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### **Computerized Comparison and Analysis of Vincent van Gogh's Painting Brushstrokes<sup>1</sup>**

JAMES Z. WANG, The Pennsylvania State University

With advanced digitization techniques, museums have routinely begun to assemble vast digital libraries of images of their collections. These images can be analyzed by computers to assist art historians for a number of tasks. In our work, we focus on three challenges: artist identification, dating of an art work, and finding distinguishing features among artists. Two complementary approaches were taken: (1) the analysis of the geometric statistics based on the extracted individual brushstroke, and (2) the modeling of overall brushstroke texture. These approaches aim at assisting art historians in comparing a painting or parts of a painting to a group of paintings based on multiple criteria. Statistical methods have been used to compare groups of paintings. Each painting image is divided into subimages. Individual brushstrokes are segmented automatically. Geometric features, including the curvature, the overall orientation, and the size, are computed for each brushstroke. We also compute the features representing the interactivity of the brushstrokes extracted. The statistics, including average and standard deviation, of those features are used to model certain aspects of the artist's brushstrokes. For capturing the local brushstroke texture, we first apply a wavelet transform to the image. A spatial model, the 2-D hidden Markov model, is used to model the texture features of each subimage. The methods have shown to be able to distinguish van Gogh paintings and non van Gogh paintings to a great extent. The techniques can provide clues for the dating of van Gogh paintings. A comparison of the van Gogh paintings, Monticelli's paintings, and paintings by contemporary artists provides insights on their similarities and differences. The analysis has provided numerical statistics for further studying these and other paintings.

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