Deep Learning Architecture for Large Scale Hand Written Devanagari Character Recognition

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Abstract – Hand written character recognition is one of task can be related to automate text recognition system. The system can be improved at level of optical character recognition. The authors has used pretrained neural network ResNet-18, ResNet-50 and ResNet-101 for image classification. furthermore result of these pretrained neural networks are combined using majority voting classifier. The minimum training accuracy 74.13% for character number 26, and maximum training accuracy is 100% for character number 33. The minimum testing accuracy 66.67% for character number 7, and maximum testing accuracy is 19.84% for character numbers 21, 31 and 32. The average accuracy for training is 92.775% and average testing accuracy is 91.13% respectively.

Key Words: Stereo imaging, 3D depth estimation, image processing, object recognition, height estimation.

1. Introduction

Character recognition is most widely used technique in area of pattern recognition and machine intelligence. It basically converts handwritten recognized character into machine processable format. Advanced record preparing is picking up notoriety for application to office and library mechanization, bank and postal administrations, distributing houses and correspondence innovation. Devanagari being the national language of India, spoken by in excess of 500 million individuals, ought to be given uncommon consideration with the goal that record recovery and investigation of rich old and current Indian writing can be viably done [1]. Four component feature extraction procedures to be specific, crossing point, shadow include, chain code histogram and straight line fitting features were used to develop OCR for Devanagari script [2]. Support vector machine and artificial neural networks based classifiers has been used for Devanagari character recognition [3]. Two arrangements of highlight are figured and two classifiers are consolidated to get higher precision of Devanagari character recognition. Size of the feature vector of each set is 392. First list of capabilities is processed dependent on the directional data got from the circular segment digression of the inclination. Since a large portion of the Devanagari written characters have some bend like expressions, and flow based element guided by inclination data is registered for the second arrangement of highlights. Consolidated utilization of Support Vector Machines (SVM) and Modified Quadratic Discriminant Function (MQDF) are applied here for better execution of Devanagari character recognition [4]. block based feature extraction and PCA-SVM classifier has been proposed [5] for Devanagari character recognition.

2. Data Acquisition

In proposed study, an image dataset has been downloaded from UCI machine learning repository [6] of handwritten Devanagari digit characters. There are total of 92000 images are available in this datasets, that are further more divided in 36 class of Devanagari consonants and 10 class of Devanagari numerals each having 2000 images [7] . Table 1 and Table will show sample images of Devanagari numerals and consonants used for this paper.

