Optical computers at speed of light

Simson F. Garfinkel / Special to The Post

OPTICAL computers are no longer an impossible dream. Recent advances in materials engineering and micromanufacturing have brought the possibility of optical computing much closer in the past few years. But what are optical computers and how do they differ from today's computers?

The goal of optical computing is to solve problems using light and optical devices, such as lenses, lasers, holographs and mirrors in place of electronic computers or manual calculations. Optical computers will be much faster than today's computers because light travels and can be switched many times faster than electricity. Today's primitive optical switches can already switch a signal over a hundred times faster than the quickest electronic switch.

Also, unlike electronic computers which can only execute one instruction at a time, optical computers will probably be parallel processors executing literally millions of instructions simultaneously. Inside an electronic computer, each signal must be guided by a small wire, but no physical device is required to guide a beam of light. This may make optical computers easier to design and manufacture and they will also be free of the electronic noise which plagues many of today's computers.

The U.S. Strategic Defence Initiative – "Star Wars" – has provided a great deal of motivation to recent work in this field. Many experts believe that any SDI system will have to rely on optical computing to achieve the performance and reliability required by such a defence project.

At a recent conference held at the Hebrew University's Givat Ram campus, over 150 scientists from around the world gathered to discuss the latest developments in this new scientific field. The conference, or to give it its full title, The International Optical Computing Conference, was organized by the Israel Laser and Electro-Optics Society and sponsored by the International Commission for Optics (ICO), the Optical Society of America (OCA), the International Society for Optical Engineering (SPIE) and the Institute of Electrical and Electronics Engineers (IEEE):

ACCORDING to Henri H. Arsenault, one of the speakers at the conference from the Universitie Laval in Quebec, Canada, symbolic processing is likely to be one of the significant differences between optical computers and today's present models. "This is a really big potential field for optical computers," he said, "because it is something you can't do well electronically." While electronic computers are very well suited to performing numerical calculations, they are not very good at performing symbolic manipulations.

Optical processing easily manipulates symbols, since symbols can be easily represented by small pictures, Arsenault continued. Symbolic processing, a field which includes natural language recognition, algebraic manipulation of mathematical equations and expert system design, is heavily used in artificial intelligence applications.

Many of the papers presented at the conference addressed the question of optical image recognition. If you look at the above sentence, it is very easy to pick out the letter "e". But for a computer this task of distinguishing an "e" from other letters is a very difficult and time consuming operation.

The majority of the papers discussed ways in which optical filters could be made which would be sensitive to a particular image, such as that of an aircraft. If a picture containing an aircraft and several other objects were passed through such a filter, the filtered image would be dark everywhere except at the point where the aircraft was in the original picture. At that point, there would be a bright spot.

Such an image filter could be used as the basis of a targeting system for an anti-aircraft missile. Although these filters exist today, they are not very reliable. Several papers discussed ways in which image filters can be made insensitive to the noise in the image, along with scale, rotation, size and contrast of the target.

Another exciting application of optical computing is the construction of large associative memories.

An associative memory is a computer memory that knows what is stored inside of itself. Most computer memories are like filing cabinets – you can only find out what is inside the memory if you know the name of the file, or where to look. But if you had a file cabinet built out of associative memories, you could place a photocopy of a letter on top of the cabinet and it would automatically open to the file containing the original.

One presentation demonstrated a holographic associative memory which had been used to record several photographs of faces. After the images had been recorded, a small fragment of one of the original faces – the eyes – was presented to the hologram. The hologram was able to instantly reconstruct the entire picture. Being able to match names with faces and recognizing faces from minor details are two major potential applications for associative memories.

Using a conventional computer system to perform the same task would require an extensive comparison of the fragment with each photograph in the computer's memory. The process could take hours, even for a very small set of photographs.

In a second presentation, Dr. George Eichmann from City College, New York University, stored in an associative memory the radar images of several aircraft and their identification numbers. He then later presented the memory with a fragment of a B52 radar signal and the memory output the letters "B52."

There are many other applications for associative memories, such as fingerprint identification, management of encyclopedic databases, and artificial intelligence.

EVEN THE most complicated electronic computers are built from a small number of simple electronic "building blocks." Several papers presented at the conference discussed ways in which these building blocks could be constructed from optical, rather than electronic, components. Such optical building blocks could be combined into a computer which only used light for its calculations. Such an optical computer would be a very fast analogue of an electronic computer but would not exploit the additional possibilities which optical computing promises.

