A Comparison of Feature and Pixel-based Methods for Recognizing Handwritten Bangla Digits

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ABSTRACT

« The novel handwritten recognition method for isolated handwritten Bangla digits called the *Contour Angular Technique* is proposed.

« The goal of this study is to explore performance differences between two feature methods and two pixel-based methods.

« The results show that the fast contour angular technique outperforms the other techniques when not very many training examples are used.

Feature Extraction Technique

The Contour Angular Technique (CAT)

« The CAT implementation is a fast implementation of quantized angle co-occurrence computation. The CAT creates **feature vectors of size 192**.

« The technique consists of two stages.

1 Divides the character into *16 non-overlapping blocks* and considers the contour of the handwritten image as *8-directional codes*. This setting computes *128 features*.
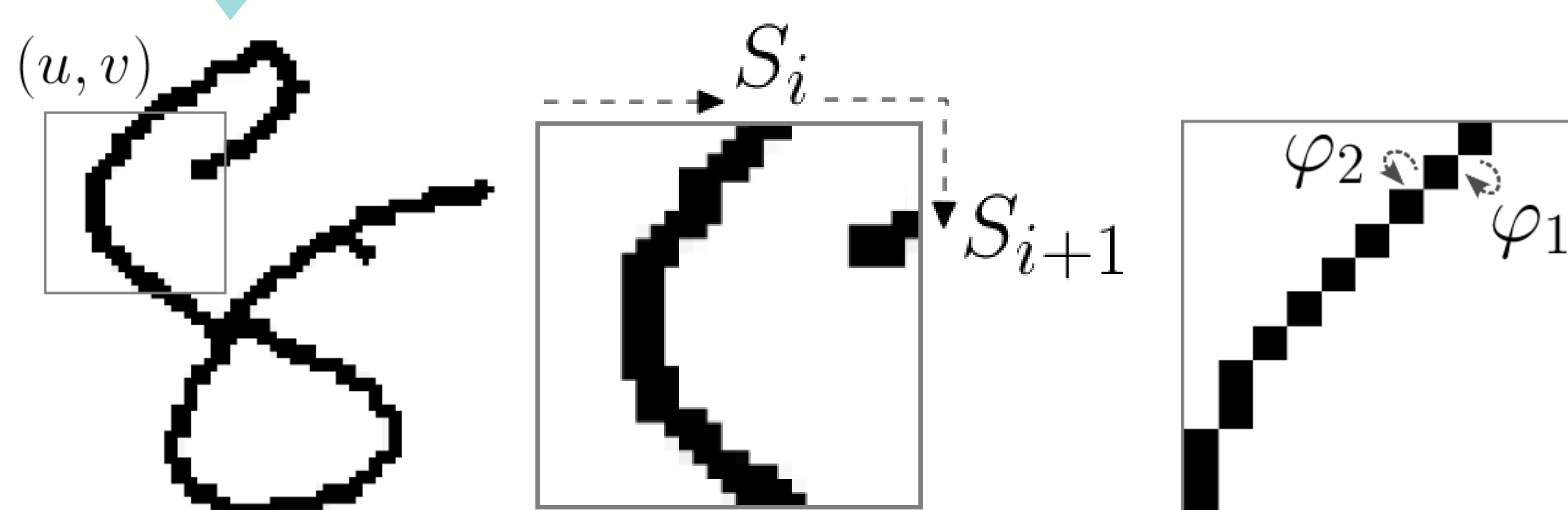
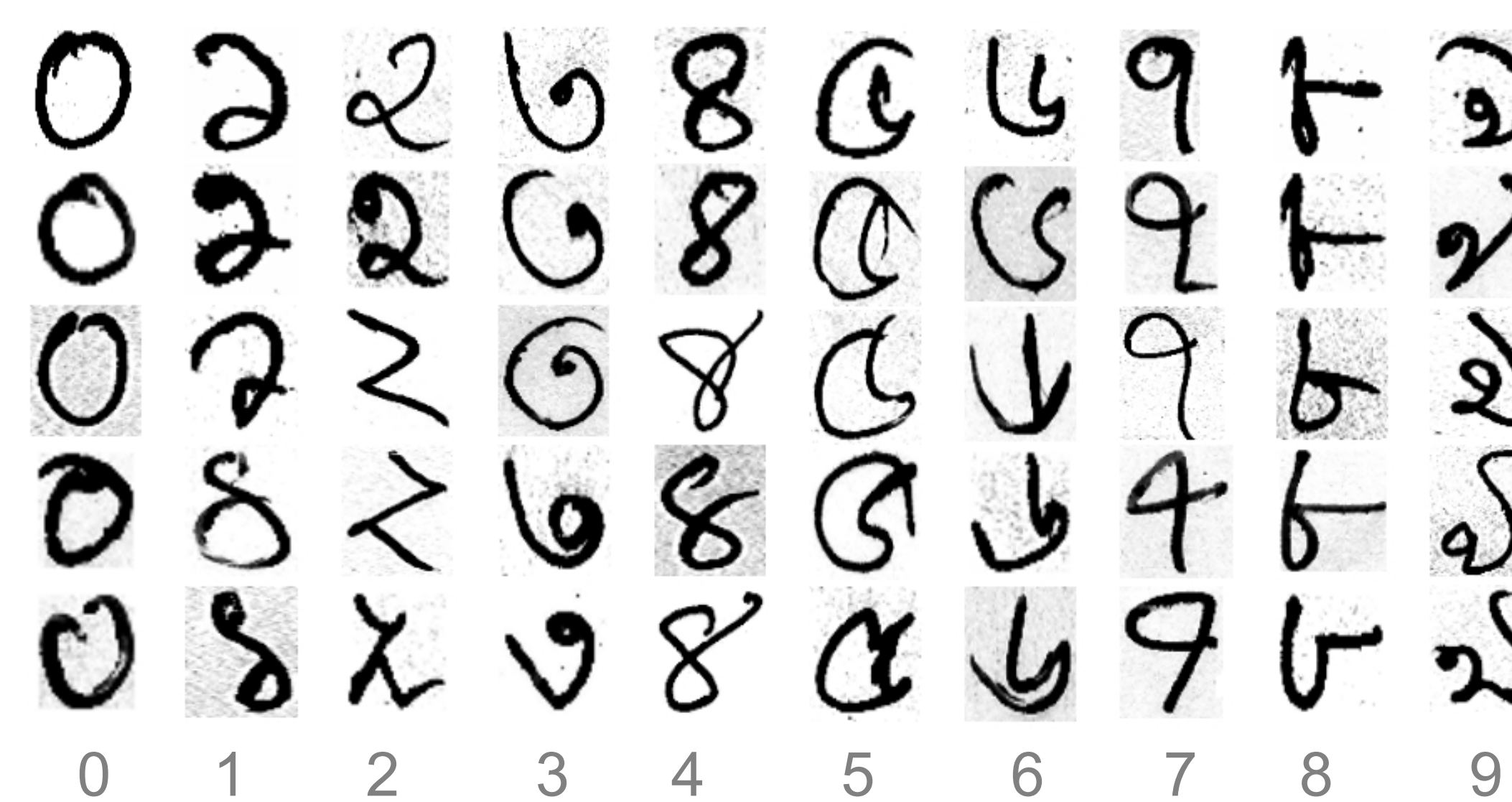« The starting point S_i is searched along the (u, v) borders.

