

Scientific/Digital Image Processing

High-resolution digital image processing is widely used in the graphic arts and publishing industries. Scientific and quantitative digital image analysis is less common. The complexity of digital images can rapidly surpass the human ability to analyze visual information. The Nikon 35mm LS-3500 SR1 is a professional-quality slide scanner that can digitally scan an image at a higher resolution than chemical-based photographic grain. Each slide may be scanned from 10% to 1000% of original image size and from 30 to 1000 dots per inch (dpi). This would allow enlargement of any portion of the slide for further analysis. The high-resolution, 24-bit per pixel image of 4096 x 6144 pixels at 1000 dpi can be saved to MS-DOS or Apple TIFF, TARGA, PICT2, and PostScript files, with four-color separations. By importing the image into Photoshop

2.01, the file also can be saved in many formats (Photoshop, Amiga IFF/ILBM, CompuServe GIF, EPS, MacPaint, PICT File, PICT Resource, PIXAR, Pixelpaint, Raw, Scitex CT, and TGA). In digital form, draft copies can be printed to the 600-dpi Apple LaserWriter IIg and true-color (24 bit, 16.7 million colors; the average person can distinguish just under 10 million colors) proofs can be printed to the Canon CJ-10 color printer/copier/flatbed scanner at a materials' cost of less than \$1 per 8.5 x 11-inch page. The advantages over chemical-based photography are improved quantitative and qualitative image analysis/manipulation, unlimited archival abilities, improved publishing and dissemination capabilities, speed and control over product, ease of replication, electronic transmission, and the precision and stability of digital information.

For comparison, the Nikon High Definition Television camera has a resolution of only 1920 x 1035 pixels. Newer, more expensive scanners, such as the Leafscan 45, can scan up to 4800 dpi and 48 bits per pixel. The radius Trinitron 19-inch monitor with its accelerated 24-bit, true-color Nubus board can display one million colors at the same time. True color (24 bit) allows 16,777,216 separate colors. For the graphic arts industry, the Stratavision Co. (St. George, Utah) is selling software than can manipulate 16 trillion colors. Typical image file size at full resolution is an uncompressed 130 megabytes. To fully manipulate this image, a hard-drive scratch disk of equal file size must be available to enable the undo functions.

Compression programs allow files to be compressed to one-third to one-half their original size for storage and electronic transmission. To use the upper range of this scanner's resolution adequately, the following CPU enhancements are recommended: increasing random-access memory (RAM) to 128 megabytes and internal hard-drive space to three gigabytes and adding multiple Motorola 68040 33 MHz CPU accelerators. A minimum computer configuration to use this technology would be a Motorola 68030 chip with 20 megabytes of RAM and a 230-megabyte hard disk, or an Intel 486 with the same RAM and hard disk.

The cover illustrates this process applied in a study of postharvest floral senescence. Each of the flowers was photographed against a black background on a copy stand fitted with four 250-W photoflood lights, using 35-mm Kodak Ektachrome slide film (ASA 100) and an 80A dark-blue filter. The resulting slides were scanned using the default settings within ColorStudio 1.5, driving the Nikon LS-3500 SR1 (LS-3510 is the current model) at 300 dpi, and running on an Apple Macintosh IIfx with 20 megabytes of RAM and a 160-megabyte internal hard drive. For storage and third-party printing, the Horticulture/Landscape Computer Laboratory has a 1.2-gigabyte hard drive, a 90-megabyte Bernoulli, and a 44-megabyte Syquest removable hard drive.

Digital technology eliminates any distinction between the original and a copy and allows an infinite number of post-experiment manipulations.

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Front cover: Representative image of the steps involved in digital image processing. An original post-experiment slide was scanned and digitized, and the image of a single flower was selected and sized. This digital image was enhanced and combined with images held in separate tiles for final output to paper, film, or disk. See related article on p. 201.