Table 1. Devanagari digits

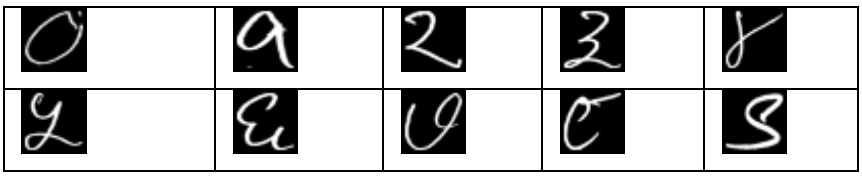
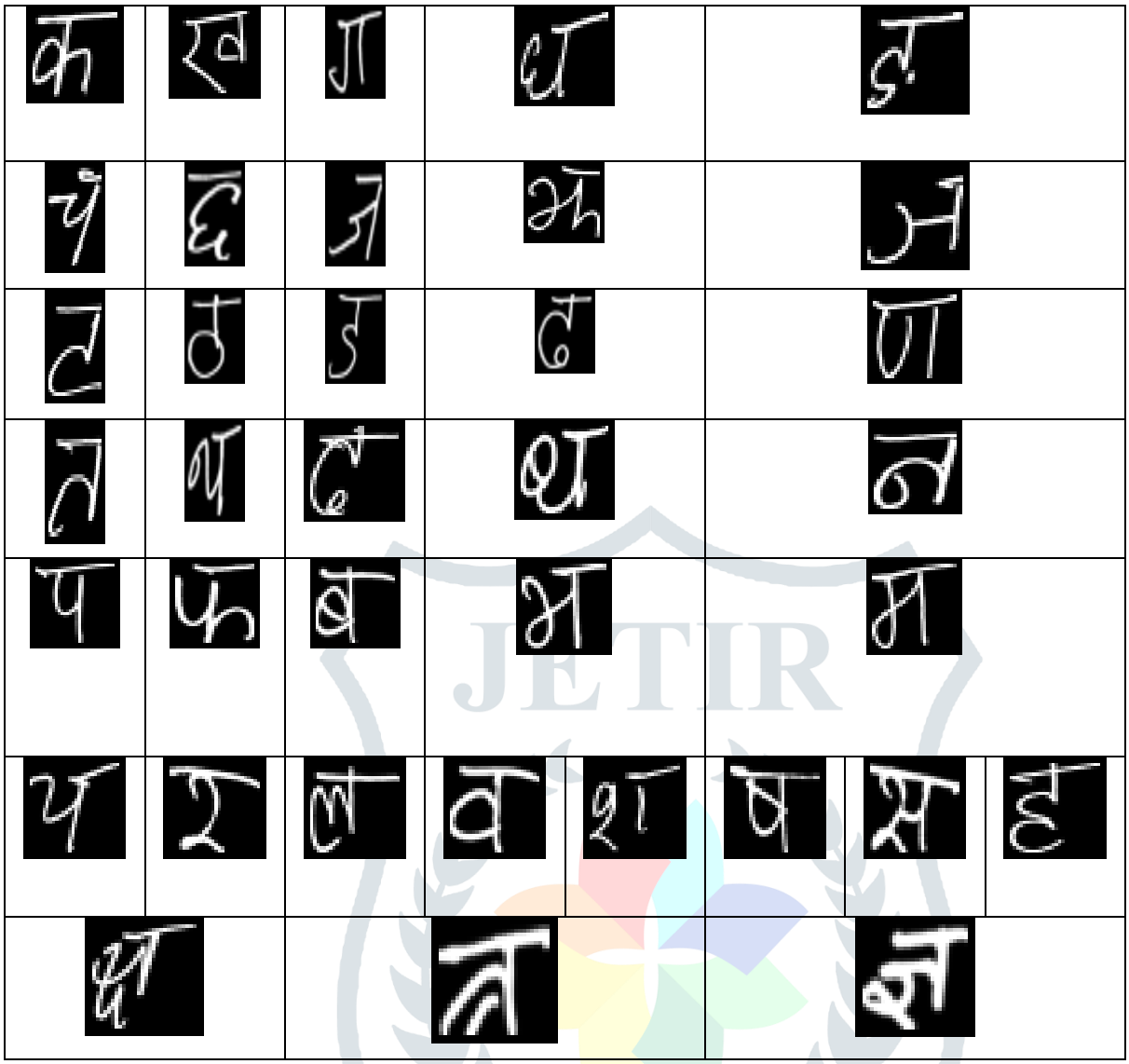


Table 2. Devanagari consonants



3. Data Pre-Processing

Data pre-processing involves modification in datasets prior to image classification tasks. This require a following steps like conversion of all images of same size 64 x 64, remove unnecessary noise present in an image as well as image enhancement techniques. The entire dataset has been splatted into training set (70%), and testing set (30%) which is further analysed in paper. Figure 1 shows random 100 training images.

