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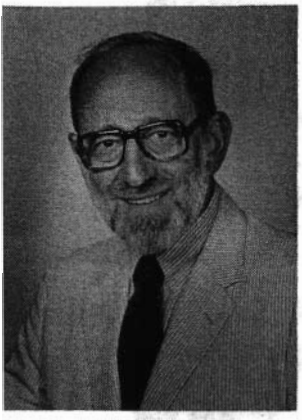
Describing Art Objects to Computers



ıssell A. Kirsch

rector of Research of The Sturvil
ɔrporation, a non-profit, public inter-
t research organization. He was a
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st automatically sequenced electronic
mputer in the United States Govern-
ɛnt, at the National Bureau of Stan-
rds, where he was responsible for re-
ırch and development in computers,
age processing, and artificial intel-
ence for over 33 years from 1951 to
85. He did the research that started
ɛ fields of computer image process-
ɡ, syntactical pattern recognition, and
mputer searching of chemical struc-
ɛs. He was among the early research-
in the fields of natural language pro-
ɛsing, computers in library science,
ıe sharing, and artificial intelligence
biomedicine. He has been a scientific
visor to most departments of the
S. Government. His ambition for the
e arts is no less than it was for com-
ɛrs three decades ago.

dress:
e Sturvil Corporation
ırksburg, MD, 20871
S.A.

The computer specialist Russel A. Kirsch is Director of the "Sturvil Corporation", an American non-profit, public interest research organization. He is a specialist in computer image processing and pattern recognition. In his article, Kirsch points out that these future oriented areas will, one day, also be of prominent importance for art history.

Art critics, historians, and studio artists can all make use of descriptions of art objects, the descriptions serving as surrogates of the art works for purposes of storing, searching, and analyzing them. Classically, these descriptions were in the form of verbal statements. Usually, these verbal statements were intended for use by other scholars. In recent years, it became possible to use these verbal descriptions as input data for computers that were intended to serve as aids in the analysis process. This enabled the extensively developed tradition of verbal analysis to be exploited for computer aided storage, search, and analysis of these surrogates.

For the past three decades, however, it has become increasingly possible to use computers for manipulating art work descriptions that are closer to the art than are verbal descriptions. These descriptions assume several forms that are pictorial in nature. The research underlying this capability occurs in the computer science fields of image processing, pattern recognition, and computer graphics. *

Whereas a verbal description is one-dimensional, a computer scanned image of an art work is two-dimensional. It may be stored in computer form, reproduced for visual inspection, and may be searched in two ways: by associating verbal description with the stored image, and by using automatic pattern recognition methods for inspecting the image to elicit the verbal description used in searching. Video disc and optical digital disc images are common examples of two-dimensional descriptions commonly used to refer to art works.

Another pictorial form of description of art works is the three-dimensional model. A description of a sculpture may be constructed for storage in a computer. If suitably prepared (from two or more stereo photographs, for example), this description may be used to reconstruct any number of two-dimensional views of the sculpture as seen from different viewpoints. These different views may be automatically produced by the computer. Then, the two-dimensional views may be manipulated in the same way as more orthodox two-dimensional views.

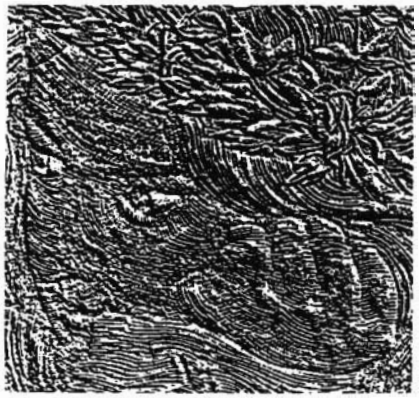
For both two - and three - dimensional images stored in a computer, automatic pattern recognition can be used to save some effort in encoding the verbal descriptions used to index the images. The trouble with this approach is that the pattern recognition technology has not yet advanced to the stage where subtle analysis of art works are possible. The kind of pattern recognition now possible, ranges from that of the common image scanners used in supermarkets for recognizing encoded symbols on packages, to that of the industrial inspection devices used on assembly lines to detect departures from standard images in objects being inspected. The beneficiaries of pattern recognition technology are the industrial, commercial, and military users who have invested protracted effort in research on automated pattern recognition for their tasks. If art scholars were to perform comparable research (strictly in art scholarship), we could expect to see the benefits of automated pattern recognition accrue to the field of analysis of art works.

