Journal of
Computer Based Parallel Programming

e-ISSN: 2582-2179
Volume-6, Issue-3 (September-December, 2021)

www.matjournals.com

https://doi.org/10.46610/JoCPP.2021.v06i03.001

Devanagari Handwritten Marathi Compound Character Recognition System

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ABSTRACT

Handwritten character recognition a field of research in AI, computer vision, and pattern recognition. Devanagari handwritten Marathi compound character recognition is most tedious tasks because of its complexity as compared to other languages. As compound character is combination of two or more characters it becomes challenging task to recognize it. However, the researchers used various methods like Neural Network, SVM, KNN, Wavelet transformation to classify the features of compound Marathi characters and tried to give the accuracy in the recognition of it. But the problem of feature extraction, and time required is large. In this paper I am proposing the Offline handwritten Marathi compound character recognition using deep convolution neural network which reduces the computational time and increases the accuracy.

Keywords-- Deep convolution neural network, Deep Devanagari characters, Handwritten character recognition

INTRODUCTION

Handwritten Marathi compound character recognition is a challenging task as the writing style varies person to person, combination of alphabets and because of this problem the computer program does not find good accuracy for recognition task. The review of literature focuses on different techniques of feature extraction and recognition of handwritten Marathi compound characters. In this approach, first handwritten Marathi compound characters on plain white paper are collected , scanned, and stored in the form of images or documents. Then performed pre-processing, feature extraction and identification of character using deep convolution neural network.

Due to the variation in strokes, the shape of the character, pen width, pen ink and mental and physical situation of person on writing style, it becomes very difficult to recognize the characters. From the early 2000s, Deep neural networks are used for object detection, segmentation, and recognition in image processing field with immense success. It is also widely used for many other pattern recognition problems such as handwritten digits and characters recognition, speech recognition, drug discovery and genomics [1].

Deep Learning a new application of machine learning for learning representation of data. DL algorithms have taken the top place in the object recognition field due to the good performance improvement they have provided [1]. As Convolutional Neural Networks (CNNs) are a type of neural networks that are applied in many fields and provide efficient solutions in many problems, where there is some translation invariance like some applications of object recognition and speech recognition. However, CNN DL solutions require a lot of training samples, which places computational requirements on the system. There are several frameworks for Deep Learning like TensorFlow, which is an open-source code and capable of using GPUs very well. Second simpler framework is Keras, this paper focuses on the Offline handwritten Marathi compound character recognition. Generally, Marathi script consists of 52 alphabets including 16 vowels called as swar and 36 consonants called as vyajnas. The sample of compound characters is given as follows in Fig. 1.

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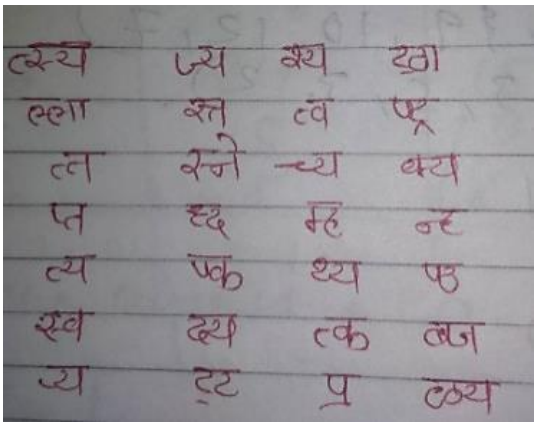

Figure 1: *Sample compound characters.*

REVIEW OF LITERATURE

The very first effort in the direction of character recognition was made by Turing who attempted to develop an aid for visually handicapped. The first character recognizer appeared in around 1040s. the period from 1980-1990 witnesses a growth in character recognition system development due to rapid growth in information technology structural approaches were initiated in many systems in additional to statistics methods.