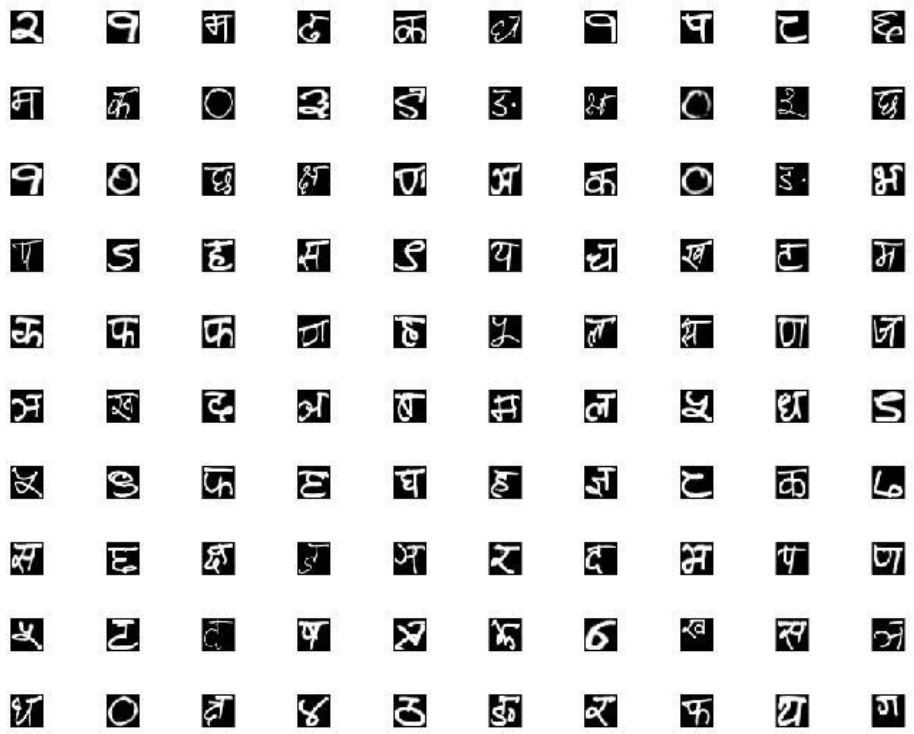


Figure 1. Random training images

4. Deep Learning Architecture

Deep learning is core part of artificial intelligence, where a machine can learn from image directly. Idea behind using of deep learning architecture is to reduce the complexity of feature extraction. Deep learning learns by their architecture. Various layers such as convolution, subsampling, batch normalization, dense, fully connected, relu and softmax layers has been used for it.

For Devanagari character recognition the authors has used ResNet-18, ResNet-50 and ResNet-101 pretrained convolution neural networks [8][9] and their final results has been aggregated using majority voting classifier. The proposed methodology has been explained in figure 2. Figure 3 will explain residual block.

