

MARATHI CHARACTER RECOGNITION USING DEEP LEARNING

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Abstract- Character Recognition plays an important role because of increasing digitalization. It is difficult to search and share physical documents. So it is important to convert physical documents into digitalize form. For this purpose, character recognition is necessary. There are several applications in different fields like banking, healthcare, administration offices, etc. In this paper deep learning is used to recognize the Marathi characters and digits. Deep learning is a field of machine learning which uses artificial neural networks based algorithms. We have chosen deep learning because it works efficiently with images. Aim of this survey paper is to discuss various existing methods used for character recognition.

Keywords- Pre-processing, Segmentation, Classification, Convolutional Neural Network, Deep Learning.

I. INTRODUCTION

Handwritten character recognition is a field of research in deep learning, computer vision and pattern recognition. Computer system which is performing handwriting recognition can acquire and detect characters in paper documents, pictures, etc. and convert them into digitalize form. This is needed because we cannot carry physical documents everywhere also it is difficult to manipulate physical document. Now a days such systems are implemented using different deep learning algorithms.

Handwritten Marathi character recognition consists of five stages which includes image acquisition which means handwritten samples are collected and scanned, next is preprocessing which is used to enhance the image after that segmentation is performed to sharpen the image. In next step classification and recognition is performed and in postprocessing output is stored in text file.

Deep learning is a branch of machine learning which uses neural networks inspired by human brain neural networks. Neural network consists of multiple layers. Deep networks have a hierarchical structure which makes them particularly well adapted to learn the hierarchies of knowledge. Single layer can compute a very complex function but to extract complex features deep learning is necessary. As deep learning uses hierarchical structures, it can be used with image data efficiently so we have chosen deep learning for handwritten Marathi character recognition. In deep learning, algorithm is not provided with already extracted features as an input because algorithm itself performs feature extraction and it will find all possible features which can be used to get highest accuracy of the classification model. Thus input to the algorithm is preprocessed image. There are various classification algorithms in deep learning such as Recurrent Neural Network (RNN), Back Propagation Neural Network (BPNN), Convolutional Neural Network (CNN), Deep Convolutional Neural Network (DCNN), Deep Belief Network (DBF), Deep Neural Network (DNN) etc. After several studies it is observed that each algorithm has its own pros and cons. For example, DNN is widely used but it has slow training process. RNN is best used for sequential data whereas CNN algorithm is best method for correlated data e.g. images. After studying the pros and cons of

these neural networks we have decided to use Convolutional Neural Network (CNN) for handwritten Marathi character recognition.

TABLE 1. COMPARATIVE STUDY OF MACHINE LEARNING METHODS

Sr. No.	Algorithms used for character recognition	Accuracy achieved(in percentage)
1.	Linear classifier	61.09%
2.	Random forest	69.57%
3.	K-nearest neighbors	81.03%
4.	Support vector machines	82.59%
5.	Deep learning	90.04%

Above table shows accuracy (in percentage) of different algorithms used for character recognition. Linear classifier, Random forest, K-nearest neighbors, Support vector machines and Deep learning are different algorithms used for recognition of character, from which deep learning algorithms gives highest accuracy among all even with large dataset. Following graph represents the comparison between the accuracies of different algorithms.

