

# The **A**dvanced **D**igital **D**isplay **L**ab



creating the future of digital printing and  
information display

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<http://www.engr.uky.edu/~dllau/halftoning>



## Introduction:

As part of the University of Kentucky's Applied Science and Technology Commercialization Center (ASTeCC), the goal of the Advanced Digital Display Lab (ADDL) is to assist our industrial and government partners in addressing problems in digital imaging and information display. Currently, the lab is involved in a wide range of imaging problems including high fidelity printing, document security, real-time 3D imaging, and automated video surveillance.

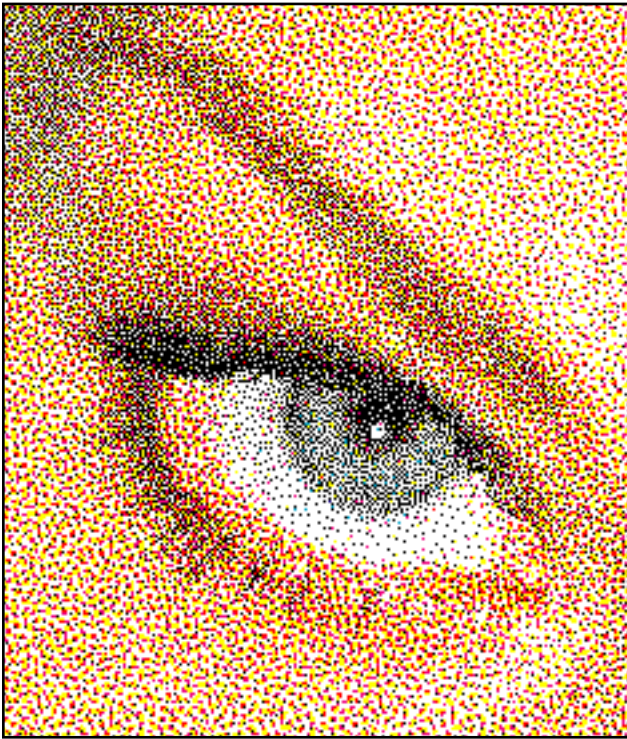
## Equipment:

- Howtek HiResolve Sprint 4000 dpi drum scanner
- Apple 800x2MHz Power Macintosh Workstation with 1.5Gb RAM, 2x60Gb HD, 250Mb ZIP, DVD-R/CD-RW drive, 22" Cinema Display, and a 21" Sony Trinitron Display
- 2 Apple 867MHz Power Macintosh Workstations with 1.5Gb RAM, 2x60Gb HD, 250Mb ZIP, and 17" Apple flat panel displays
- 800MHz Intel Pentium III Dell Workstation with 256Mb RAM, 10Gb HD, and 21" Sony Trinitron Display
- HP Scanjet 4560 2400 dpi flatbed scanner
- 12"x12" Wacom Art Tablet
- Xerox Tektronix Phaser 860 Solid Inkjet printer
- HP 600MP Laserjet printer



**Daniel L. Lau,**  
**ADDL Director**

**Biography:** Daniel L. Lau received his B. Sc. in Electrical Engineering from Purdue University with highest distinction in May 1995 and then his Ph.D. from the University of Delaware in May 1999. Daniel has conducted research at the Lawrence Livermore National Laboratory in Livermore, CA, and has worked in digital communications as a DSL engineering at Aware Inc., in Bedford, MA. Among Daniel's published works in halftoning is an article in the December 1998 issue of the *Proceedings of the IEEE* and his own book entitled *Modern Digital Halftoning* and published by Marcel Dekker NY, 2001. Currently, Daniel is an Assistant Professor in the Department of Electrical and Computer Engineering at the University of Kentucky conducting research in digital halftoning, color reproduction, and computer vision.



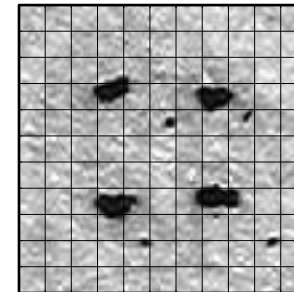
### High Fidelity Printing:

The ADDL has lead the industry in developing robust stochastic halftoning technologies for use in electrophotographic (laser) printers. Our lab was the first to describe visually pleasing halftones composed of a stochastic arrangement of randomly sized and shaped minority pixel clusters as *green-noise*, and we were the first to introduce computationally convenient green-noise dither arrays or masks. With our recent introduction of *stochastic moire* analysis, our research will continue to lead the industry by developing optimal color halftoning algorithms for use in devices that cannot guarantee prefect screen alignment.

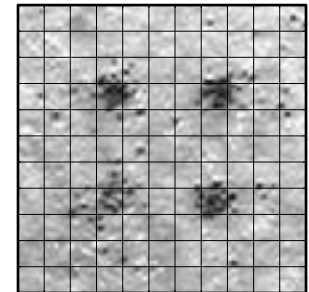


### Document Security:

Through the manipulation of dot placement in binary halftones, it is possible to encode a data stream into the halftones of printed documents as a digital watermark for the purpose of (1) ensuring the authenticity of a document from sender to receiver, (2) uniquely identify the author of a particular document, and/or (3) passing secret messages from sender to receiver. Here at the ADDL, we are hard at work developing new halftoning algorithms that achieve maximum data capacity without the introduction of visual artifacts or image degradation. As an example, the image below holds approximately 1000 bits of information that has been stored into the green-noise halftone pattern.



inkjet printer dots



laser printer dots

### High Resolution Scanning:

No study of digital halftoning can be complete without the ability to understand the nature of the printed dot. Here at the ADDL, we make use of state of the art imaging equipment along with our proprietary analysis software to quickly and accurately identify the deficiencies in any printing technology. With this information, we can tune our halftoning algorithms for maximum color accuracy and edge detail. The high resolution afforded by our drum scanning equipment is especially advantageous for our watermarking and inverse halftoning research where obtaining the intended halftone image is of vital importance.