FINAL REPORT

March 31, 1999

NASA Grant No. NAGW-2866; JHU account No. X464-Y00-2057
"Integrated Dual Imaging Detector"

/N - 74

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Introduction

A new type of image detector was designed to simultaneously analyze the polarization of light at all picture elements in a scene. The Integrated Dual Imaging Detector (IDID) consists of a lenslet array and a polarizing beamsplitter bonded to a commercial charge-coupled device (CCD). The IDID simplifies the design and operation of solar vector magnetographs and the imaging polarimeters and spectroscopic imagers used, for example, in atmospheric and solar research. When used in a solar telescope, the IDID is designed to chart the polarization, which can then be converted to maps of the vector magnetic fields on the solar surface. Other applications include environmental monitoring, robot vision, and medical diagnoses (through the eye). Innovations in the IDID include (1) two interleaved imaging arrays (one for each polarization plane); (2) large dynamic range (well depth of 10^5 electrons per pixel); (3) simultaneous readout and display of both images; and (4) laptop computer signal processing to produce polarization maps in field situations.

Accomplishments

As described in the attached publications, an IDID was originally designed for custom fabrication. When the cost of custom fabrication far exceeded the allowed budget, we purchased a commercial CCD camera and modified it for dual polarization imaging. In that case a Ronchi ruling was used to mask off alternate rows of light-sensitive pixels. This version of the IDID was successfully demonstrated.

In the last two years of the program, to September 30, 1997, we attempted to increase the resolution and the light gathering efficiency of the IDID. We designed a custom array of lenslets to be cemented to the face of a larger CCD than was used in the first IDID. A batch of custom lenslet arrays was fabricated and a dozen CCD chips were purchased. Unfortunately, the modification program failed to produce a usable IDID because we could not develop a technique for cementing the lenslet array to the face of the CCDs without damaging the CCDs themselves. A major problem was that the commercial CCDs were packaged with fine wire connectors that interfere with orientation and cementing of the lenslets. We researched alternate approaches, and we believe that it would be possible to fabricate a CCD with integral lenslets, in a process similar to that used in some commercial electronic cameras. However, development of the process would require a major investment.

Future Prospects

With improved manipulation techniques and equipment, we believe that the existing lenslets could be affixed to commercial CCD chips. The resulting camera would still be able to fulfill the objectives of the original program, especially now that common laptop computers are so much faster than they were in 1991 when we proposed a custom processor.

Publications, Presentations and Patents

Rust, D. M. and K. E. Thompson, An Integrated Imaging Detector Of Polarization And Spectral Contents, Remote Sensing Reviews 8, 215-225, 1993.

Thompson, K. E., Rust, D. M., and Chen, H., A Compact Polarization Imager, Johns Hopkins APL Technical Digest 16, 258, 1995.

Rust, D. M., Kumar, A. and Thompson, K. E., A Compact Imaging Detector Of Polarization And Spectral Content, Workshop on Advanced Technologies for Planetary Instruments, 1993.

Patent Number 5,438,414, Integrated Dual Imaging Detector, assigned to the Johns Hopkins University Applied Physics Lab.

Equipment purchased

LTE Elite 4/75 CX, S/N 6518HFHJ50215 Compaq laptop computer, $4750 from Ameridata, Inc.

Dacpac XL Data Acquistion System from Keithley Metrabyte, Inc, $1499.

420 MB Hard Disk from Computer Installations Inc., $1514.

Electrim EDC-1000 Electronic Camera, $450, from Electrim Corp.