Abstract

A pencil and paper are often preferable for every one to use during the first draft preparation instead of using keyboard and other computer input interfaces like this. How much easier and faster the lives will be for those, who are non-natives to English, computer novices and feel inconvenient in using keyboard and keypad (old people), if a system (multi-lingual) having the intelligence in recognizing the natural handwriting for all possible scripts around the world exists. Under the purview of this, a novel approach on a complete template-based on-line writer independent natural handwritten character recognition system for Nepali is explored. It enjoys the advantages of 'Dynamic Time Warping' (DTW) in classifying the digitized strokes into its own class at the same time of writing.

The number of strokes, their order, directions, shapes and sizes, tilting angles and similarity in between the characters from one another are variable in cursive handwriting. Nepali is one of the examples of cursive handwriting. A number of strokes within a class of character from many users are merged based on their similarity and clustered them accordingly in order to reduce the number of prototype training samples (templates). The prototype classifier takes an advantage of single-linkage agglomerative hierarchical clustering. We construct a prototype classifier that uses the DTW algorithm to align handwritten strokes with stored stroke templates and determine their similarity. Both the pen-tip position and pen direction at every position along the pen trajectory is used as the feature of the stroke for classification. In addition to the structural feature of the stroke, spatial information has been taken into account for greater classification accuracy. To evaluate the system, we collected examples of 46 classes of different alphanumeric characters from Nepalese natives, and then performed a series of experiments. A prototype template-based classifier is developed by using both the structural properties of the strokes and their spatial relation. An inclusion of spatial relation between/among the strokes within the character in the classifier improves the performance. More than 95% classification rate is achieved from the classifier, where spatial information is included with the structural properties of the strokes while it is 5% less in the classifier, where spatial information is not in use.

Not only the recognition rate of the classifier, the recognition speed is also counted under the classifier's performance. As the classifiers use matching procedure for identification of test strokes, the speed is variably determined from one stroke to another. The number and size of strokes in the test letter and templates affect the recognition speed. In addition, degree of dimension of the feature vector sequence plays a crucial role. Hence, different recognition speeds are achieved. However, 12 seconds per character is the fastest average speed of the classifier among a series of experiments.

The methodology used in this classification engine is general and hence flexible in adding extra symbols in Nepali and can be extended to other scripts as well.