The Kritzel System for Handwriting Interpretation *

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Introduction

We present a new system for recognizing on-line cursive handwriting. The system, which is called the Kritzel System, has four features.

First, the system characterizes handwriting as a sequence of feature vectors. Second, the system adapts to a particular writing style itself through a learning process. Third, the reasoning of the system is formulated in propositional logic with likelihoods. Fourth, the system can be readily linked with other English processing systems for lexical and contextual checking.

System Structure

The Kritzel System is organized into three modules: Interpretation module, Partition module and Learning module.

The Interpretation module extracts local topological features along the pen trajectory, yielding a sequence of time-ordered feature vectors. By scanning the sequence against character templates, it identifies all possible characters and provides a confidence value for them. Using lexical and contextual checking, it selects reasonable words from these candidates.

The Partition module is invoked when the Interpretation module fails to provide the correct word. It asks the user for the exact word written, then partitions the handwriting into discrete segments which correspond to each character of the word.

Using the results of the Partition module, the Learning module analyzes the mistakes of the Interpretation module and adjusts the templates. The Learning module has three alternative ways to adjust the templates. Each of the alternatives is evaluated by a logic program and the best one is selected.

System Implementation

The Kritzel System is implemented in the C programming language. The logic programs are compiled by the Leibniz System.

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The Interpretation module implements a five-layer decision pyramid. At layer 1, it reads X-Y coordinate values of the pen trajectory. At layer 2, it extracts local topological features such as maxima, minima, slope and curvature. This yields a sequence of time-ordered feature vectors. At layer 3, it does template matching to find all possible characters along the sequence. At layer 4, it figures out the relationships between each pair of those characters. At layer 5, it searches for the written word, using the Laempel System which performs lexical and contextual checking.

The Partition module is invoked when the result of the Interpretation module is incorrect. First, it locates the tall characters in the word. Then, using all feature vectors of the templates and a reasoning program, it searches for the remaining characters. The search is performed on each range separated by the already identified tall characters. If the word has not been fully segmented, it searches the possible ranges again using selected feature vectors of the characters.

The Learning module analyzes the mistakes made by the Interpretation module. For each mistake, it either does a monotone adjustment, or replaces an infrequently used template in the database, or adds a new template to the database. Monotone adjustment involves changing the thresholds or weights of some parameters of the feature vectors. By checking for conflicts with history and reasoning involving likelihoods, it selects the option which will improve the system the most.

Results To-Date

The Interpretation module, the Partition module and the Learning module have been developed. The system is under integration testing.

References

1. Leibniz System for Logic Programming, Version 4.0, Leibniz, Plano, Texas 75023, 1994
2. Laempel System, Version 1.1, University of Texas at Dallas, Richardson, Texas, 75083-0688, 1995