Scale-Space Based Feature Point Detection for Noisy Digital Curves

Tevfik Metin Sezgin & Randall Davis

Artificial Intelligence Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

http://www.ai.mit.edu

The Problem: We are building systems that support sketch based interaction with computers. These systems rely on having a lower level module that takes freehand strokes consisting of a series of pixel positions along with their timestamps and generates more meaningful descriptions that approximate the input stroke in terms of lines, curves and their combination. One of the important phases in this stroke approximation process is the feature detection phase where the corners of the input stroke are identified.

Motivation: We previously described methods for feature point detection and stroke approximation that use the speed and direction change data [3]. These methods work well for data with relatively little noise, but contain many false positives for noisy input. Although noise in the data can be filtered out by convolving the direction and speed data by appropriate filters, this requires selecting filters a priori which may not work equally well for different strokes. A method that doesn't depend on preset constants is needed.

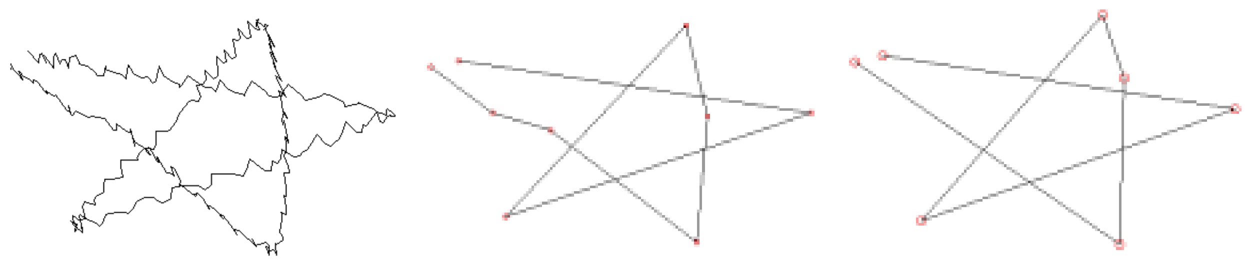

Figure 1: A noisy stroke and the feature points chosen by our method using the scale spaces of curvature and speed data.

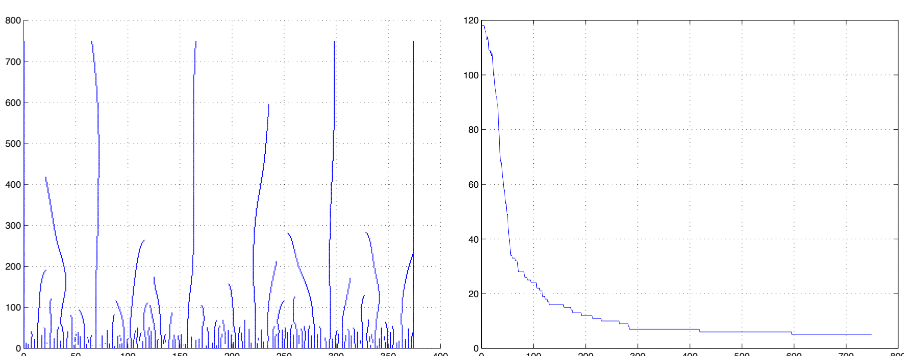

Figure 2: The scale space and the feature count graphs for the curvature data of the noisy stroke in Fig. 1.

Previous Work: Related work on feature point detection and stroke approximation can be found in [2, 4]. The methods described in these works do not deal with noise.

In the scale space community, the work in Rattarangsi et al.[1] describes a scale space based approach for dominant point detection. Our approach differs from their work in several aspects. We utilize curvature as well as speed data for feature point detection and we use scale space techniques in both settings. In addition we build the curvature scale space by convolving the curvature data rather than convolving x and y positions of the points separately and then deriving the curvature as it is done in [1]. This has speed advantages.

Approach: The scale space based method deals with the problem stated above by looking at the number of feature points present at different scales in the scale space. As seen in Fig. 2, the feature count graph for curvature has two distinct regions where the feature count drops with different rates. This behavior is typical for freehand strokes.

Our task is selecting a scale where most of the noise is filtered out. This is done by modeling the feature count graph by fitting two lines to it: one to the region with the steep drop corresponding to places where the feature points due to noise disappear and the other to the flatter region where real feature points disappear. We take the scale corresponding to the intersection of these two lines as our scale.

The results obtained by applying this technique to curvature and speed data are in Fig. 1. The scale space and the feature count graphs are in Fig. 2.

Impact: This technique will increase feature point detection accuracy in noisy data. As a consequence higher level recognition modules will reach better recognition rates making sketching interfaces less error prone.

Future Work: Feature point detection is one of the key stages in stroke approximation for sketching systems. It is followed by curve detection (i.e., detection of curved regions in a stroke). In order to integrate this method to the stroke approximation framework, a curve detection method that works in presence of noise should be devised.

Research Support: This research is supported in part by the Ford / MIT Collaboration, under the Virtual Engineering Project, and by the MIT Project Oxygen.

References:

[1] A. Rattarangsi and R. T. Chin. Scale-based detection of corners of planar curves. *IEEE Transactionsos Pattern Analysis and Machine Intelligence*, 14(4):430–339, April 1992.

[2] P. Schneider. Phoenix: An interactive curve design system based on the automatic fitting of hand-sketched curves. Master's thesis, University of Washington, 1988.

[3] Metin Sezgin and Randall Davis. arly processing in sketch understanding. *MIT Artificial Intelligence Laboratory Annual Abstract*, September 2000.

[4] R. Zeleznik. Sketch: An interface for sketching 3d scenes. In *Proceedings of SIGGRAPH'96*, pages 163–170, 1996.