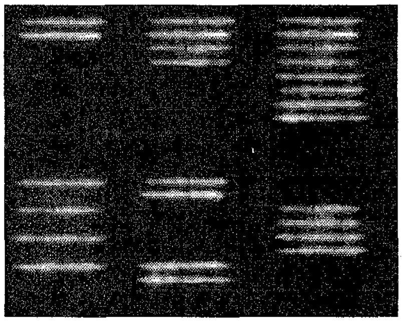

CTuA6 Fig. 3 Images of lasing light from an eight-line array projected onto a screen, in various on/off states. Both line spacing and width between ITO lines are 100 μm.

An array of addressable lines was created by patterning one of the glass plates with eight 100-μm-wide strips of ITO, separated by 100 μm. Lines were addressed by pumping the entire region with an appodized beam and applying voltage selectively to various combinations of lines. Figure 3 shows how lines in the array can be actuated in this way.

Further work is underway to create a two-inch diagonal active matrix lasing display, which has over 10^5 pixels for very large scale projection applications.

**Division of Engineering*

***Department of Physics and Division of Engineering*

CTuA7 9:30 am

Modular integrated dynamic holographic memory with refreshed holograms

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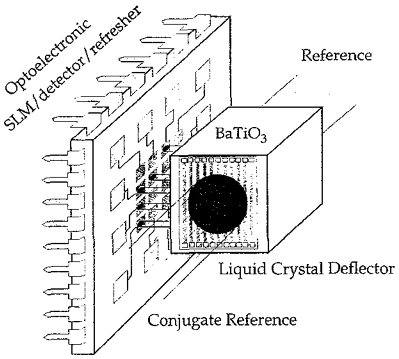


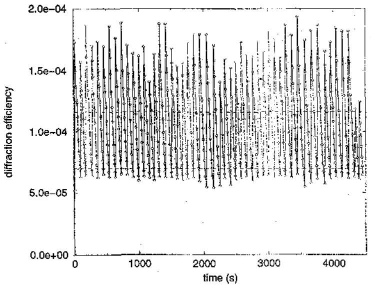
CTuA7 Fig. 1 Compact angularly multiplexed holographic storage module.

The use of counter-propagating reference beams for recording and readout in volume holographic memories enables compact storage modules with lensless signal beam paths. The reference beam for readout is the conjugate of the reference beam for recording. We refer to this technique as conjugate readout. Figure 1 shows a compact module employing angular multiplexing. The module is comprised of a photorefractive crystal in which holograms are stored, liquid crystal beam steerers that are responsible for angularly multiplexing holograms, and an optoelectronic integrated circuit (OEIC), called dynamic hologram refresher (DHR), that merges the functions of a reflective spatial light modulator (SLM) for recording holograms and a detector array for readout. Holograms are written by letting the signal beam modulated by the OEIC interfere with the plane wave coming from the back of the crystal. Holograms are read out by illuminating the crystal from the front with a counter-propagating plane wave, which is the conjugate of the reference wave employed to write holograms. The resulting conjugate reconstruction self-focuses back on the OEIC.

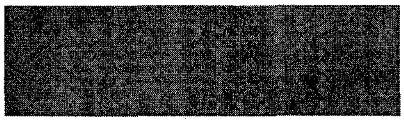
The module illustrated in Fig. 1 offers cost and compactness benefits compared to conventional read/write holographic systems, which employ separate SLM and detector array devices, as well as high-resolution imaging optics between the SLM and the detector array. Linear phase distortions are undone by the readout process.

The OEIC enables the module shown in Fig. 1 to sustain dynamic holograms in a read/write system, and simplifies the system's integration and alignment. When a proper conjugate reference is incident on the recording material, the reconstructed signal beam is aligned at unit magnification with the photodetectors located in the same pixels as the liquid crystal modulators. Furthermore, the OEIC provides a solution to the volatility of holograms stored in a read/write photorefractive memory: holograms are periodically sensed, memorized in a temporary memory, and re-recorded at the same location. We designed and tested a DHR chip, and employed it to record and refresh holograms in a storage module prototype. Figure 2 shows the time evolution of the diffraction efficiency of a hologram over 50 refresh-decay cycles; Fig. 3 shows the final conjugate reconstruction.

We describe a practical realization of the module architecture shown in Fig. 1. We estimate that the storage density of this module is $\geq 1.5 \times 10^{-4}$ bits/μm^3. This estimate takes into account the volume overhead associated with all beam routing elements. We describe the design of a one-terabit modular memory using this architecture, and discuss tradeoffs and optimizations leading to a high-performance, cost-competitive system. We report on the projected cost and performance of the storage module and of the system (transfer rate,



CTuA7 Fig. 2 Evolution of the diffraction efficiency of a hologram during 50 refresh-decay cycles.



(d)

CTuA7 Fig. 3 Conjugate reconstruction of a binary pattern after fifty refresh-decay cycles.

access time, capacity per module, power dissipation). The holographic memory provides a transfer rate improvement of up to two orders of magnitude compared to magnetic storage, while its cost is up to six times lower than that of a semiconductor memory system with the same capacity.

CTuA8 9:45 am

Demagnified compact holographic storage using beam confinement and phase-conjugate readout

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For high fidelity storage of high-resolution images or data, the required area of the recording medium to capture the necessary higher spatial frequency components results in less than optimum storage densities. As shown in Fig. 1, the diffracted components from the object must be recorded to maintain high feature resolution, which necessitates using a low f-number optical system. This results in inefficient use of the full dynamic range of the material. The minimum aperture of the recording medium $P_{\min}$ is

$$P_{\min} = D + 2(z + L)\left(\frac{\lambda N}{D}\right) \qquad (1)$$

where N is the space-bandwidth product of the recorded image (i.e., the SLM) and L is the material thickness. As shown by Eq. (1), for direct recording of the image, the required hologram dimension is larger than other schemes such as imaging or Fourier transform holography.

This problem of requiring larger aperture recording media is partially addressed by storage using a 4-f Fourier plane storage approach, as shown in Fig. 2, with the recording medium slightly offset from the Fourier plane to avoid recording dynamic range saturation.[1]