages, still there is no practical use of this optical computers in the todays world. As we know photonic communication is much easier and efficient than the electronic communication. As we know that the photons have the ability to transfer data much quicker than electrons and as result signal fiber optic networks are emerging out to enhance the technological era with photonic speed. Yet electrons have some unique properties that light don't have at all. [1] The three important parameters that play an important role in this are size, power and heat. They are the parameters that have impended the photonic revolution for computing and hence there is an increment in the computer speed exponentially.

The major problem about this is that the maximum wavelength of light which is suitable for computing has been in infrared region (IR) about 1000nm in size [2], while improvements in silicon transistors have seen them reach and they are having tendency to pass the threshold value of 10 nanometers. As per the recent discovery to etch the silicon wafers the puzzled way to do it is to provide etching process in an efficient manner. To get rid of the size problem, SURFACE PLASMONS come into picture with enhances the efficiency of transmission by the electrons. In principle, electrons have been excited and made to move along the surface of the materials, exploiting the quantum philosophy to behave and travel more like a photonic particle than an electron.

When the range of communication is more than the speed of the communication signal matters a lot, so the first imagined computing application for photonics is in the relatively longer distance communication between processor cores. Nowadays, copper wire connects these superfast components. These wires allow them to work collectively in the efficient manner- but the communication between cores is starting to lag further behind the speed of any one of those cores individually. However even after having so much of advantages there is a major problem that plasmons loses there energy very fast. They can move very fast but still they tend to peter out long before reaching the destination, which is called as pump the wire into an active plasmonic components, this will help in keeping the wire in the state where the plasmons will not lose their energy as they pave their motion and all, which itself is practically very very difficult to achieve. Even after achieving these one major problem is ther that is heat. Both of this wavelength and power problems can be solved by surface plasmons and active plasmonic, but this overheating problem is still there and this is one of

the major problem to crack. It's still a bit way half between the electricity and photons. And this can be overcome by the involvement of the optical computers.

ADVANTAGES OF THE OPTICAL COMPUTERS :-

There are some issues with electronic medium which light can easily avoid

- Resistance of wires cause creation of heat- this heat is so much that without a thermal sensor on a microprocessor to shut down when it overheats, and a fan to cool it , it would vapourize in milliseconds. This limits how fast you can clock a processor. But light can avoid all these issues.
- Every wire or transistors has a certain inductance and capacitance- this causes a lag called propagation delay. As billions of transistors are stacked, the delays build up and pose extreme challenges for the chip designers. At the clock frequencies that current microprocessors run at, inductive effect become very powerful. It's not at all easy to increase clock speed much further.[3]
- Electricity is energy inefficient, it dissipates into heat and electromagnetic radiations. An optical signal can be send to 100 of kilometers without a repeater. An equivalent electric cable would be much larger, huger, heavier and require much more power.

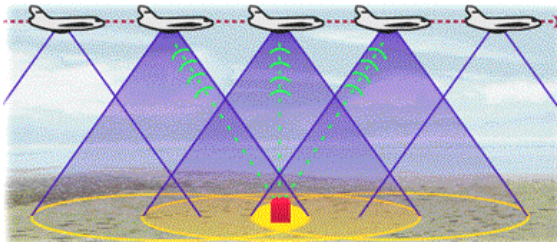
A purely photonic computer could probably be hundreds of times faster and hundreds of times more efficient than the electronic ones.

APPLICATIONS :

The field of photonics and optical computing has been fast emerging in the 21st century. Various applications of photonics is under research. Currently, very few applications have been established.

SYNTHETIC APERTURE RADAR (SAR)

This 21st century improvised RADAR has many advantages over the conventional RADAR. Firstly, it functions very well under all weather conditions. Additionally, it can be used irrespective of time of day. This major merit over the RADAR is due to the light independent sensors present in SAR system as opposed to its older counterpart.



The antennas of SAR are usually fixed onto any moving object such as an airplane or a satellite. It is known that a larger antenna gives an image of better resolution by combing the ideas of antenna theory and antenna phased array theory. In the making of SAR this physics

has been exploited. Instead of using one big antenna, a small antenna is fixed the body which as it travels gives images from different positions which essentially acts as multiple fixed antennas. This results in higher resolution images as the feedback for the antenna is from different angles of view. This also gives greater detail on the height and span of the object.

PARALLEL COMPUTING

Optical computers are best when used in parallel processing systems where the efficiency is mostly dependent on the speed of transmission between processors. This requirement is better satisfied by optical computers over conventional transistor based computers. Traditional parallel processing requires huge space for storing the computers. Over the years transistors have been shrinking in size but are now approaching the limit. The use of optical components can solve this issue as they can be made at much smaller sizes. As a result, we can reduce the required space or even increasing the number of processors in the given space further increasing the processing speeds.

REAL LIFE IMPACTS :

Primarily, as light travels at speeds of 3E8 m/s and electrons travel at speed of 2.8E8 m/s. This difference is speed basically means higher data transmission speeds. Also lesser energy is consumed as there is no resistance or energy loss during transmission through optical fibers.

In recent days the rise of optical fibers for data transmission has been seen. The data from computers are sent in the form of electric signals which are later converted to light signals and then converted back in to digital signals to be used by another machine. Also when the light signal is to be sent from the source, it must have the address of the destination for which it is made to pass a switch which converts the light to electric form. These several conversions between light to electric and vice versa consume a lot of energy. Optical Computing helps by reducing these conversions to a very minimal level i.e only at the repeaters. As the computing is done using optical signals which gives output in the same form, it is directly used for transmission through the optical cables. Hewlett Packard Labs developed a optical wafer with millions of lasers and has stated that the cost of making the photonic transceivers could be cut by 10. This shows that the expenses on computing around the world can be cut down a lot considering how much of the world relies on computing for almost everything.

CONCLUSION:

Optical computers can prove to be an asset to the technology and can frame a new dimension of the world.

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