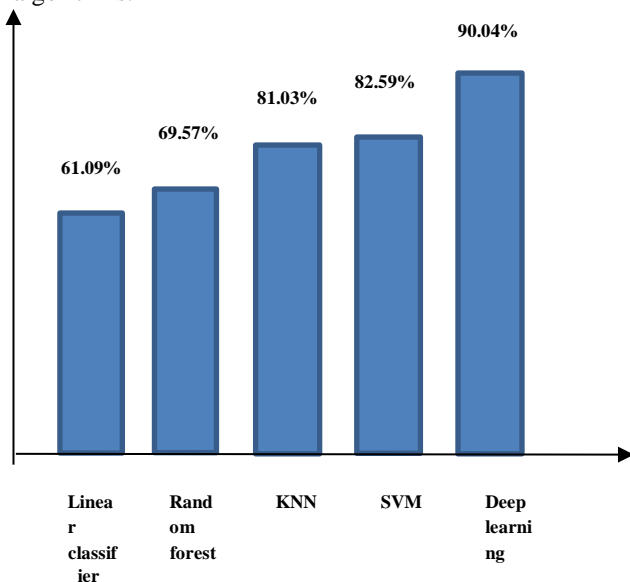


Fig.1 Graphical representation of different machine learning algorithms

II. GENERALIZED APPROACH

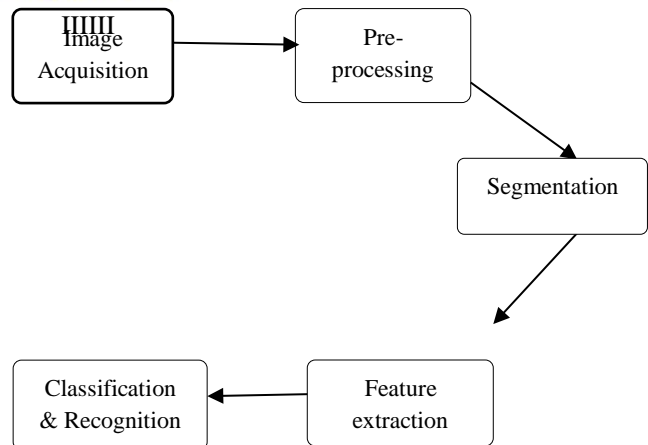


Fig.2 System Modules

A. Image Acquisition

Handwritten Marathi character samples are collected from different peoples and scanned with the help of camera or scanner to convert them into picture format.

B. Pre-processing

As the handwriting samples are collected from different peoples there may be different problems associated with it such as noise, image may be blur, etc. So the pre-processing techniques are applied on images to remove such noise and to enhance the image quality. Initially image is in RGB color format therefore there are some complexities while processing image. So the RGB to grayscale conversion is required to reduce complexity from a 3D pixel value to 1D value. Many tasks do not fare better with 3D pixels for example edge detection.

C. Segmentation

Pre-processed image is given as input to segmentation process. Segmentation is carried out to separate the character from its background. In this case character will be represented in white or black color. Accordingly, background may be black or white. This is one of the important steps in character recognition.

D. Feature Extraction

Segmented image is given as an input to this module. This module will extract the features of the character from its image. Features can be Geometrical features such as area, perimeter, eccentricity, etc., low level features such as color, texture of an image, etc. and high level features such as vertical line, horizontal line, curve, etc.

E. Classification and recognition

Classification is a process of identifying the character and assigning a correct class label to it. The output of feature extraction module is given as an input to classifier. Classifier will learn from extracted features and recognize the correct

class label for the input image. For classification there are different techniques available. One of them deep learning. Deep learning uses different artificial neural networks such as CNN, ANN, RNN, etc. From all these neural networks CNN is the only neural network to which we don't need to provide already extracted features. CNN takes the image as an input and extract maximum features as different layers. The main advantage of CNN is it reduces the human efforts of extracting the features. CNN works efficiently with large amount of data such as images.

III. WORKING OF CNN

Convolutional neural network (CNN) is a type of neural network which uses special type of layer called as convolution layer. CNN consists of multiple layers such as convolution layer, non-linearity (ReLU) layer, pooling or sub-sampling layer and fully-connected layer.

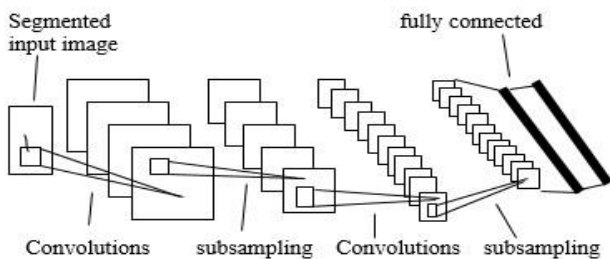


Fig.3 CNN for character recognition

Each convolution layer consists of a filter which is shared between multiple neurons within that layer. The size of these filters is smaller than the image size. The filters are used to extract the features from the input image. The subarea of the image from which the filter extract the features is called as receptive field and the extracted feature is called as feature map i.e. filter will perform dot product with the previous layer. The result of these dot products are stored in separate neurons of the convolution layer.

