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

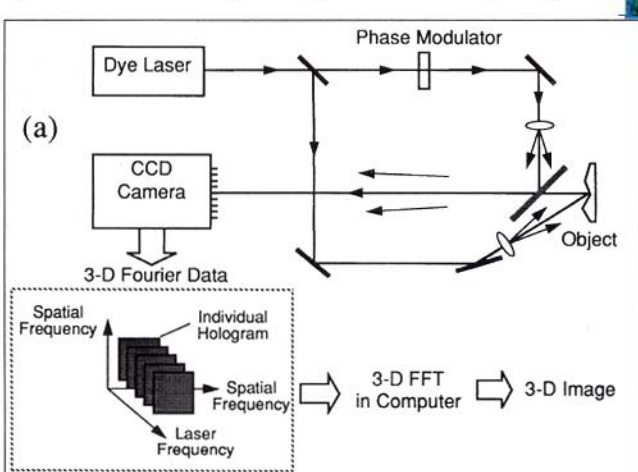
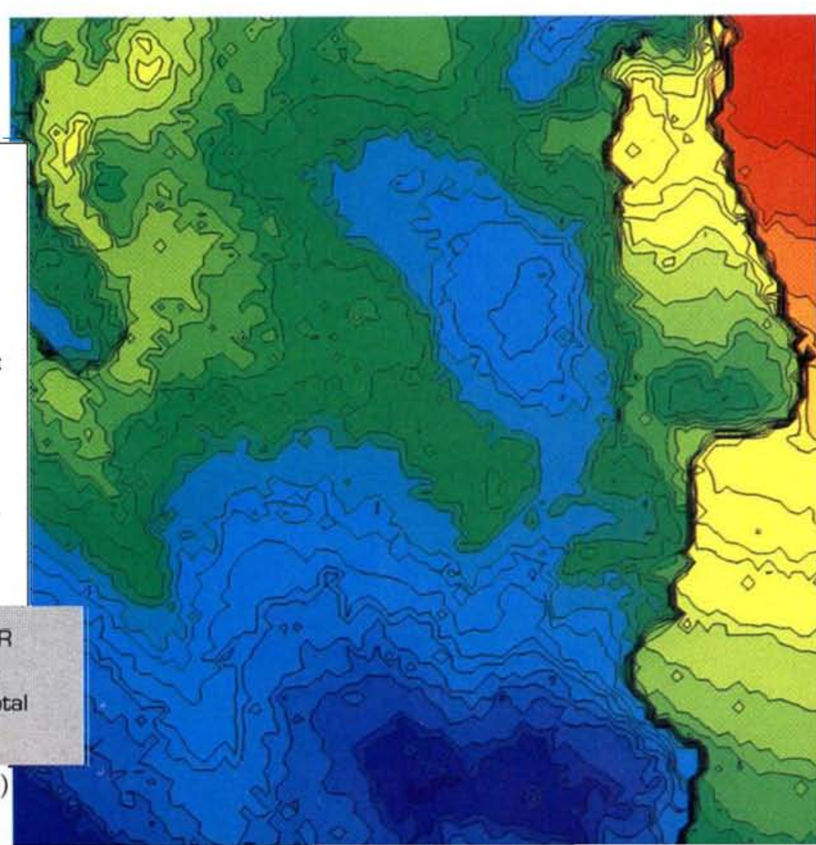


Figure 1. (a) Experimental setup used to record HLR data. **(b)** Range encoded image of President Lincoln taken from a penny. Contour interval is 8 μm and total range extent of image is 268 μm.

(b)



light passes to a lensless charge-coupled device (CCD) detector array. The reference beam is also expanded and passes to the CCD array which records the interference pattern of the object and reference beams. This single recording is essentially a digital Fourier transform hologram. To eliminate the need for a spatial carrier frequency, we record four versions of the hologram with the phase of the reference beam shifted by 0, $\pi/2$, π, and $3\pi/2$ radians, and in this manner we record complex valued holograms. Digital Fourier transformation of one of these holograms yields a standard angle-angle image of the object.

For HLR, the hologram recording procedure is repeated for a series of laser frequencies. As shown in Figure 1(a), the resulting data comprises a 3-D volume of Fourier data. The object's 3-D complex reflectivity is then recovered by digital inverse Fourier transformation of the data set. The resulting image occupies a 3-D array of complex-valued reflectivity values. There are a variety of ways to view the data. We typically transform the data set to a 2-D form by determining the range value where the maximum reflectivity occurs for each angular pixel. Figure 1(b) shows such a range encoded image. This image is a portion of President Lincoln's face taken from a penny. The depth interval between contours is roughly 8 μm and the total range extent of the image is 268 μm.

The resolution capabilities of HLR are dictated by several factors. First, the angular resolution is given by $\lambda R/D$, where R is the distance from the object to the detector array and D is the detector array width. Fine angular resolution can thus be obtained without the use of a lens. The range resolution of the system is given by $\lambda^2/(2\Delta\lambda)$ where $\Delta\lambda$ is the total bandwidth over which the laser is tuned. Thus broad tunability gives fine range resolution. By processing the phase of the 3-D image data, one can measure range with interferometric precision ultimately giving range resolution on the order of nanometers. One final feature of HLR imagery is that if the range extent of the object exceeds the unambiguous range of the system, the resulting image is wrapped in the range dimension, and for deep objects, range unwrapping must be performed.

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Free-space WDM Optical Mesh-connected Bus Interconnect

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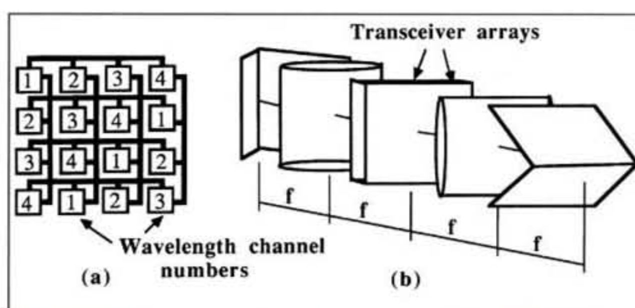
Have you ever wondered how the above-ground public transportation in a crowded urban area such as New York city is handled? The next time you visit "the Big Apple," note that most of the city buses follow routes along either east-west oriented streets or north-south oriented avenues in Manhattan. By taking three consecutive bus rides (turning corners twice), you can reach any desti-



(c)

Figure 1. (a) A schematic WDM-based MCB interconnecting 16 nodes with four different frequency channels; (b) a compact free-space WDM MCB layout using cylindrical optics for WDM bus array formations; and (c) video signal routing results of our three-stage optical demonstration prototype.