R.J. Marks II, "Optical computing at the University of Washington", Laser Focus, pp.137-138, October 1989.

GLOBAL ELECTRO-OPTIC TECHNOLOGY AND MARKETS

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LASER FOCUS WORLD

October 1989

25 Years

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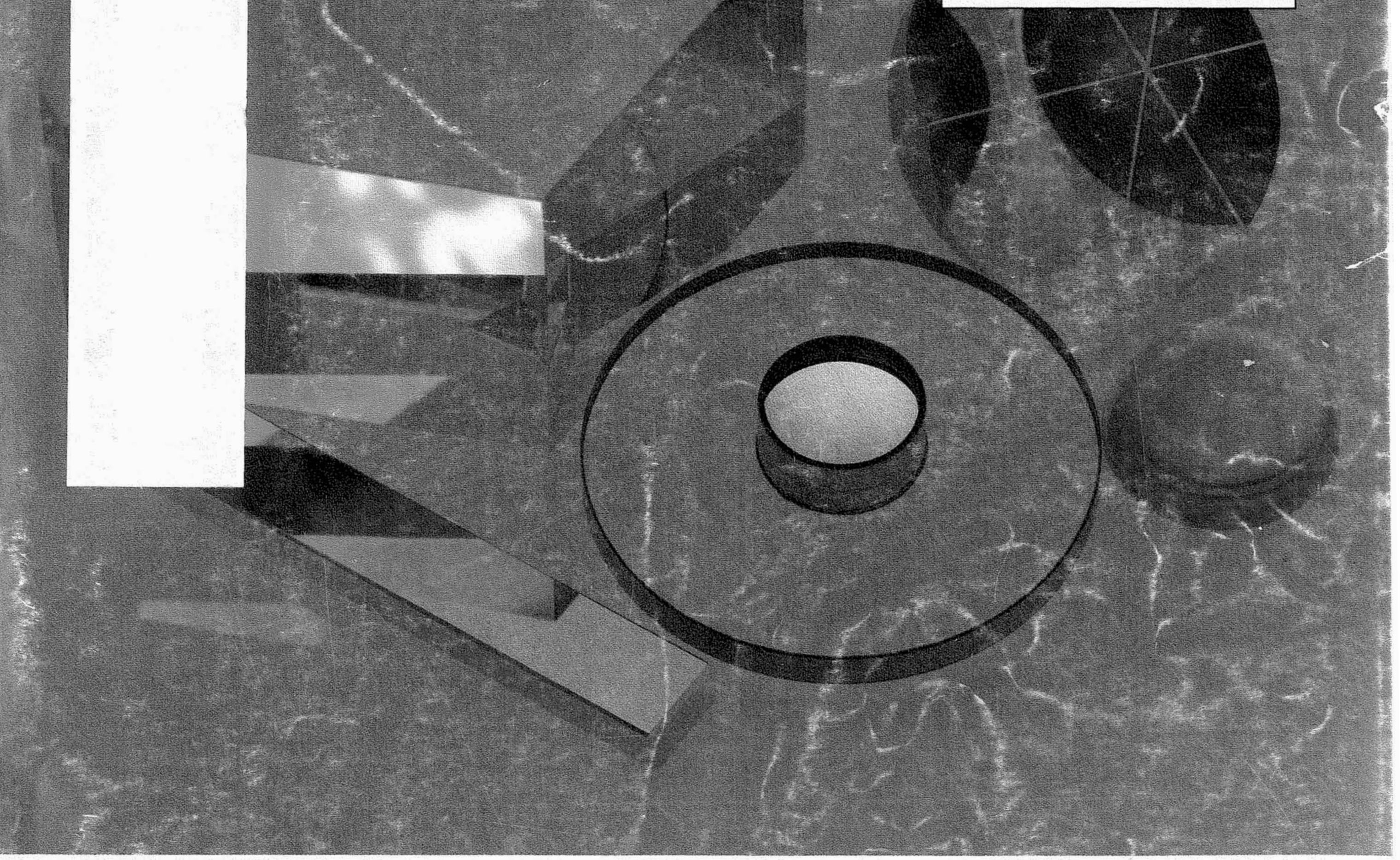
- Optics takes the offensive
- N_2 laser uses abound