Next layer is pooling layer which is also called as subsampling layer. Each neuron of pooling layer works over the feature maps created in previous convolution layer. The main aim of pooling layer is to minimize the input. The pooling is done in two ways which are max pooling and average pooling. In max pooling the maximum value from feature map is found and those pixels are replaced with the single pixel which has maximum value. In case of average pooling the average value from feature map is found and those pixels are replaced with the single pixel which has average value. At the end of this layer we will get the minimized version of the previous image. Again

this minimized image is given as an input to the next convolution layer and the process will be repeated. The repetition of the process depends on number of layers in the network. Number of layers are not fixed which will vary as per requirement.

Last layer is fully connected layer. This layer also known as output layer of the convolutional neural network. Task performed by this layer is classification. In fully connected layer every neuron is connected with every other neuron as shown in figure.

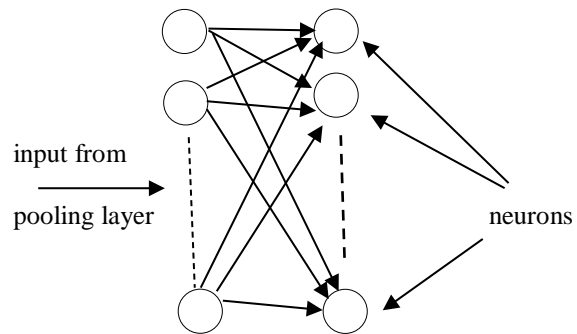


Fig.4 Fully connected layer

IV. LITERATURE REVIEW

In this paper [1] Shailesh Acharya, Ashok Kumar Pant, Prashna Kumar Gyawali proposed a deep learning architecture for recognition of marathi hand written characters. They focus the use of Dropout and dataset increment approach to improve test accuracy. We have learned Deep Convolutional Neural Network from this paper.

In this paper [2] Ms.Padma Ramkrushna Bagde, Dr.Ajay Anil Gurjar mainly focus on the genetic algorithm approach and existing methods for it. Performances of different classification methods with different features and segmentation methods are compared. We are going to refer classifier like neural network and genetic algorithm.

In this paper [3] Jinfeng Bai, Zhineng Chen, Bailan Feng, Bo Xu attempt to introduce the Shared Hidden Layer Convolutional Neural Network framework to image character recognition. It shows that the SHL-CNN can reduce recognition errors by 16-30% relatively compared with model strained by characters of only one language using conventional.

In this paper [4] Miss. Minakshi Sanjay Bhandare, Miss. Anuradha Sopan Kakade has shown the result of pre-processing

and segmentation of compound character. We are going to apply those techniques in our dataset for better result.

In this paper [5] Supriya Deshmukh, Leena Raghya proposed efficient method for feature extraction like Directional algorithm. Two kind of directional features are examined, one by using stroke length distribution method and other by using contour.

In this paper [6] Bishwajit Purkaystha, Tapos Datta, Md Saiful Islam used deep convolutional neural network for recognizing hand written Marathi characters.

In this paper [7] Parshuram M. Kamble, Ravindra S. Hegadi propose feature extraction from handwritten Marathi characters using connected pixel based features like area, perimeter, eccentricity, orientation and Euler number. We are going to refer methods for extracting the above geometrical features.

In this paper [8] Dhanashree Joshi, Sarika Pansare proposed techniques like combination of edge detection with binarization and morphological operations to improve the result in pre processing step. We are going to prefer K-Nearest Neighbor classifier.

In this paper [9] Ravindra S. Hegadi, Parshuram M. Kamble used multilayer feed-forward neural network for recognizing handwritten Marathi character.

In this paper [10] Sanjay S. Gharde, Dr. R. J. Ramteke, Vijay A. Kotkar, Dipak D. Bage performs the recognition of handwritten Devanagari numeral and vowel by using hybrid approach which combines Invariant Moment and Affine Moment Invariant feature extraction techniques. For recognition, Support Vector Machine and Fuzzy Gaussian Membership Function are applied on numerals and vowels respectively.

In this paper [11] Xin Gao, Jie Zhang, Zhe Wei provided performance comparison among three deep learning models: CNN, RNN and CNN-RNN models. These models help to find an appropriate deep learning model for a special sequence pattern.

