Nonimpact Printing

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Electronic images are generated and displayed by a variety of methods. Some of these methods are purely electronic, such as digital cameras or electronic displays, but there is also a very widespread and rapidly evolving use of printed images on paper as either input or output. Dramatic progress is being made in nonimpact printing technology, driven in large part by advances in higher speed and lower cost microelectronics.

Ten years ago, for example, computers had only recently started to proliferate outside of centralized shared facilities. Fully formed character printers were declining in usage and dot matrix impact printers were becoming widespread, which did allow limited image printing but with rather poor print quality. Electrophotographic printers were available and had higher quality, but were only found in centralized facilities because of their high cost. Color printing was not readily available.

Now a number of nonimpact printing techniques are in common use that provide much higher print quality with good printing speed at costs that are dramatically lower than in the past. Color printing is becoming much more widespread as well, particularly with the introduction of low-cost ink-jet printers that can provide very good quality color.

The technology evolution is continuing and significant further increases in quality and reductions in cost are expected. Advances in a variety of electronic imaging techniques are a key component of the evolution of this technology, along with further progress in marking technology.

This special section consists of eight papers that address a broad range of nonimpact printing technology issues. All are based on or closely related to work presented in October 1992 at IS&T's Eighth International Congress on Advances in Non-Impact Printing Technologies in Williamsburg, Virginia. These papers cover key electronic imaging issues, as opposed to marking technology issues within the field of nonimpact printing.

We start with Lee and Winslow's paper on print quality since increases in print quality have been a significant driver behind the growth of nonimpact printing. This paper addresses the perception of print quality by the human visual system by comparing subjective quality ratings by a panel of observers to several quantitative metrics, each based on microscopic features of the print.

Next we present three image processing papers that address the conversion of gray-scale images into binary images for printing. This is an important area since most printers cannot print variable optical densities, but can represent gray-scale images by halftoning or error diffusion. Knox and Eschbach mathematically analyze threshold-modulated error diffusion. This modification of error diffusion has been shown to change significantly the fine structure of the binary patterns that are produced, and can be used to enhance edges or to break up unwanted texture patterns. Next, Pappas, Dong, and Neuhoff describe an approach for estimating printer model parameters from measurements of reflectance of test patterns, and they then use these parameters in model-based halftoning techniques. Then Rosenberg's paper explores the use of the large round dot model to generate tone correction curves for halftoning algorithms.

The last four papers in the special section address some of the significant issues arising in color nonimpact printing. Kanamori et al. describe a color processor for device-independent color that uses an interpolation scheme together with moderately sized look-up tables. Farrell and Wandell analyze the linearity of scanner measurements of various types of color images and study the significant deviations that can be caused by both scattered light and fluorescence. Rich identifies and quantifies the errors, both material dependent and instrument dependent, that can affect spectrocolorimeter measurements of nonimpact prints. Finally, Yamasaki et al. propose a new color interchange mechanism that can incorporate color adaptation and gamut mapping.

Eric G. Hanson is a project manager at Hewlett Packard (HP) Laboratories in Palo Alto, California, where he has managed a research team investigating advanced nonimpact printing since 1984. His primary focus has been on technology advances that enable the development of higher performance thermal ink-jet print heads. These have included improvements in materials, fabrication techniques, and geometries to address such issues as higher resolution and gray scale. He has also conducted research on other nonimpact printing marking techniques, and has analyzed technical trends in the major nonimpact printing technologies. Prior to his ink-jet work, he conducted research on optical fiber fabrication, also at HP Laboratories. He received a PhD in physics in 1976 from the University of California at Berkeley, with a specialization in the area of optical properties of solid state materials. He has been awarded six patents and has several more pending.