INCLUDING

FIBEROPTICS WORLD

- Planar guides couple lightwaves



■ LASERS ■ OPTICS ■ FIBEROPTICS ■ DETECTORS ■ IMAGING

OPTICAL COMPUTING NEWSLETTER

October 1989 Volume 3 Number 1

■ ISSUE HIGHLIGHTS

Optical computing at the University of Washington . . . Light-amplifying optical switch in works . . . Hybrid image processing . . . Conference Calendar

■ WHERE TO WRITE

Readers are invited to submit news items or short articles on any aspect of optical computing and to suggest topics to cover in future issues. Send queries to:

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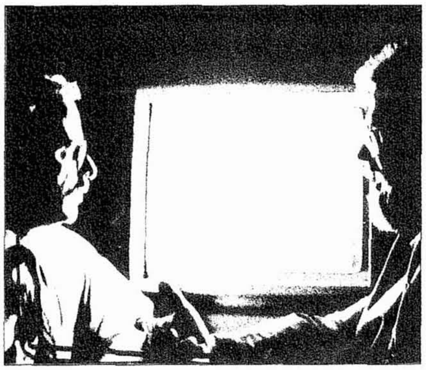
Optical computing at the University of Washington

SEATTLE, WA: We are investigating the use of optical computing in the course of our research at the Interactive Systems Design Laboratory (ISDL), located in the Electrical Engineering Department at the University of Washington, Seattle. We feel that optical computing is a good candidate for the realization of our ideas. Currently, three optical computing projects are underway: increasing the accuracy of optical processors, exploring architectures for artificial neural networks, and investigating the asynchronous behavior of optical processors that use feedback. The ISDL was set up in 1984 under the leadership of professors L. E. Atlas and R. J. Marks II, shown at left and right of photo, respectively.



Increasing the accuracy of optical processors

Analog optical processors have the innate capacity for processing large amounts of data in parallel. Yet in their generic form they are relatively inaccurate. At ISDL we are looking at techniques whereby the massive throughput capabilities of optical processors can be traded for higher accuracy. This is in contrast to the use of quantization where the processor's dynamic range is sacrificed to the cause of higher accuracy, as in digital optical processing.

Accuracy can be increased in an inaccurate processor by redundant computation. Within the processor, redundancy can either be lumped or distributed. An example of lumped redundancy is the use of a small number of parallel channels to compute a coded form of the processor output so that error detection and correction can be performed in the spirit of conventional error-correction codes. Neural networks are an example of distributed redundancy. Here, outputs resulting from perturbed inputs and/or systems can still be quite good.

Accuracy can also be increased by the wise use of nonlinearities. In correlation-based optical associative memories, for example, a suitable strong nonlinearity in the correlation domain can guarantee the accuracy of the memory output. In neural networks, forming a hidden layer of neurons that is nonlinearly related to the input neural states can increase both the capacity and accuracy of the network.

Artificial neural networks

In the artificial neural networks project, we have proposed an architecture for an Alternating Projection Neural Network (APNN) that iterates at light speed using passive optical feedback and whose performance is unaffected by clock skew. Nonlinear optical phenomena invariably involve the interaction of light with materials. By placing nonlinearities in the feedback path of an optical processor, iteration is therefore slowed. The APNN, on the other hand, places nonlinearities in input rather than the feedback path. There is thus only a single interaction time delay rather than one delay per iteration. A prototype of the processor is currently being made at the Optical Systems Laboratory at Texas Tech University, Lubbock, Tex.

Asynchronous behavior and feedback

The third project at ISDL concerns the asynchronous behavior of optical processors that use feedback. Predicted speed and accuracy in an optical processor is sometimes not achieved due to the inherent asynchronous nature of such processors. The effect of processor clock skew needs to be understood in order to accurately ascertain the fundamental accuracy and limits to the speed of optical processors.

Our ongoing work is observing the effects of clock skew on iterative optical processors and on the processor's predicted accuracy. We have shown that if the iterative operation is contractive, then the processor's steady-state solution is unaffected by clock skew. However, if the iteration contains hard nonlinearities such as a sign function, the clock skew can alter the steady-state solution.

The ISDL projects in optical computing and artificial neural networks are currently funded by the Strategic Defense Initiative administered by the Office of Naval Research, the National Science Foundation, and the Washington Technology Center here at the University of Washington.

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