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Computer Image Analysis in the Study of Art

David G. Stork
Jim Coddington
Editors

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Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
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and
IS&T—The Society for Imaging Science and Technology
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Telephone +1 703 642 9090 (Eastern Time) · Fax +1 703 642 9094
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Introduction

From imaging to computer image analysis in the study of art

This volume is the product of the first IS&T–SPIE symposium to consider the wide-range of computer image analysis techniques in the study of visual arts, in particular master drawings, paintings, and modern art, held January 28–29, 2008 at IS&T–SPIE Electronic Imaging in San Jose, California. The symposium brought together leading international researchers from art museums, academia, and industry and their work demonstrated both the breadth and the power of computer techniques to shed light on problems in the understanding and interpretation of visual arts.

Science has, for many years, complemented traditional humanistic studies in the visual arts, of course, from archeology to chemical and physical analyses of paints and media to sensory and perceptual psychology of vision. Even the "dismal science" of economics has shed light on the career trajectory of artists' creativity. Closer to our interests, there is a long history of technical imaging in the study of visual arts, from x-ray imaging to infrared reflectography to UV-induced fluorescent imaging, perhaps reaching its apotheosis in the decoding of the Archimedes Palimpsest, such as discussed in this volume. Ever since the Renaissance, too, scholars and artists themselves have employed simple image analysis methods, such as the study of perspective through drawing lines over copies of artworks and making simple measurements and calculations based on the results. Throughout such work, the processed information is interpreted first and foremost by the art scholar.

We are, however, entering a new era, one in which computer algorithms themselves perform some of the analysis, analyses that simply could not be performed by even the most astute viewer because of the amount, the subtlety, or the unusual nature of the visual information. Several of the computer vision and pattern recognition algorithms scholars have applied to art were first developed in forensic image analysis, where the subtle evidence of a forger or photo manipulator escapes the scrutiny of all but the best experts from law enforcement, and in robotics and surveillance, where recognizing objects in the world and understanding their behaviors can be a matter of life and death.

Similarly to date, much image analysis has been focused on authentication problems, a small but significant part of art historical research. The insights gleaned from computer analysis are not just about authentication or for the professional art expert or collector, however. Computers can reveal the fallibility in our own perception and teach all of us to see with a more informed eye and mind. When a painting appears in perfect perspective, rigorous computer methods can reveal that it is not; when the lighting in a tableau appears to be

from a particular location, rigorous computer methods can reveal that it is not. Armed with these new perspectives provided by computer vision, we can focus on the source of these visual discrepancies, including the artist's technical or expressive reasons for them.

There is widespread acknowledgment that problems in three important areas must be addressed if this new discipline is to advance:

- Improved communication and collaboration: It is not likely that in the near future art historians will learn sophisticated computer programming or that computer scientists will fully understand the cultural contexts in which works of art are created as deeply as do art historians; as such it is essential that there be more and improved communication between scholars in these two broad disciplines. It is only through such discussions and collaborations that computer scientists can develop and refine algorithms that will be useful addressing important art historical problems, and that art historians can learn the range of computer techniques that might be of use in their own studies. A new branch in the disciplinary tree of the "hard humanities" seems to be growing. We borrow from Albert Einstein and exaggerate a bit: Computer image analysis without deep knowledge of art is lame, art history without computer image analysis is blind.

- Unified, refined terminology: It is natural that the science of pattern classification and computer vision on the one hand, and the humanistic study of art on the other, have developed their own methodologies and terminologies. For a scientist, "focal point" refers to the position in an optical system where parallel light 1 rays are brought together; to an art historian the same term refers to the "most interesting" or most important location within a painting, where the eye is drawn. When an art historian refers to a brush stroke as "bold," or "tentative," or "free," what exactly does she mean? If these disciplines are to enhance and complement each other, scholars from each will have to learn at the very least the language and terminology of the other. When the Renaissance art scholar understands median filter and the computer scientist understands chiaroscuro, we will know we are making progress.

- Adequate data: As with any study of human activities, scientific image analysis of art is highly empirical, and thus high-quality data (images) are essential—the more the better. The computer community needs high-resolution color scans of individual paintings, for instance to reveal subtle structure in brush strokes, as well as a images of a large number of different paintings, in order to learn the subtle regularities and differences between the works of different artists or between genuine and fake works. We need to find a balance between the intellectual property rights of

museums, collectors, and copyright holders with scholars' needs for high-resolution color scans of art works.

Like a microscope to a biologist, a telescope to an astronomer, a particle accelerator to a physicist, or a centrifuge to a microbiologist, these computer techniques, suitably refined, tested, and informed by art historical knowledge, will expand the power of connoisseurs, auctioneers, conservators and art historians as they address problems in the visual arts, such as authentication or understanding the working methods of artists. They will help give us all, expert and lay person alike, a deeper understanding of art.

We would like to thank our symposium program committee, Anna Bentkowska-Kafel, Peter Paul Biro, Guidomaria Cortelazzo, Charles R. Dyer, Roger L. Easton, Irfan Essa, Katherine Jones-Smith, Christian Lahanier, Kirk Martinez, Daniel N. Rockmore, Silvio Savarese and Stefano Soatto, for prompt, eager, and able assistance selecting papers and suggesting improvements to their authors, and our guest speaker Roger Malina, executive editor of *Leonardo*, for his historical insights on publishing and scholarship at the interface of science and the arts, and especially the scholars who presented their work. Finally, we express our deep gratitude to the conference organizers and leadership committees at IS&T–SPIE, particularly Michael Kriss, steering committee member, for handling several unusual challenges with wisdom and grace, making Electronic Imaging a welcoming home for this interdisciplinary research.

David G. Stork
Jim Coddington