The syntactic and structural approaches require efficient extraction of primitives. These primitives include different types of line segments and curves, but there existed an upper limit in recognition technique without using any semantic information. After 1990, image processing techniques and pattern recognition were combine using artificial intelligence. Along with powerful computers and more accurate electronics equipment such as scanners, cameras and electronics tablets, also modern use of methodologies such as neural networks (NNs), hidden markov models (HMMs), fuzzy set recognizing and natural language processing. Although research a recognizing isolated handwritten characters has been quite successful, recognizing offline handwriting has been found to be challenging problem.

A lot of work has been done in compound Marathi character recognition. The research in optical character recognition work was started in 1970. Basically, the Devanagari character recognition contains basic simple characters, numerical and compound character done by V. Bansal [2]. The work on On-Line and Off- Line Handwritten Character Recognition Survey done by Plamondon R. and Srihari [3]. Handwritten (Marathi) compound character recognition work done by Minakshi Bhandari and Anuradha Kakade in 2011 in which they have focussed on the techniques used for the pre-processing as well as segmentation of compound characters are easier than other [4]. The work done proposed by Karbhari V. Kale, by using Zernike moment on feature extraction techniques for extracting the features. on handwritten Devanagari compound character recognition. After that support vector machine and the K-NN classifier is used to classify characters [5]. Sandhya Arora and Debotosh Bhattacharjee worked on Combining Multiple Feature Extraction Techniques for Handwritten Devanagari Character Recognition [6]. Offline Handwritten Character Recognition Using Neural Network system implemented by Anshul Gupta, Manisha Srivastava etc.in 2011. Layer-Wise Training of Deep Convolutional Neural Networks and Adaptive Gradient Methods proposed by Mahesh Jangid and Sumit Srivastava using deep convolution neural network.in 2018.

Amol A. Kadam and Dr. Milind V. Bhalerao done the work on various features of compound characters and the zoning-based feature extraction method and statistical feature extraction methods [5].

In this paper, we propose a system for handwritten Marathi compound character recognition by using deep convolution neural network.

PROPOSED SYSTEM

In this proposed system we aim to recognize the handwritten Marathi compound characters. This is done by using the deep neural network feature extraction techniques. Deep neural network is used to extract the features of compound characters. In this paper, I present Transfer learning, which is a deep learning technique that uses a pre-developed model for a task as a starting point for another task. With the help of optimization technique like transfer learning which improves the performance of the second task. Transfer learning can be used in two cases mainly: (i) Develop Model Approach or (ii) Pre-trained Approach. In the first case,

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means develop model approach, the model is designed for one task and reused for the second task, however, in the pre-trained approach, one of the models available from different research organization is chosen as a starting point to make ready for the second problem (Fig. 2).