Several scientists expressed their doubts about the feasibility or desirability of constructing such a fully "optical computer." The electronic computer technology is versatile, fast and cheap enough that optical computers are not needed, they said.

Rather than the construction of a fully optical computer, the next few years will probably see the substitution of particular electronic components with optical analogues. For example, wires used to connect computers over long distances are now being replaced with fibre optic cable, which can transmit signals faster and with less noise. One of optical processing's first applications, according to Peter Smith from Bell Communications Research Inc., New Jersey, will be to filter and preprocess information from fibre optics. Already, Smith continued, companies making fibre-optic based communication systems have reached the limit of processing speed capable with electronic components.

Classroom computers pass the screen test

Greer Fay Cashman / Special to The Jerusalem Post

(Centre for Technological Education)

Pupils in a Netivot classroom learn mathematics with the help of computers.

COMPUTERS in schools are becoming almost as familiar as classroom blackboards and chalk. To allay any possible apprehension on the part of the pupils, children are introduced to this new learning aid as soon as possible, even in the first grade.

There are also pre-school computer preparation programmes such as those developed by a team from kibbutzim in the Western Galilee. Alon Blitz of Kibbutz Hasolelim is one of the nucleus of this group of developers. He is that still rare combination of educator and computer programmer.

In a paper which he presented to the 18th international congress of the World Organization for Early Childhood Education in Jerusalem, Blitz noted that as with all subjects, expertise is not comprehensive. Educators are not always sufficiently knowledgeable about computers and what they can do to upgrade the standards of their pupils; and a good programmer is not automatically a good teacher.

Blitz and his colleagues are trained in both fields and for the past six months have been working through GTM Information Technologies Ltd., a subsidiary of Milouad, which is the computer services unit of Milouot, an industrial cooperative located near Acre and owned by 40 Western Galilee kibbutzim.

The software created by the team is marketed as Triple P (pre-school preparation programme) and is designed to help the child develop basic concepts and facilitate a learning readiness. In the first grade, he emphasized, children already have to deal with software contents – questions, exercises, typing. Their approach will be that much more positive if they are as familiar with the computer as they are with any other classroom furniture.

The motivation behind the Triple P series was an interest by its creators in using the advantages of the computer and combining them with the existing range of kindergarten activities. The idea was not to replace those activities but to complement them, using the computer as a play-to-learn tool.

- the computer works fast, can repeat itself indefinitely; has plenty of patience and does not get angry when dealing with mistakes.
- it offers unlimited use of software, unlike a colouring book, which once it has been filled in, is useless.
- unlike books, cards, crayons and building blocks, software can be stored compactly.
- children can develop a feeling of creative partnership with the computer by watching on the screen the step-by-step creation of every image. In colouring books and assignment cards, the outlines of objects, people and animals are already completed and the child is not given any comprehension of how they have been made.

Perhaps even more important is the fact that the computer enables a child to develop mental capabilities at his own natural pace, without fear of being reprimanded by a teacher. The computer provides immediate feedback when the child makes a mis-

Because the child receives the right answer automatically after making a mistake, there is no need to stop the work and wait for a teacher to explain where it was that he erred.

THE MAJOR advantage of Triple P for adults is that they don't have to learn a language before working with it because the use of the keyboard is minimal. The role of the adult is to choose an assignment from the menu list, which presumably the child of kindergarten age can't read. But after that, it's independent plain sailing for the child, who in using the system learns the concepts of shape, colour, size, quantity, direction and order. The child has a joy stick to play to learn.

With computers soon destined to be one of the basics of kindergarten equipment, an obvious question arises: will primary and secondary school teachers eventually become obsolete? Blitz responds with an emphatic "no." Nothing, he says, can replace the teacher. No computer can give more intellectual stimu-

ElectroInk: The sharper image

NEW WORLDS

uses less energy than other photocopy systems and is also faster.

Benny Landa of Indigo says that no other company has managed to perfect electronically responsive inks. The idea of fusing electronic imaging and printing ink was abandoned by everyone else in the field

with the idea, because it makes their presence (or more likely, absence) a matter of historical record, but apparently they felt they couldn't stand in the way of progress.

IT IS hoped that the keeping of systematic records on work acci-

The computer programme must respond to anyone's voice, regardless of peculiarities in pitch or pronunciation. In addition, the speaker should not have to pause between words or limit his vocabulary.

According to a software expert, continuous speech requires six to 10