THE SLATER PERSPECTIVE

The End of Film

Digital Cameras Fall Short Today, But Their Eventual Domination Is Assured

Digital cameras have become remarkably popular in the past year. Following the trend that has already played out with audio recording, microprocessors first moved into conventional cameras as controllers and are now moving into the data path. This shift will create a new market for high-performance microprocessors and memory chips in cameras as well as a major new application for PCs.

With prices down to a few hundred dollars, digital cameras have been showing up not only in computer stores but in mainstream consumer electronics outlets. Unfortunately, for most consumers, today's digital cameras are almost sure to disappoint. Today's low-cost consumer digital cameras are great for taking snapshots to be posted to Web sites—but not much else.

The allure is clear. No more film to buy. No processing delays and hassles. Instead of a shoebox full of negatives that often become disassociated from the prints, everything can be stored on a hard drive and backup tapes. With the right software, those photo albums that so rarely get completed would be easier, and more fun, to create on-screen.

The problem with today's affordable digital cameras is resolution. Most reasonably priced cameras have a maximum resolution of 640 × 480, with 24 bits per pixel. This resolution results in images of just under 1 million bytes each. Although a 640 × 480 image looks good on a computer screen, it doesn't come close to matching the quality of even a mediocre snapshot. With a print size of just 3" × 4", this resolution translates to only 160 dots per inch (dpi).

To get to just 300 dpi for a conventional snapshot size of 3" × 5" requires a resolution of 900 × 1500 (about 4M at 24 bits/pixel). The common "jumbo" print of 4" × 6" pushes the resolution to 1,200 × 1,800 (over 6M at 24 bits/pixel). Digital cameras with this resolution sell today for $5,000–$10,000 and are popular with press photographers because developing delays are eliminated and photos can be e-mailed.

Moving up to a modest 8 × 10 enlargement pushes the required resolution for 300 dpi to a stratospheric 2,400 × 3,000 (20.6M at 24 bits/pixel). With enough money, you can get it: for $28,000, Kodak's DCS 460 provides a resolution of 2,036 × 3,060 with 36 bits per pixel.

There are two barriers to delivering these high resolutions in affordable cameras: the CCD that captures the image and the memory that stores it. Reaching a resolution of 1,200 × 1,800 requires about six times as many bits as today's consumer digital cameras. Following a traditional memory-density improvement curve of a 4× increase every three years, this resolution should be reached in sub-$500 cameras in four or five years. Unfortunately, CCDs don't scale as readily as memory chips, but increasing volumes will cut costs considerably. In addition, CMOS imagers are showing promise.

Today's consumer cameras store about 50 pictures (more in reduced-resolution modes). This is acceptable for a single outing but inadequate for a vacation. Eventually, providing solid-state storage for hundreds of pictures will be affordable. For the next five to ten years, however, most of the increase in affordable memory size will be consumed by increasing resolution.

Removable solid-state memory cards in the camera are a convenient but expensive solution. For users who travel with a notebook computer, pictures can be downloaded to the computer each night. Even a high-resolution picture takes only a few megabytes after compression, so a notebook computer with 1G free on the hard drive can store hundreds of pictures. A MiniDisk in the camera is another option.

Yet another solution is to transmit the pictures to a service bureau or to the user's own e-mail account. With today's modem speeds, however, this is tedious and expensive: at 28.8 kbps, 50 pictures of 1M each would take four hours to transmit! A 500-kbps connection, through ADSL or a cable modem, would cut this to a tolerable 15 minutes.

Printing these pictures raises another hurdle. Even today, low-cost ink-jet printers (such as the 720-dpi Epson Stylus) produce impressive results, and new 1,440-dpi versions due this year will be even better. These printers use discrete dots with fixed colors, so a mix of several dots is required to render an arbitrary color. Such printers thus need a much higher resolution than the image itself. While the prints look good from a distance, there are annoying artifacts when examined closely. Dye-sublimation printers provide continuous-tone images that are impressive even at 200 dpi, but the printers and the prints are expensive. Another problem is that no computer printer today delivers prints with archival qualities nearly as good as photographic prints.

Digital photography has a long way to go before it will take over consumer picture taking. The time when film will be used only by art photographers is within sight, however. A massive, though gradual, transition for the photography industry looms ahead; within ten years, film-based cameras will be in decline. It is no coincidence that Kodak's current chairman was previously the chairman of Motorola. M

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