For purposes of analysis of art works, it is, fortunately, not necessary to be restricted to one-dimensional (verbal) descriptions for automated analysis, nor is it necessary to use the (undeveloped) pattern recognition methods with two-dimensional and three-dimensional images. Instead, we may use a kind of one and one half dimensional form of description of art works, in-

* Computer image processing and pattern recognition as a field of research goes back to (Kirsch 1). Its current status is summarized in texts like (Pratt 2) and (Rosenfeld 3). Computer graphics goes back to (Sutherland 4). Its current status is represented by the text (Foley and Van Dam 5). Journals reporting current research in image processing and pattern recognition are (IEEE-PAMI 6) and (Computer Vision, Graphics, and Image Processing 7) and the annual (IEEE-CVPR 8). For computer graphics the appropriate journals are (IEEE Computer Graphics 9) and the annual (ACM-Siggraph 10).

Fig. 1 Albrecht Durer, Melencolia I, 1514, Engraving, 240 × 187 mm.

Fig. 3 Computer enhanced detail of Fig. 1 showing edge direction information.



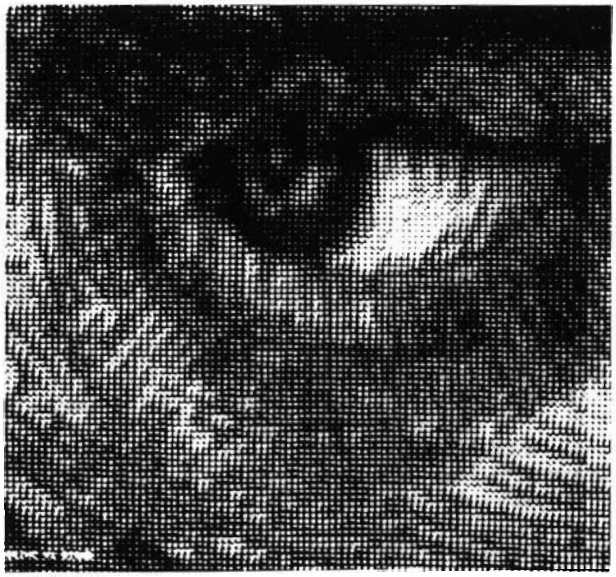


Fig. 2 Computer scanned and reproduced detail with a scanning resolution of 50 micrometers.

volving the use of computer graphics. Such a description is prepared in the form of a drawing made on a special tablet connected to a computer. The drawing may be a sketch or a tracing of an art work. The drawing is stored in the computer as a sequence of many points in the order in which they are made in the drawing. As each part of the drawing is completed, it may be described to the computer with whatever verbal description is appropriate. It may also be associated with a corresponding two – or even three – dimensional image. The computer graphic description may then be stored, searched, and analyzed just as the images may be. Since it is already manually decomposed *(during the drawing process), the pat*tern recognition problem is avoided. Descriptions that may be associated with parts of the computer graphic image may be as elaborate as desired by the art scholar producing the descriptions. The computer graphic description thus provides the advantages of deep analysis by the scholar with automatic processing by the computer, all in the context of graphic images which are more descriptive of the art work than purely verbal descriptions.

Research in Computer Science for automatic processing of images is progressing rapidly, especially in certain areas like medical image processing (11). The use of descriptive methods (largely drawn from modern linguistics) has developed since 1964 (12–15) with outstanding developments in iconics (16) and architecture (17, 18).