« 8-directional codes are used for identifying the contour of the neighbor pixels.

« The angular co-occurrence for which angle $\varphi1$ and $\varphi2$ are computed.

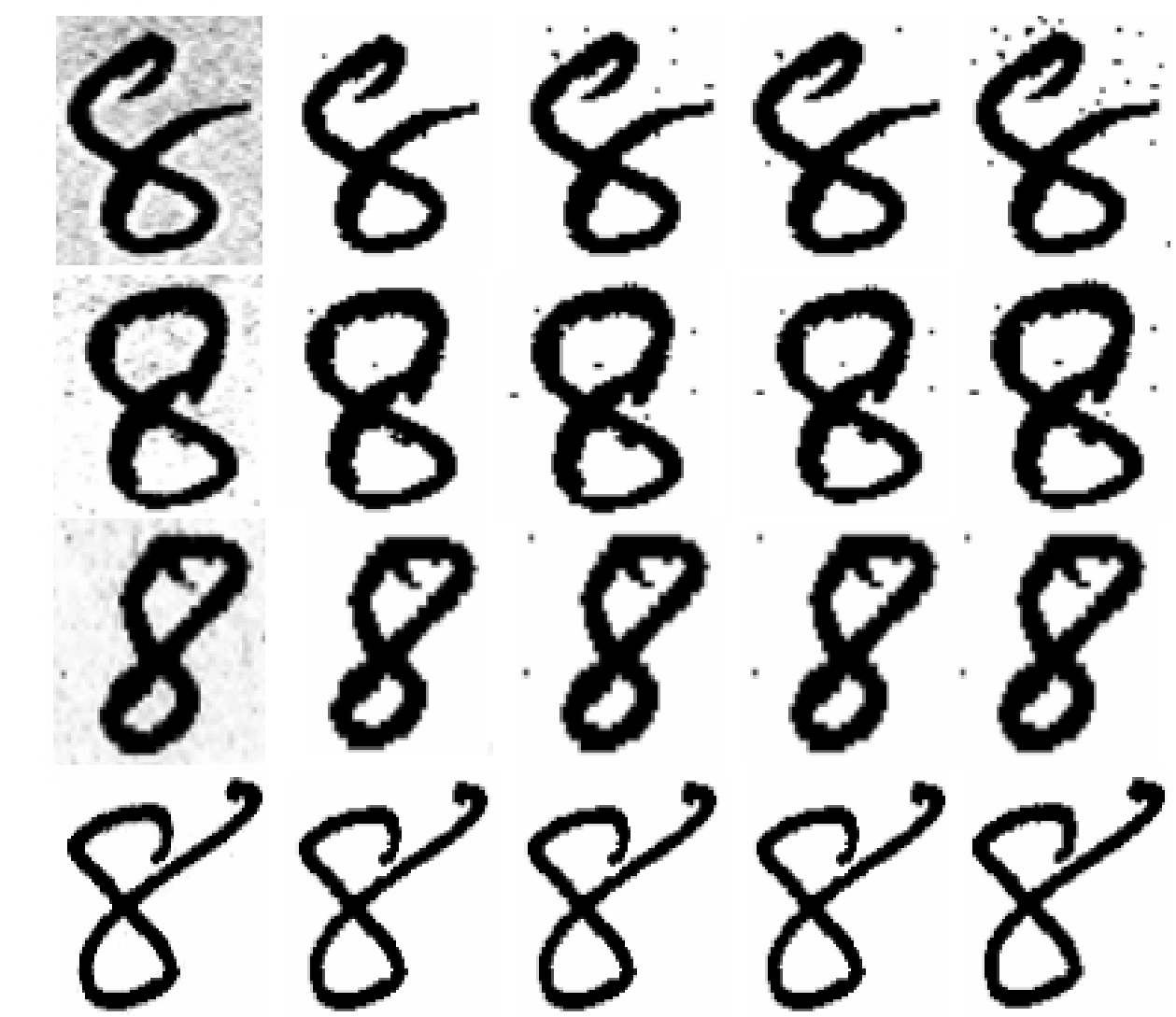**2** Computes the contour of the handwritten image. The angles that move from starting point until the last pixel are considered. Then, the *co-occurring angles* in a two-dimensional array are counted. *(Figure above)*

DATASET PREPARATION

« The Bangla digit dataset is composed of 10,920 examples of the numbers 0 to 9.

« In this experiment, Otsu's algorithm was the best algorithm to transform a gray image into a binary image without noise.


Results of handwritten images after applying the binarization methods.

First column, the handwritten image before removing background noise.

Second – fifth column, background noise is removed by Otsu's, Wolf's, Sauvola's and Niblack's algorithm, respectively.

A variety of handwritten Bangla digit samples. Set of numbers from 0 to 9.

EXPERIMENTAL RESULTS & CONCLUSION

« We choose the **RBF** kernel as a non-linear similarity function in the SVM classifier. The best values of the C and the **Gamma** γ parameters, that were found with grid search, are chosen.

« We have used **10-fold cross validation** to evaluate the results of the handwritten Bangla digit recognition methods.

« We used the unweighted majority vote method (UMV) to combine the outputs from four different **SVM classifiers**.

« We used training set sizes of 10, 20, 30, 40 and 90%, respectively of 10,920 examples in total.