In this paper [12] Dhara S. Joshi, Yogesh R. Risodkar used algorithms filtering, edge detection, morphological transformation etc., for feature extraction.

In this paper [13] Dr. P. S. Deshpande, Mrs. Latesh Malik, Mrs. Sandhya Arora proposed two methods i.e. segmentation

and evolved regular expressions. Their proposed system did not contain preprocessing and training.

In this paper [14] Martin Rajnoha, Radim Burget, Malay Kishore Datta compared traditional machine learning algorithms with deep learning approach. We are going to use deep learning approach in our work to achieve better accuracy.

In this paper [15] Rohan Vaidya, Darshan Trivedi, Sagar Satra, Prof. Mrunalini Pimpale describes the use of OpenCV for performing Image processing and Tensorflow for training a neural Network. They present the system using python programming language.

In this paper [16] Sushama Shelke, Shaila Apte describes multistage feature extraction and classification scheme. Multistage feature extraction consists of different stages like high, mid and low level features.

In this paper [17] Moazam Soomro, Rana Hammad Raza, Muhammad Ali Farooq presents two models AlexNet uses pooling layer and GoogleNet uses ReLU layer.

In this paper [18] Tan Chiang Wei, Ab Al-Hadi Ab Rahman, U.U. Sheikh proposed deep neural network. We studied deep neural network concept.

In this paper [19] Ranjana S. Zinjore, R.J. Ramteke preferred shape context computation and cost to minimize the matching distance between training images and test images.

In this paper [20] Rismiyati, Khadijah, Adi Nurhadiyah performed deep learning techniques for classification and recognition of images. The classification is performed using convolutional neural network (CNN) and Deep Neural Network (DNN).

V. CHALLENGES

1. Deep learning need to find and process massive datasets for training.
2. In deep learning overfitting occurs. Overfitting in neural networks occurs when performance of model on unseen data is lower than that on seen data.
3. To implement deep learning algorithm it requires high performance hardware.
4. Lack of flexibility and multitasking because once the model is trained it can give efficient and accurate solution for specific problem.

VI. CONCLUSION

This review paper provides the information about the importance and applications of handwritten Marathi character recognition. This paper also discusses the various techniques available to recognize the character. It discusses about various neural networks available in deep learning. It also provides the summary about all the works done in this field till date. In this survey paper, it has been observed that task of extracting various features is challenging task as the image get classified with wrong class sometimes if some features not get detected. This paper has also discussed various challenges in character recognition, so this will affect the accuracy of classifier. It is challenging to recognize the character image is it is oriented, not clear, or blur, edge distortion or noise distortion etc. In this paper various aspects of deep learning algorithms are discussed. Handwritten character recognition can be used in various fields like in banking sector for check processing, document processing etc. The handwritten character recognition can explore more application areas.

