sal operator for the spin, and the photon spin is behind the SOP property of the light.

Since its discovery, the OCM has been used in a number of optical applications. For example, polarization-insensitive interferometers in Michelson or ring configurations.[1] These optical circuits provide the basis for the development of coherent optical sensors like hydrophones, strain-gauges, thermometers, and fiber optic gyros. A generalization of the OCM properties for dicroic birefringent components, proposed by Bandhari,[7] has been successfully proved by van Deventer.[8] The results can be applied to the development polarization-independent optical amplifiers or lasers and to solve the optical-reflection sensitivity in many circuits. Another use is in current sensors based on the Faraday effect.[2,3] Unlike optical activity, the magneto-optical induced activity is non-reciprocal and cannot be compensated by the OCM. Nevertheless, the presence of the OCM limits the effects of vibrations and temperature changes on the fiber optic current circuits.

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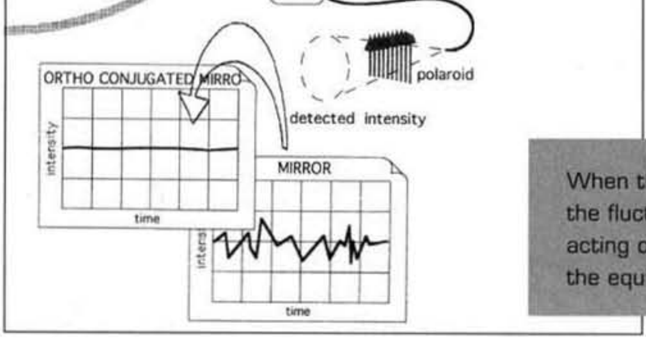

When the mirror is replaced by the Ortho Conjugated Mirror (OCM), the fluctuations of polarization induced by environmental perturbations acting on the optical fiber are completely cancelled. The OCM produces the equivalent of the time reversal operation for the polarization state.

Magnetorheological Finishing

BY W.I. KORDONSKY, I.V. PROKHOROV, AND G. GORODKIN, BYELOCORP SCIENTIFIC INC., ROCHESTER, N.Y.; AND S.D. JACOBS, B. PUCHEBNER, AND D. PIETROWSKI, CENTER FOR OPTICS MANUFACTURING AND LABORATORY FOR LASER ENERGETICS, UNIVERSITY OF ROCHESTER, ROCHESTER, N.Y.

Magnetorheological (MR) suspensions, used in optical manufacturing, constitute a new and novel optical finishing technology. These suspensions consist of micron-sized magnetic particles in a carrier liquid[1] and are representative of a class of "intelligent" fluids, *i.e.* media with controllable properties. They can exhibit rapid and reversible changes in their structure. As an example, the rheological property of viscosity varies by over two orders of magnitude with the application of a magnetic field.[2] The ability to induce changes in mechanical properties has been used in a variety of actuators from vibration isolators and shock absorbers to robotic positioning devices by the Byelocorp Scientific staff,[3] and now to the figuring and finishing of optics.[4]

The method for optical finishing with a MR suspension is illustrated in the figure. The process starts with a glass lens that has been generated by deterministic microgrinding on an *Opticam* computer-controlled machining center at the Center for Optics Manufacturing (COM). A typical microground part has the correct surface figure within 1/2 wave p-v; surface roughness less than 150Å rms; and subsurface damage of less than 2 μm.[5] The generated part is mounted on a rotating spindle that is placed into contact with the MR suspension confined within a non-magnetic rotating trough. Conventional polishing abrasives are added to the suspension, and polishing occurs in the area affected by the electromagnet.

The MR finishing process is best understood by thinking of the MR suspension as a compliant replacement for the conventional rigid lap in the loose abrasive grinding or polishing process. Application of a magnetic field causes the viscosity and plasticity of the MR suspension to change from low (soft) to high (stiff). A zone of high pressure is created in a spot beneath the surface of the part. The rotating trough continuously delivers new polishing abrasive particles into the high pressure zone where, under the action of nonhomogeneous magnetic fields, they contact the glass surface to effect material removal. The magnitude and form of the zone's polishing spot are controlled by the magnetic field.

Polishing of a spherical surface is achieved by varying the lens contact angle, Θ, and the dwell time with computer

Magnetorheological Finishing: Spindle mounted optic is polished in the abrasive slurry supported by the compliant MR "fluid lap."

numerical control of the spindle. Other non-spherical removal modalities may be designed by changing the controlling computer algorithm and/or the characteristics of the polishing spot.