« **CAT outperforms** the best pixel-based method when the training dataset is not very large.

« When the training dataset size increases, the best pixel-based method slightly outperforms CAT.
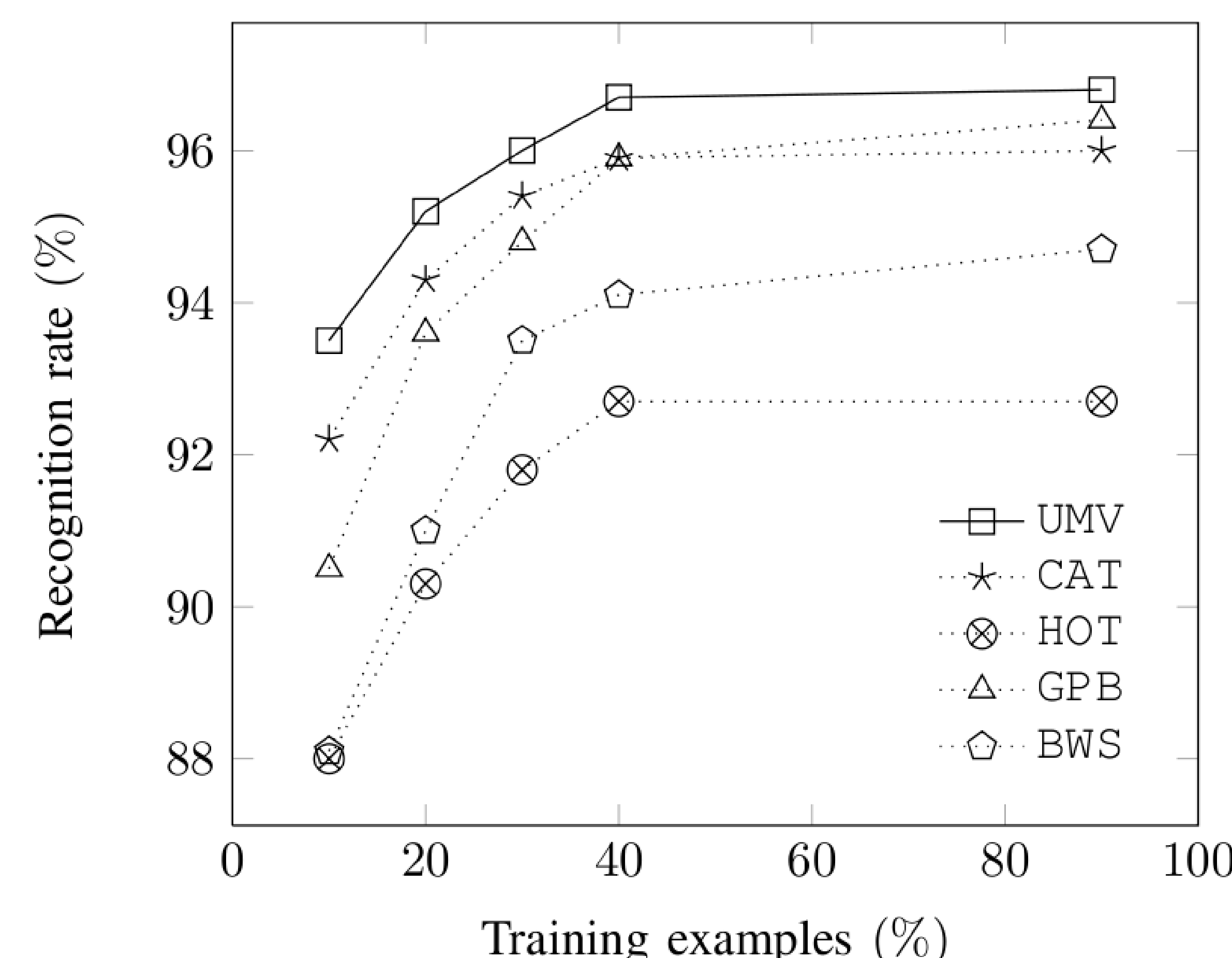
The recognition rates of feature techniques and the majority vote for combining SVM classifiers on the handwritten Bangla digit dataset.

* **HOT** = Hotspot Technique
* **GPB** = Gray Pixel-Based Method
* **BWS** = Black and White Down Scaled Method

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