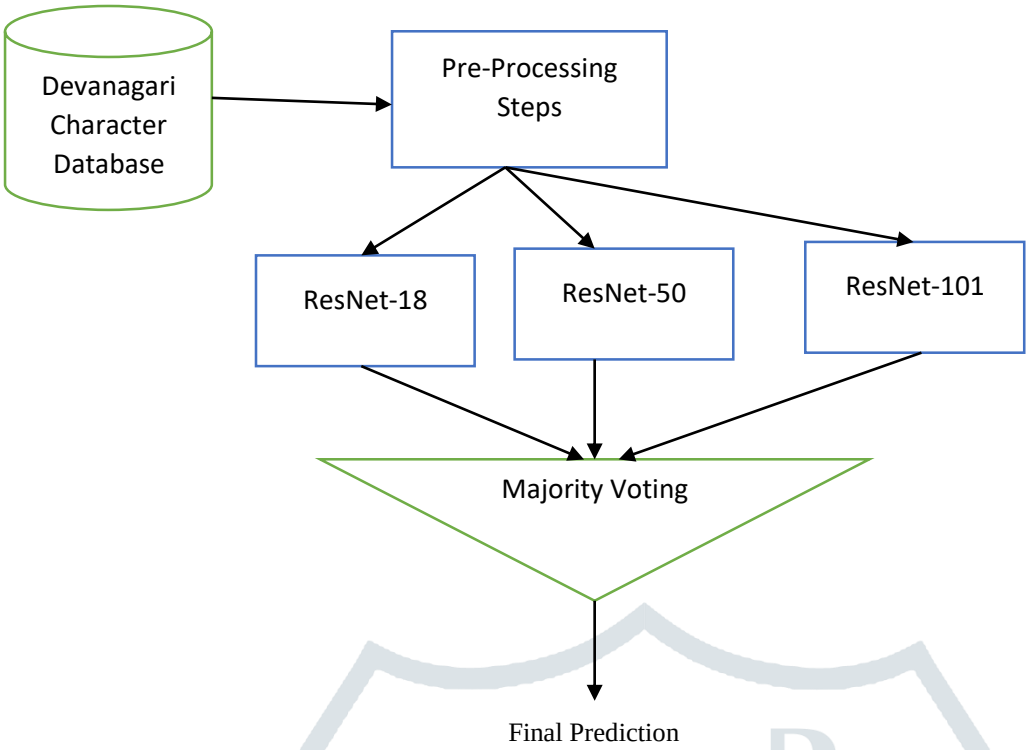


Figure 2. Proposed Methodology

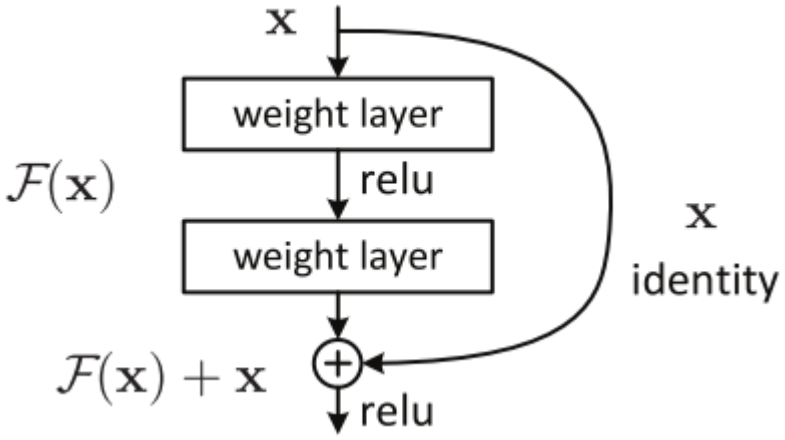


Figure 3. residual block

5. Result and Discussion

All experiment results has been carried out on windows operating system with i7 1st generation CPU @ speed of 2.2 GHz and 12 GB primary memory. For this research purpose the authors has used python programming language. Table 3 will show the training and testing accuracy of each characters. Figure 5 will show training loss and figure 6 will compare training and testing accuracy respectively.

Table 3. Training and testing accuracy of individual characters

Images	Train Images	Training Accuracy	Test Image	Testing Accuracy
Character 1	1400	92.8571429	600	83.3333333
Character 2	1400	96.4285714	600	91.6666667
Character 3	1400	94.2857143	600	88.3333333
Character 4	1400	92.1428571	600	86.6666667
Character 5	1400	93.5714286	600	85
Character 6	1400	95	600	81.6666667
Character 7	1400	97.1428571	600	66.6666667
Character 8	1400	85.7142857	600	83.3333333
Character 9	1400	98.5714286	600	84.1666667
Character 10	1400	98.7142857	600	85.1666667
Character 11	1400	98.5714286	600	88.3333333
Character 12	1400	98.5714286	600	89.1666667
Character 13	1400	99.2857143	600	91.6666667
Character 14	1400	99.4285714	600	96.6666667
Character 15	1400	92.8571429	600	90.8333333
Character 16	1400	78.5714286	600	88.3333333
Character 17	1400	85.7142857	600	85
Character 18	1400	91.4285714	600	86.6666667
Character 19	1400	88.9285714	600	84.1666667
Character 20	1400	97.1428571	600	91.6666667
Character 21	1400	99.2857143	600	98.3333333
Character 22	1400	94.2857143	600	91.6666667
Character 23	1400	97.1428571	600	99
Character 24	1400	98.3571429	600	93.3333333
Character 25	1400	89.2857143	600	88.3333333
Character 26	1400	71.4285714	600	96.6666667
Character 27	1400	96.4285714	600	90
Character 28	1400	95.7142857	600	91.6666667
Character 29	1400	96.7857143	600	95
Character 30	1400	77.8571429	600	91.6666667
Character 31	1400	99.2857143	600	98.8333333
Character 32	1400	99.8571429	600	99.8333333
Character 33	1400	100	600	99.1666667
Character 34	1400	85.7142857	600	96.6666667
Character 35	1400	89.7142857	600	97.5
Character 36	1400	85	600	99.1666667
Digit 0	1400	92.1428571	600	97.5
Digit 1	1400	92.7142857	600	94.1666667

Digit 2	1400	96.1428571	600	95.8333333
Digit 3	1400	94.5	600	97.6666667
Digit 4	1400	97.6428571	600	92.5
Digit 5	1400	96.4285714	600	86.6666667
Digit 6	1400	99.8571429	600	87.5
Digit 7	1400	72.8571429	600	90.8333333
Digit 8	1400	87.8571429	600	96.6666667
Digit 9	1400	86.4285714	600	97.5
	64400	92.7748447	27600	91.134058