We may see examples of how these descriptive methods are used in Figs. 1–3 which show computer scanned two-dimensional images of a Dürer engraving. Examples of three-dimensional computer reconstructions of a sculpture are shown in Figs. 4–7. The procedure that a computer uses in doing automatic pattern recognition is illustrated in Figs. 8–12 in which we see the successive stages that an image undergoes in being abstracted by automatic methods. Finally, in Figs. 13–16, we see examples of the kind of computer graphic methods that can be used to analyze a composition like the Cezanne painting analyzed (19) before computer descriptive methods were available.

The few uses of computers in analyzing art works have largely developed out of a tradition that has treated art works as susceptible to verbal description and analysis. It is now clear, however, that much more powerful methods may deal more directly with images of art works. As art critics, historians, archivists, and studio artists contribute more research in their own specialties, becoming fully cognizant of the opportunities offered by computers, we can expect to see powerful new insights developing to benefit the deeper understanding of art.

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Fig. 4 Left member of stereo photo pair of sculpture with texture superimposed.

Fig. 5 Right member of stereo photo pair of sculpture with texture superimposed.

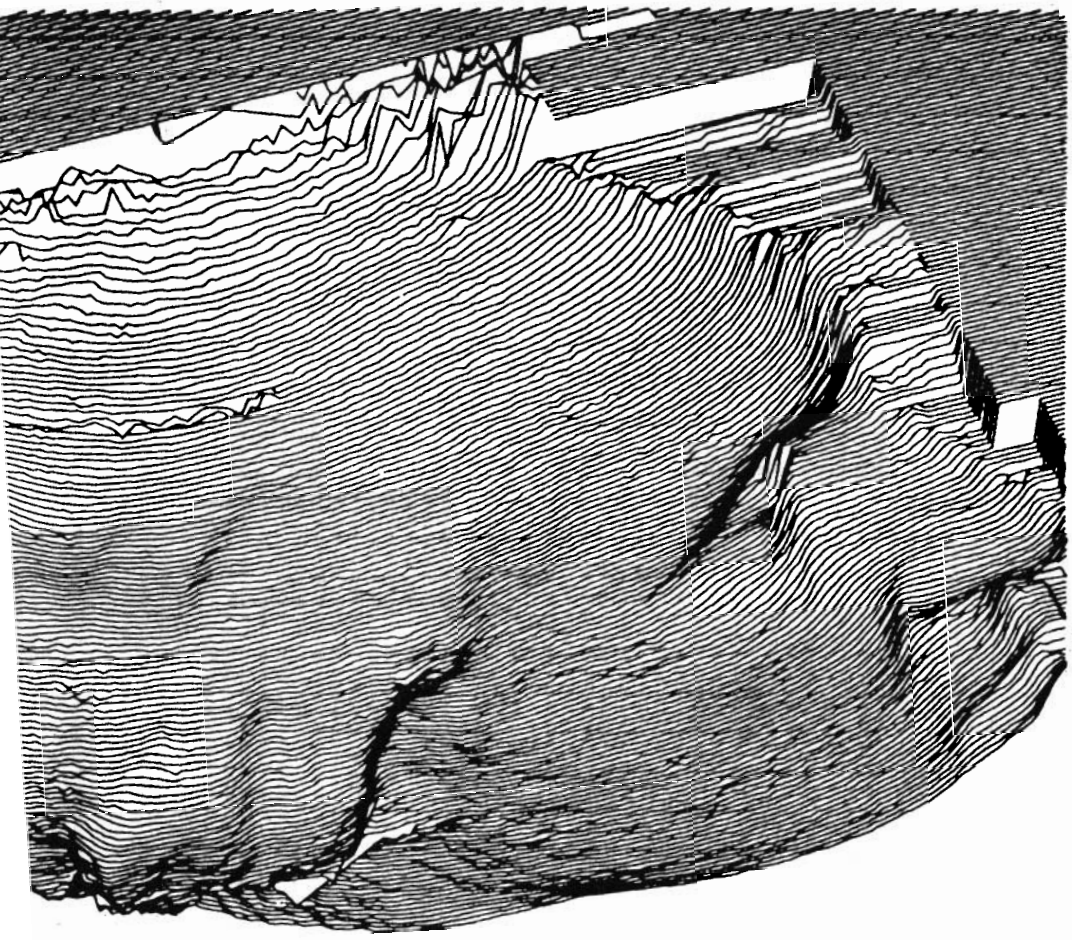

Fig. 7 Computer generated view from above sculpture of Fig. 4–5.

