

The eight features of chain code and fourteen features of wavelet decomposition coefficients are given to the KNN and SVM classifier for classification.

Testing Phase:

3.4 Algorithm: Recognition of Kannada Numerals

Input: Isolated test Numeral image.

Output: Recognition of the Numeral.

Start:

Step 1: Extract the features by using Algorithm 3.3.

Step 2: Compute the distance between the feature vectors of the test image and with the feature vector of the trained image stored in knowledge base.

Step 3: Minimum distance computed in the above step 2 is the recognized Numeral.

End.

4. Experimental Results and Discussion

The proposed method is implemented using Intel Core 2 Quad processor @ 2.66 GHz machine and MATLAB 2012b. Based on the KNN and SVM classifiers 2000 Kannada handwritten and 2000 Kannada printed digits are classified. The data set for handwritten numerals consists of 2000 images and with 200 images representing each class/numerals, considering 50% for training and 50% for testing. For result computation we have used k-fold cross validation technique. The experiments were carried out by varying the values of k i. e .k= 1, 3, 5 and found optimal result when k=3 as shown in Table 3. The average percentage of recognition accuracy is 96.61 and 97.88 was obtained for handwritten numerals.

The experimental results are obtained by using 2000 training samples and 2000 testing samples for mixed Kannada handwritten and printed digits (Table 5). Here each class consisting of 400 images of numerals by considering 50% for training and 50% for testing. The performance of an algorithm is tested using 2-fold cross validation when k= 3. The results obtained are encouraging for mixed handwritten and printed Kannada numerals. The Table 3 and Table 4, presents the recognition accuracy of Kannada handwritten and printed Digits separately. The Table 5 shows overall recognition for mixed handwritten and printed Kannada digits.

Table 3: Percentage of Recognition Accuracy for Handwritten Kannada Numerals with KNN and SVM Classifier.

Training samples = 1000, Test samples = 1000 and Number of features = 22				
Handwritten Kannada numeral	No. of sample Tested	No. of sample Trained	Percentage of recognition Accuracy with KNN	Percentage of recognition Accuracy with SVM
0	100	100	97.8	98.2
1	100	100	98.52	99.01
2	100	100	97.5	100
3	100	100	90.25	94.82

8	100	100	100	100
9	100	100	98.24	98
0	100	100	96.58	98.62
1	100	100	90.45	92.2
2	100	100	96.82	98
3	100	100	100.00	100.00
Average Percentage of Recognition accuracy			96.61	97.88

Table 4: Percentage of Recognition Accuracy for Printed Kannada Numerals with KNN and SVM Classifier.

Training samples = 1000, Test samples = 1000 and Number of features = 22				
Printed Kannada numerals	No. of sample Tested	No. of sample Trained	Percentage of recognition Accuracy with KNN	Percentage of recognition Accuracy with SVM
0	100	100	98.65	99.8
1	100	100	100	100
2	100	100	97.8	100
3	100	100	100	100
4	100	100	100	100
5	100	100	99.0	100
6	100	100	98.4	99.0
7	100	100	98.8	99.5
8	100	100	99.8	99.8
9	100	100	100	100
Average Percentage of Recognition accuracy			99.245	99.84

Table 5: Percentage of Recognition Accuracy for Mixed Handwritten and Printed Kannada Numerals.

Training samples = 2000, Test samples = 2000 and Number of features = 22				
Mixed Printed and Handwritten Kannada numerals	No. of sample Tested	No. of sample Trained	Percentage of recognition Accuracy with KNN	Percentage of recognition Accuracy with SVM
0	200	200	99.32	99.55
1	200	200	99.26	99.35
2	200	200	97.65	100
3	200	200	95.12	96.03
4	200	200	100	100
5	200	200	98.62	98.77
6	200	200	97.49	100
7	200	200	94.62	99.018
8	200	200	98.31	98.54
9	200	200	100	100

Average Percentage of Recognition accuracy	98.04	99.12
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5. Conclusion

An algorithm proposed here for recognition of mixed printed and handwritten Kannada Numerals using Normalized chain code and wavelet transform. The proposed method has shown the encouraging results for recognition of mixed handwritten and printed Kannada digits by using KNN and SVM classifiers. We have obtained recognition accuracy of 98.04% and 99.12% for mixed handwritten and printed Kannada digits with KNN and SVM classifiers respectively. In any recognition process, the important steps are to address the feature extraction method and correct classifier method. The proposed algorithm and classifier tries to meet desired accuracy with few feature vector set. The Novelty of the proposed method is independent of thing. Our future plan is to extend the proposed method for recognition of mixture of printed and hand printed numerals of other Indian languages.

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