# ON-LINE GESTURE RECOGNITION BY FEATURE ANALYSIS

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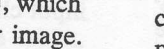
## Abstract

A feature analysus method was developed for the recognition of hand generated gestures (or markings). Gesture recognition differs from handwriting recognition because gestures are often generated in different proportions, rotations, and sometimes in mirror images. The features are based on direction changes and they are applied successfully to gestural variations. This recognition system is a part of a keyboardless direct manipulation interface to a spreadsheet application.

KEYWORDS: Direct manipulation, gestural variations, gesture recognition, electronic tablet, feature analysis.

## Introduction

In recent years, recognition of hand-generated tablet-captured symbols has progressed to symbols other than handwritten characters and include shorthand, editing symbols, and flow chart symbols [1,2,3]. Recognition of such symbols usually depends on shape consistency. The difference between different instances of the same symbol must be less than the difference between different symbols. However, there is a class of symbols in which the same symbol can differ, in some respects, more than different symbols, yet recognizable by humans. An example is a commonly used delete symbol (  ), which varies in size, orientation, and sometimes in mirror image. Computer recognition of such symbols has been difficult because computers were not taught the features that will correctly classify such symbols.

## Problems in gesture recognition

Unlike handwriting, there is no fixed set of gestures defined and used over the population. Proofreader's editing symbols are defined but not widely used. Additionally, gesture generation is not an overlearned skill for most people. Gesture generation is usually a slow conscious process. There seem to be room to define a set of gestures and let users learn and use them. The same gesture is often made differently by the same person at different times, and recognition should be designed for this possibility. Gestures also come in different sizes and orientations. Handwriting, in most cases, is on a writing line (which may be invisible), and have fixed heights. On the other hand, some gestures such as scoping can be small for a small scope like one letter but large for a large scope like a paragraph. The difference measures and features developed for handwriting recognition do not always work for gestures. Thus, a new measure of difference is necessary for reliable recognition of gestures. Figure 1 shows some delete gestures and circular enclosing scope gestures for a spreadsheet application.

We identified the following variations (Figure 2) in gestures.

1. Non-linear scaling
2. Rotation
3. Mirror image
4. Reverse direction at production time

We call them gestural variations.

In many handwriting recognition systems, the same letter, produced differently, is often recognized as more than one shape but later mapped to one symbol. For example, Suen [4] has identified 16 different ways of producing "E". Recognizing all of them as possible variations requires too much time and space. The same approach is possible for gestures - recognize the variations as different shapes, and then map all different shapes to the same gesture. Again, this allows recognition but each gesture may have to be recognized as many shapes and we encounter vocabulary explosion.

We have concluded that it is necessary to develop a new recognition algorithm to handle gestural variations. A new feature, direction change, was found to handle gestural variations. A recognition system that utilizes directions for fixed shape gestures and direction changes for varying gestures is developed.

### *Application*

The gesture recognizer is a part of a spreadsheet application interface. Instead of a keyboard and a separate screen, a specially made transparent tablet on top of a flat screen [5] is used as an input/output device. With a cursor following the pen when the pen is close to the tablet surface and