VIII. REFERENCES

- [1] Shailesh Acharya, Ashok Kumar Pant, Prashna Kumar Gyawali, "Deep Learning Based Large Scale Handwritten Devanagari Character Recognition", 2015 9th International Conference on Software, Knowledge, Information Management and Applications (SKIMA).
- [2] Ms. Padma Ramkrushna Bagde, Dr. Ajay Anil Gurjar, "A Handwritten Recognition for Free Style Marathi Script using Genetic Algorithm", 2016 International Conference on Global Trends in Signal Processing, Information Computing and Communication.
- [3] Jinfeng Bai, Zhineng Chen, Bailan Feng, Bo Xu, "IMAGE CHARACTER RECOGNITION USING DEEP CONVOLUTIONAL NEURAL NETWORK LEARNED FROM DIFFERENT LANGUAGES", Interactive Digital Media Technology Research Center, Institute of Automation, Chinese Academy of Sciences, Beijing 100190, China.
- [4] Miss. Minakshi Sanjay Bhandare, Miss. Anuradha Sopan Kakade, "Handwritten (Marathi) Compound Character Recognition", IEEE Sponsored 2nd International Conference on Innovations in Information, Embedded and Communication systems (ICIIECS) 2015.
- [5] Supriya Deshmukh, Leena Raha, "Analysis of Directional Features - Stroke and Contour for Handwritten Character Recognition", 2009 IEEE International Advance Computing Conference (IACC 2009) Patiala, India, 6-7 March 2009.
- [6] Bishwajit Purkaystha, Tapos Datta, Md Saiful Islam, "Bengali Handwritten Character Recognition Using Deep Convolutional Neural Network", 2017 20th International Conference of Computer and Information Technology (ICCIT), 22-24 December, 2017.
- [7] Parshuram M. Kamble, Ravindra S. Hegadi, "Geometrical features extraction and KNN based Classification of Handwritten Marathi characters", Communication Technologies 978-1-5090-5573-9/16 \$31.00 © 2016 IEEE DOI 10.1109/WCCCT.2016.61219 World Congress on Computing and Communication Technologies (WCCCT).
- [8] Dhanashree Joshi, Sarika Pansare, "Combination of multiple image features along with KNN classifier for classification of Marathi Barakhadi", 2015 International Conference on Computing Communication Control and Automation.
- [9] Ravindra S. Hegadi, Parshuram M. Kamble, "Recognition of Marathi Handwritten Numerals Using Multi-layer Feed-Forward Neural Network", 2014 World Congress on Computing and Communication Technologies.
- [10] Sanjay S. Gharde, Dr. R. J. Ramteke, Vijay A. Kotkar, Dipak D. Bage, "Handwritten Devanagari Numeral and Vowel Recognition using Invariant Moments", 2016 International Conference on Global Trends in Signal Processing, Information Computing and Communication.
- [11] Xin Gao, Jie Zhang, Zhe Wei, "Deep Learning for Sequence Pattern Recognition", 978-1-5386-5053-0/18/\$31.00 ©2018 IEEE.
- [12] Dhara S. Joshi, Yogesh R. Risodkar, "Deep Learning Based Gujarati Handwritten Character Recognition", 2018 International Conference On Advances in Communication and Computing Technology (ICACCT).
- [13] Dr. P. S. Deshpande, Mrs. Latesh Malik, Mrs. Sandhya Arora, "Characterizing Hand Written Devanagari Characters using Evolved Regular Expressions", 1-4244-05491/06/\$20.00 2006 IEEE.
- [14] Martin Rajnoha, Radim Burget, Malay Kishore Datta, "Handwriting Comenia Script Recognition with Convolutional Neural Network", 978-1-5090-3982-1/17/\$31.00 ©2017 IEEE.

[15] Rohan Vaidya , Darshan Trivedi , Sagar Satra, Prof. Mrunalini Pimpale2,” Handwritten Character Recognition Using Deep-Learning”, Proceedings of the 2nd International Conference on Inventive Communication and Computational Technologies (ICICCT 2018) IEEE Xplore Compliant - Part Number: CFP18BAC-ART; ISBN:978-1-5386-1974-2.

[16] Sushama Shelke, Shaila Apte,” A Novel Multi-feature Multi-Classfier Scheme for Unconstrained Handwritten Devanagari Character Recognition”, 2010 12th International Conference on Frontiers in Handwriting Recognition.

[17] Moazam Soomro, Rana Hammad Raza,Muhammad Ali Farooq,” Performance Evaluation of Advanced Deep Learning Architectures for Offline Handwritten Character Recognition”, 2017 International Conference on Frontiers of Information Technology.

[18] Tan Chiang Wei, Ab Al-Hadi Ab Rahman,U.U.Sheikh,” Improved Optical Character Recognition with Deep Neural Network”, 2018 IEEE 14th International Colloquium on Signal Processing & its Applications (CSPA 2018), 9 -10 March 2018, Penang, Malaysia.

[19] Ranjana S. Zinjore, R.J.Ramteke,” Recognition of Handwritten Bilingual Characters- Numerals using Shape Context”, 2016 IEEE International WIE Conference on Electrical and Computer Engineering (WIECON-ECE) 19-21 December 2016, AISSMS, Pune, India.

[20] Rismiyati, Khadijah, Adi Nurhadiyatna,” Deep Learning for Handwritten Javanese Character Recognition ”, 2017 1st International Conference on Informatics and Computational Sciences (ICICoS).