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# Online Handwritten Strokes Recognition using Support Vector Machines

**Sukhdeep Singh***

Assistant Professor in Computer Science, Mata Sahib Kaur Girls College, Talwandi Bhai, Ferozepur, Punjab, India

***Abstratct – Handwriting recognition can be viewed in two forms as offline and online handwriting recognition. This study has been done for online handwriting recognition. The present work is a step for online handwriting recognition in Indic scripts. This paper recognizes online handwritten Devanagari strokes using a statistical recognition technique Support Vector Machines. The results have been achieved as 93.27%, 89.12% and 99.08% for upper, middle and lower zone Devanagari classes, respectively.***

***Keywords: Devanagari, Online Handwriting Recognition, SVM***

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## INTRODUCTION

Handwriting recognition has become a buzz word these days. A great work has been done for non-Indic scrips as Chinese, Japanese, Korean, Arabic and Latin script. These scripts handwriting recognition work includes the smaller units as well as larger units. The smaller units mean the strokes and characters. The larger units include the words, sentences and paragraphs. The work has been done for both offline and online mode of handwriting. Offline handwriting means the text is first scanned and then understood by the computers of mobiles, but on the other side, online handwriting refers to understanding the handwritten text at the same time when it is written on the digital surface of screen of the computer. For online handwriting recognition, the temporal information also plays an important role. For the last few decades, the online handwriting recognition has become a key area of research.

Online handwriting recognition for Indic scripts has also made a notable progress in last decade (Deepu, et. al., 2004, Swethalakshmi, et. al., 2006, Roy, et. al., 2007, Parui, et. al., 2008, Prasad, et. al., 2012, Sundaram and Ramakrishnan, 2013, Kunwar, et. al., 2014, Samanta, et. al., 2014). One of the Indic scripts is Devanagari. Although, the researchers and scientists are always motivated to work in the direction of online handwriting recognition in Indic scripts. When compared with other Indic scripts as: Telugu, Bangla and Oriya, the work done for Devanagari script is also praiseworthy. Few researchers have done work for online Devanagari handwriting recognition for larger units as words or sentences. There is a great need of working in the area of online Devanagari handwriting recognition especially larger units as words or sentences. The Devanagari is the script of commonly spoken language Hindi. The Devanagari is not an isolated script and it shares many properties with other Indic scripts. So, it falls into the category of Brahmi scripts. The present study has been done for online Devanagari handwriting recognition where isolated online handwritten Devanagari strokes have been recognized using support vector machines (SVM).

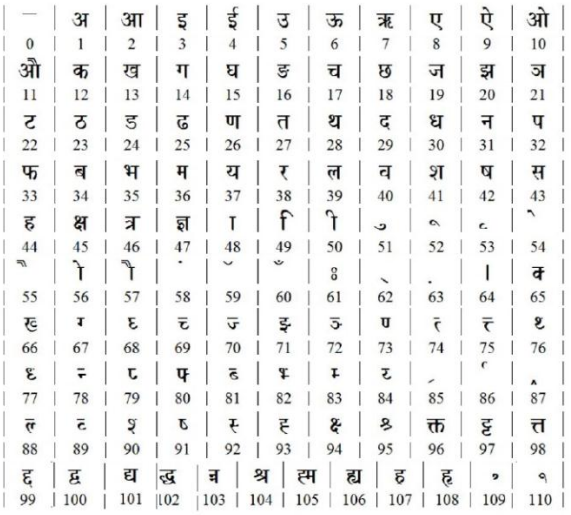

**Figure 1.Symbol set defined for Devanagari**

For online handwriting recognition in any script, it is very important to identify the primary units of script writing. These primary units are called symbols. The Devanagari symbol set is shown in figure 1. Here, the symbol 0 is the headline. The symbols 1

to 11 are independent vowels. The consonants with implicit vowel sounds are shown with the symbols 12 to 44. The symbols 48 to 63 and 109 to 110 are *matras*. The sentence ending symbol is the 64. The half characters are represented by symbols 65 to 95. The conjuncts are represented with symbols 45 to 47 and 96 to 108.

## LITERATURE SURVEY

The major work for online Devanagari handwriting recognition for smaller units as characters been done by Ghosh and Roy [9], Chowdhury et al. [10], Mondal et al. [11] and Swethalakshmi et al. [12]. The table 1 shows the Online Devanagari handwriting recognition results for smaller units (characters).