MR finishing has several advantages over conventional processes. The MR suspension is aqueous and non-hazardous. There are no set-up or dedicated tooling requirements. The removal function is predictable and under computer control. MR polishing is therefore a deterministic process.

The MR finishing process is being successfully developed at the COM with Byelocorp Scientific. Most recently, a 4x reduction in surface roughness of a 40 mm diameter convex glass part was achieved with no degradation to surface figure. Research is currently underway to study the effectiveness of various magnetic field distributions in defining an optimal polishing spot. The behaviors of various abrasives and different glass types are also being studied.

ACKNOWLEDGMENT

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Holographic Laser Radar

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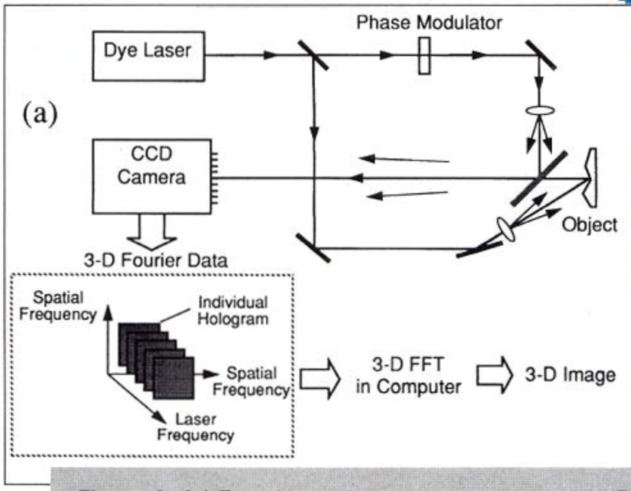
Holographic Laser Radar (HLR) is an emerging method for performing fine-resolution, 3-D imaging. It uses a frequency-tunable laser source, electronic holography recording methods and digital Fourier processing to recover 3-D representations of imaged targets. The resulting images are useful primarily for inspection applications.

Our work has concentrated on experimental demonstration of the capabilities of HLR.[1,2] The experimental setup is shown in Figure 1(a). We used a tunable dye laser for our experiments. The light from the laser is split into two parts; an object beam and a reference beam. The object beam is expanded to flood-illuminate the object and the reflected



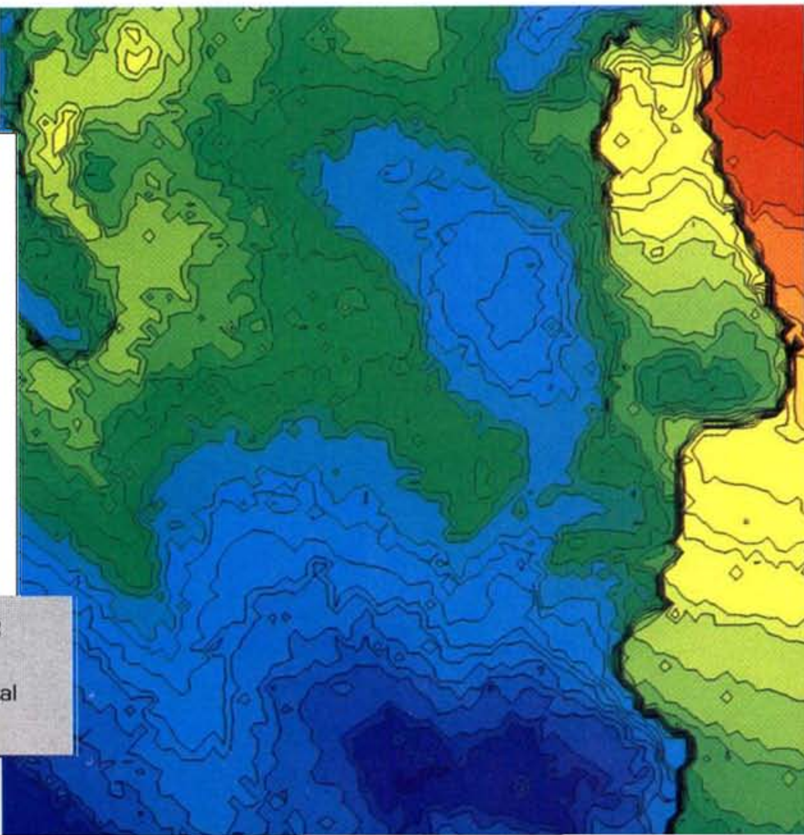


Figure 1. **(a)** Experimental setup used to record HLR data. **(b)** Range encoded image of President Lincoln taken from a penny. Contour interval is 8 μm and total range extent of image is 268 μm.