CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
S0718

Project Title
Optical Correlation of Digital Data Using Volume Holograms: The Impact of the Photodetector

Abstract

Objectives/Goals
Holographic data storage allows for storage capabilities within the volume of the recording medium, unlike CD-ROMs or DVD-ROMs which limit storage to the surface. With the ability to store 1000's of record on one medium, it becomes neccesary to develop a method of search to correlate the stored records to one search record one wishes to find. This search method is called associative retrieval. Because holographic data storage is an optical system, implmenting associative retrieval is difficult due to the errors that come with optics. I set out to study these errors and engineer an optimal system.

Methods/Materials
To study the the errors and problems with optical correlation and associative retrieval I had to first simulate a system using MATLAB to allow for studying the effect of certain system parameters without having to worry about experimental error in lab. By varying the parameters to certain components I was able to engineer a system that would be optimal in lab and real life. I then had to experiment with the same parameters in the lab to obtain and confirm the results I got in the simulation.

Results
The photodetector is CCD camera. The light it detects comes from the output of the associative search. Once all records are correlated with the search record, the photodetector measures the similarities by measuring the intensity of the light as it leaves the medium. The higher the intensity of the light, the more matching the record is to the search pattern. I found that what causes the search to be innaccurate is optical noise and the fact that the pixels on the CCD camera are spaced apart. This means that the optical noise changes the intensity of light detected by disrupting the signal that was meant to be read by the photodetector. The pixel spacing on the detector also causes some light to be lost because it hits the inactive parts of the photodetector, causing an incorrect reading.

Conclusions/Discussion
In simulation, I was able to lower the effects of noise by having the system run the same search over and over about 1000 times, each with a random amount of noise, this way an average detection can occur which allows the noise to only affect the search minimally. To account for the pixel dead space I changed the focus position of the photodetector. Now there was greater area to read the light and dead space had lost its effect.

Summary Statement
Optimizing the associative retrieval aspect of volume holographic data storage.

Help Received
Used lab equipment and simulation computers at IBM Almaden Research Center under the supervision of Dr. Geoffrey Burr.