Fig. 6 Computer generated view from beneath sculpture of Fig. 4–5.

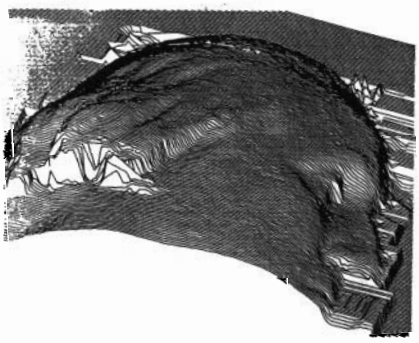

Fig. 8 Computer display of linear objects.

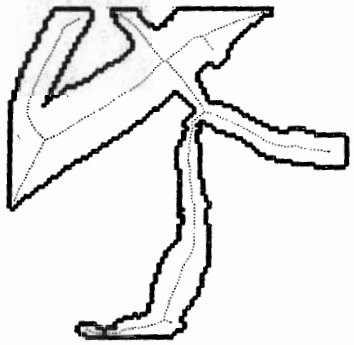

Fig. 9 Computer generated outline of Fig. 8.

Fig. 10 Computer generated thickness vectors along strikes.

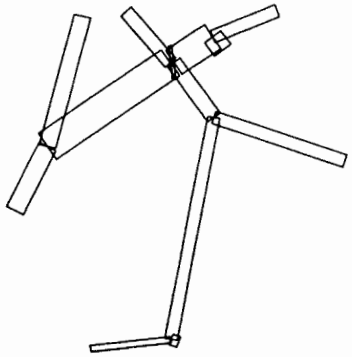

Fig. 11 Computer synthesized image with constant stroke width.

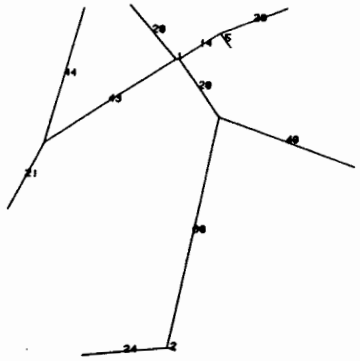

Fig. 12 Computer abstracted image from Fig. 8.

Fig. 13 Graphic tablet drawing of Loran's diagram showing tracing points.

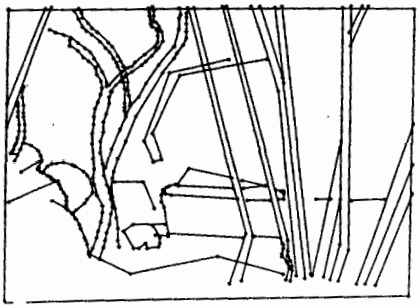

Fig. 14 Time sequence of drawing of components of Fig. 13.

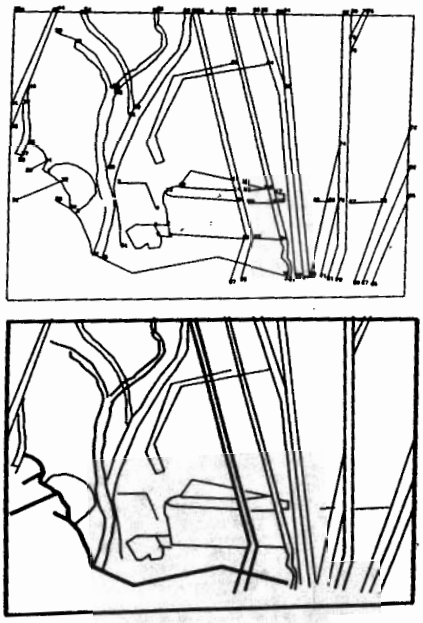

Fig. 15 Computer generated line qualities.

Fig. 16 Computer-aided edited version of Fig. 13.