Scale-space Based Feature Point Detection for Noisy Digital Curves

Tevfik Metin Sezgin and Randall Davis

The Problem: We are building systems that support sketch-based interaction with computers. Part of the foundation for these systems is a 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 by 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: This work is part of our group's effort to build natural feeling sketch based computer interfaces[2, 1]. These works describe systems that provide natural interaction with computers by speech and sketching. Our system is intended to support the sketch understanding module discussed in these works by doing feature point detection on strokes sketched by users.

We previously described methods for feature point detection and stroke approximation that use the speed and direction change data [5]. 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, a single set of filter parameters does not work equally well for different strokes. A method that doesn't depend on preset constants is needed.

Previous Work: Related work on feature point detection and stroke approximation can be found in [4, 6]. The methods described there do not deal with noise. In the scale space community, the work in Rattarangsi et al.[3] describes a scale space based approach for dominant point detection using the curvature data.

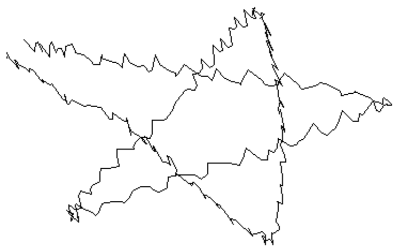

Figure 1: An example illustrating the kinds of noisy free-hand strokes we want our system to be able to handle.

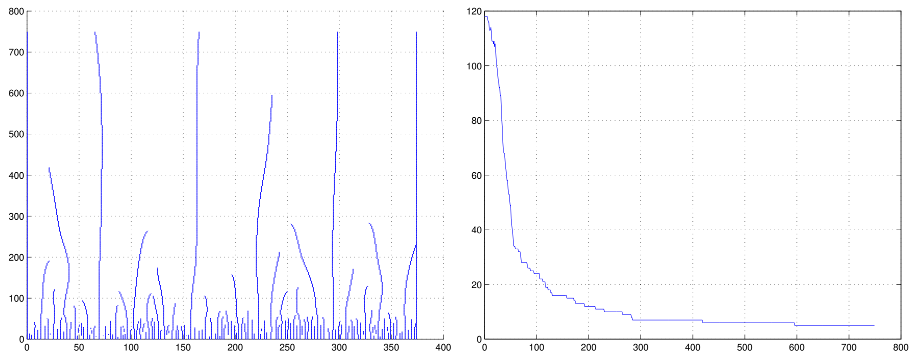

Figure 2: The scale space and the feature count graphs for the curvature data of the noisy stroke in Fig. 1.

Approach: The scale space based method we developed deals with the noise by looking at the number of feature points present at different scales in the scale space. In Fig. 1, we have a noisy stroke and the corresponding scale-space and feature count graphs are in Fig. 2. 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. 3.

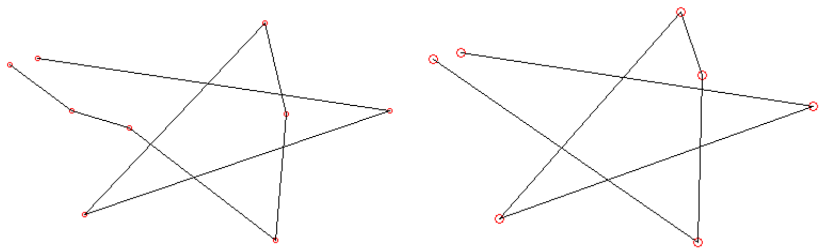

Figure 3: Two sets of feature points, one detected by the scale-space based approach using the curvature data, and the other using the speed data consecutively.

Our approach is different from the one described in Rattarangsi et al [3]. We apply the scale space based technique to curvature as well as speed data and combine the information from both sources for feature point detection. 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 [3]. This has efficiency advantages.

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 MIT Project Oxygen.

References:

[1] Christine Alvarado and Randall Davis. Resolving ambiguities to create a natural sketch based interface. *Proceedings of IJCAI-2001*.

[2] Micheal Oltmans. Understanding naturally conveyed explanations of device behavior. Master's thesis, Massachusetts Institute of Technology, 2000.

[3] 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.

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

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

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