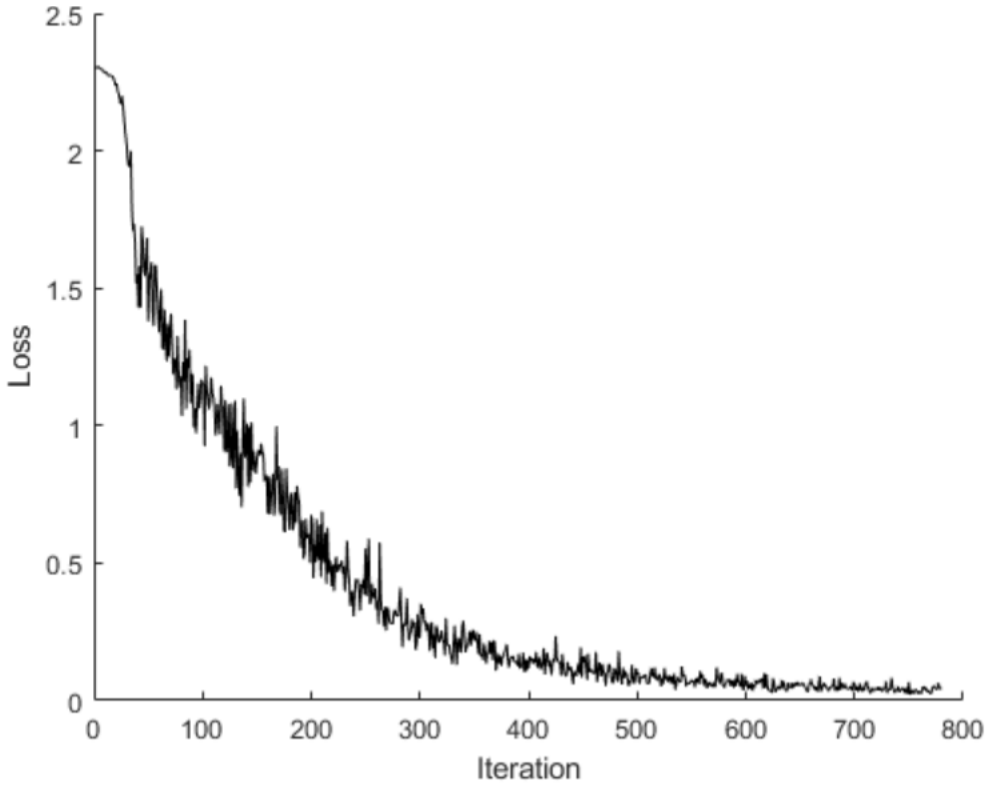


Figure 4. Training loss

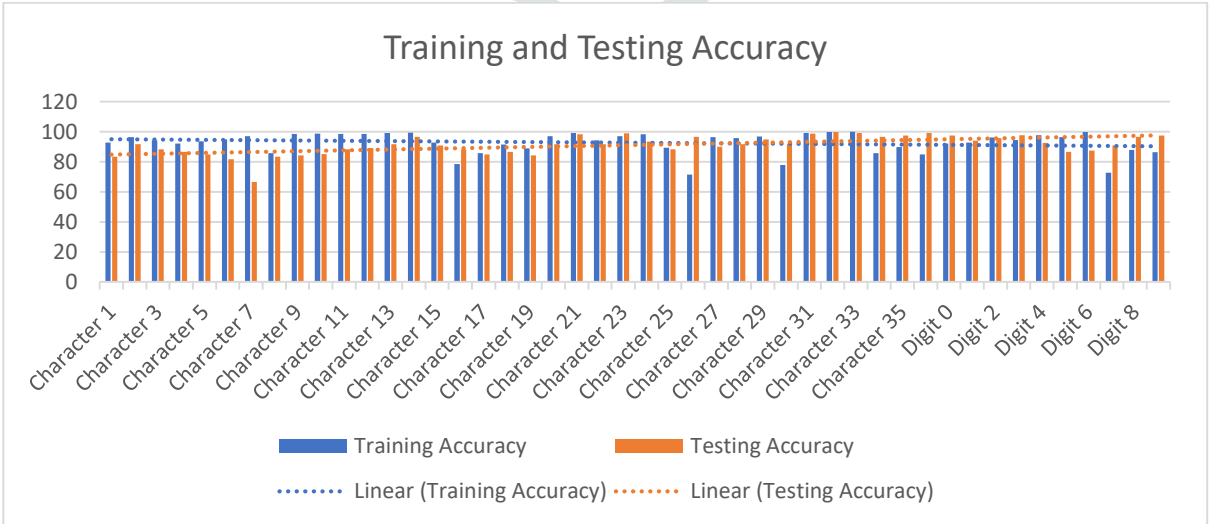


Figure 5. Training and testing accuracy

6. Conclusion

From table 3, the authors can conclude that pretrained neural network of combination of ResNet-18, ResNet-50 and ResNet-101 can be used for image classification in effective manner. The minimum training accuracy 74.13% for character number 26, and maximum training accuracy is 100% for character number 33. The minimum testing accuracy 66.67% for character number 7, and maximum testing accuracy is 19.84% for character numbers 21, 31 and 32. The average accuracy for training is 92.775% and average testing accuracy is 91.13% respectively.

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