**Table 1. Online Devanagari handwriting recognition for smaller units (characters)**

| Sr. No. | Authors and References | Year | Classification Techniques | Recognition rate (%) |
|---|---|---|---|---|
| 1 | Ghosh and Roy [9] | 2015 | ZSDP, Support Vector Machine (SVM) | 90.63 |
| 2 | Ghosh and Roy [9] | 2015 | Characters Zone wise structural and directional features (ZSD), SVM | 85.10 |
| 3 | Chowdhury et al. [10] | 2013 | Levenshtein distance metric | 83.95 |
| 4 | Mondal et al. [11] | 2010 | Point-float feature, HMM | 82.43 |
| 5 | Mondal et al. [11] | 2010 | Point-float feature, Multilayer perceptron (MLP) | 83.30 |
| 6 | Mondal et al. [11] | 2010 | Chain-code feature, HMM | 87.13 |
| 7 | Mondal et al. [11] | 2010 | Chain-code feature, MLP | 86.15 |
| 8 | Swethalakshmi et al. [12] | 2007 | SVM | 96.69 (42 classes) and 97.27 (82classes) |

## CLASSIFICATION TECHNIQUE FOR DEVELOPED DATASET

The present work uses SVM for recognition of online handwritten strokes of Devanagari. When it comes supervised learning models, the suitability of SVM technique cannot be denied in online hnadwriting recognition. Further SVM is best suitable for recognition of individual units as strokes or characters. One of the characteristics of SVM is that it is very efficient and well suitable for multiple continuous and categorical variables. The SVM uses the kernel functions like linear kernel, polynomial kernel or radial basis function kernel and finds the best separating hyperplane. In order to perform the multi class recognition, The SVM either combines the binary SVMs or extends the support vector learning method.

## EXPERIMENTAL RESULTS

The present work has used the in-house Devanagari dataset for experimentation. The experimentation used the chain code feature vector in two forms. The first form of feature vector uses the chain codes for building the feature vector of fixed length. The other form of feature vector uses the frequencies of chain codes appended at the end of the feature vector prepared using directional chain codes. In both types of feature vectors, the length of feature vector remains same irrespective the shape of stroke. The figure three exemplifies two types of feature vectors used in the present work. The recognition results for both types of feature vectors with SVM are given in table 2 and 3.

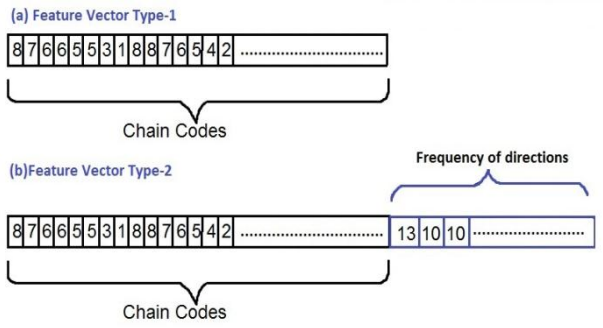


**Figure 2.Feature Vectors**

**Table 2. Recognition accuracy for SVM classifier with feature vector one**

| Train Data (%) | Test Data (%) | Upper zone Recognition Rate (%) | Middle zone Recognition Rate (%) | Lower zone Recognition Rate (%) |
|---|---|---|---|---|
| 50 | 50 | 83.89 | 79.64 | 97.06 |
| 66 | 34 | 92.24 | 87.92 | 97.95 |
| 80 | 20 | 88.54 | 86.55 | 98.08 |

**Table 3. Recognition accuracy for SVM classifier with feature vector two**

| Train Data (%) | Test Data (%) | Upper zone Recognition Rate (%) | Middle zone Recognition Rate (%) | Lower zone Recognition Rate (%) |
|---|---|---|---|---|
| 50 | 50 | 84.80 | 80.39 | 97.03 |
| 66 | 34 | 92.27 | 88.12 | 97.95 |
| 80 | 20 | 88.29 | 86.44 | 98 |

## CONCLUSION

In this study, the authors have showed the use of statistical classification technique SVM for online handwritten Devanagari strokes recognition where in-house dataset has been used for experimentation and two types of feature vectors based on chain code have been employed. So, this work has been done for smaller units called

strokes. In available studies, it has been seen that a great work for smaller units' online Devanagari handwriting recognition has been done for digits, characters and strokes. The present study is an important work for future researchers to do further research for online handwritten Devanagari text recognition using SVM for smaller. Our study has presented that there is a great requirement to do more research work for online Devanagari handwriting recognition for smaller units as well as larger units as words/sentences. For online handwritten Devanagari words and sentences recognition, a lot to be done in the future.

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**Corresponding Author**

**Sukhdeep Singh***

Assistant Professor in Computer Science, Mata Sahib Kaur Girls College, Talwandi Bhai, Ferozepur, Punjab, India

sukhdeep13@pu.ac.in