Scoring Scene Symmetry

Morteza Rezanejad[1], John D. Wilder[2], Sven Dickinson[2], Allan Jepson[2], Dirk B. Walther[3], and Kaleem Siddiqi[1]

[1]Centre for Intelligent Machines and School of Computer Science, McGill University
[2]Department of Computer Science, University of Toronto
[3]Department of Psychology, University of Toronto

Gestalt psychologists have long argued for the role of symmetry in object detection by the visual system. Many objects are composed of symmetric parts, whose surfaces project to contours which express mirror symmetry. This notion of local mirror symmetry can be captured by Blum's medial axis transform and modern methods for computing it (Blum, 1973; Siddiqi et al., 1999). While the role of symmetry in isolated object perception is well studied, its role in the perception of cluttered real-world scenes is not well understood. In fact, methods for the analysis of local contour symmetry in entire scenes are almost completely absent. Most current approaches in the literature focus on the computation of bilateral or generalized symmetries in images (Reisfeld et al. 1990; Tyler 2002).

Herein we consider an extension of the medial axis of the interior of a simple closed curve, in application to the analysis of a line drawing of an entire scene. Using the medial axis as a tool, we assign each contour pixel in the line drawing a symmetry score which captures the degree to which it participates in non-accidental local symmetry relationships. Additionally, the total amount of symmetry can be rated by the average of the symmetry values over each contour pixel.

Our method relies on an association of the medial axis with the average outward flux of the gradient of a Euclidean distance function to contour pixels, computed over a disk of shrinking size. This computation has the advantage that the limiting average outward flux value directly reveals the mapping of medial axis points to their (bi-tangent) contour points (Dimitrov et al., 2003). Thus, a measure of salience based on the total variation of the medial axis radius function can be directly mapped to the contours, to capture the degree to which they are locally parallel.

Our local symmetry analysis of a dataset of line drawings of natural scenes (Walther et al., 2011) reveals differences in the amount of symmetry between distinct categories of real world scenes. For example, man-made scenes (such as offices) typically have a higher average symmetry rating than natural scenes (such as mountain scenes). These intuitive differences support the validity of this measure of local contour symmetry for the analysis of real-world cluttered scenes.

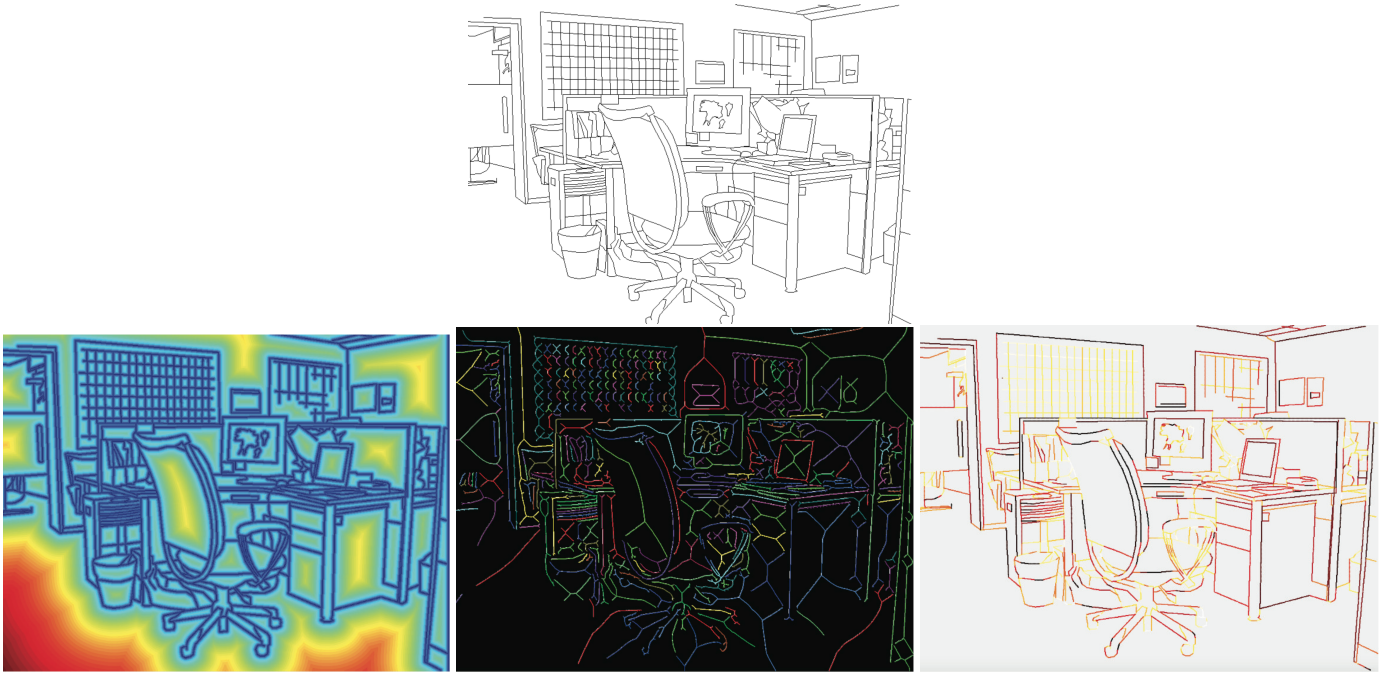

Figure 1. The top panel is a line drawing of an office scene. The lower left shows the Euclidean distance function from the contours in the scenes. Blue pixels are the closest to a contour, and red pixels are the farthest from a contour. The lower middle panel shows the medial axes, one for each region in the line drawing bounded by a closed contour. The color is changed for each medial axis/connected region. The lower right panel shows the symmetry score of each contour pixel. The symmetry values change from low symmetry (yellow) to higher symmetry (red) to the highest symmetry (black).