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## Convolutional Neural Network Training incorporating Rotation-Based Generated Patterns and Handwritten Numeral Recognition of Major Indian Scripts

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### Abstract

Handwritten numeral recognition has gained much interest in recent times because of its diverse application potentials. Bangla and Hindi are the two major languages in Indian subcontinent and a large number of population in vast land scape uses Bangla and Devnagari numeral scripts of these two languages. Well-performed handwritten numeral recognition system for Bangla and Devnagari is challenging because of similar shaped numerals in both scripts; few numerals differ from their similar ones with a very few variation even in printed form. In this study, convolutional neural network (CNN) based two different methods have been investigated for better recognition of Bangla and Devnagari handwritten numerals. Both the methods use rotation-based generated patterns along with ordinary patterns to train CNN but in two different modes. In multiple CNN case, three different training sets (one with ordinary patterns and two with clockwise and anti-clockwise rotation-based generated patterns) are prepared; three different CNNs are trained individually with each of these training sets; and their decisions are combined for final system decision. On the other hand, in the case of single CNN, combination of above three training sets is used to train one CNN. A moderated pre-processing is also employed while generating patterns from the scanned images. The proposed methods have been tested on prominent benchmark handwritten numeral datasets and have achieved remarkable recognition accuracies. The achieved recognition accuracies are found better than reported recognition accuracies of prominent existing methods; and such outperformance mounted proposed methods as better recognition systems. Moreover, CNN's performance improvement due to use of generated patterns has also been clearly identified from the presented experimental results.

### Keywords

**Author Keywords:** [Convolutional neural network](#); [Handwritten numeral recognition](#); [Image pre-processing](#); [Pattern generation](#)

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