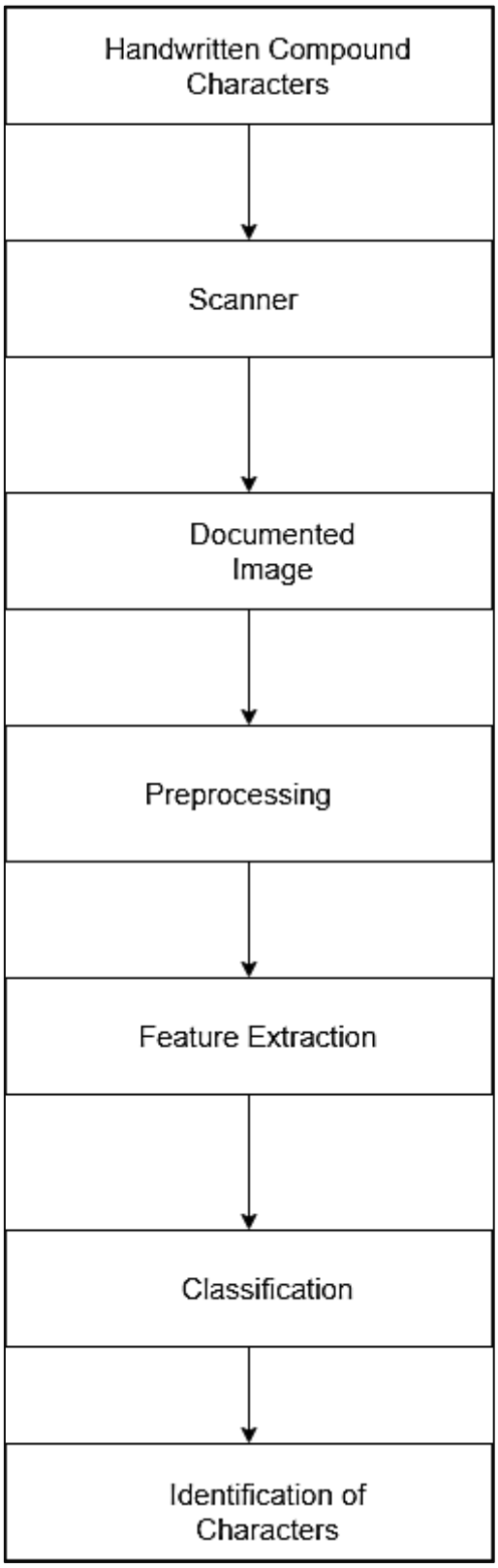

Figure 2: *Flow of the system.*

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METHODOLOGIES OF CHARACTER RECOGNITION SYSTEM

In this section the methodologies to of compound character recognition are presented.

Convolution Neural Network

CNN or Convolutional neural network is traditionally fully connected network which takes all the inputs and passed through each value to a dense network that followed into a one hot output. For example, A grey-scale Image has 2-dimensional data, and a color image has 3-dimensional. There are four key ideas behind the success of convolutional neural network. These are: multiple layers, shared weights, local connection, and pooling. There are mainly three types of layers in convolutional neural network which can be used number of times in a network.

- Convolution Layer
- Pooling Layer
- Fully Connected Layer

Convolution Layer

This is the main building block of the network. It uses number of filters called filter banks and it convolves input image with it. The training steps updates filter weights which give feature maps from input images.

Pooling Layer

When an input image is convolved with the number of filters in convolution layer, it generates stack of images. In this process, the data increases by huge amount. The pooling layer helps to reduce the data easily. It divides newly generated images into number of blocks and subsamples it to produce single value for each block. Max pooling and average pooling are the types. The combination of convolution layers and pooling layers can be regarded as feature extractor.

Fully Connected Layer

In fully connected layer, each neuron takes input from the activations of every neuron of the previous layer. The fully connected layer can be regarded as classifier.

DCNN

A deep convolutional neural network consists of many layers of neural network. In the architecture of DCNN two different types of layers involved. They are convolutional and pooling, which are alternated. In this process the depth of each filter increases from left to right in the network. And the last stage consists of more fully connected layers. For nonlinearity it uses sigmoid or rectified linear units.

In DCNN three key intuitions beyond ConvNets are used and they are: - Local local receptive field, Shared weights, and pooling. The local receptive fields are regions that gives local information and are spread over the image. Each local receptive field constitutes a neuron and shares weights in the hidden layer which gives distinct feature characteristics. Pooling layers follows convolution layers, down samples in overfitting by reducing the number of parameters. At the same time, when hidden neurons are randomly removed, it helps to avoid overfitting. Pre-trained models are trained that carries many data samples and 1000 class labels. In short transfer learning techniques is used in existing CNN models where a large dataset is not available.

In transfer learning a pre-developed model is used for a task as a starting point for another task. Hence it is a learning optimization technique which improves the performance of the second task. Transfer learning can be used in two ways: i) Develop Model Approach or ii) Pre-trained Approach. In the develop model, the model is designed for one task and reused for the second task, however, in the pre-trained approach, one of the models available from different research organization is chosen as a starting point to tune it for another problem.

Training the DCNN with random initialization is highly computationally intensive and may not be feasible practically because of limited dataset. To solve this problem transfer learning is used which allows the pretrained ConvNet for fixed feature extractor. Here, the pre-trained models are trained on ImageNet that has around 1.2 million images with 1000 different categories. The two main techniques that are used in transfer learning are:

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Finetuning

It this technique random initialization of weights of different layers, in the network is initialized with a pretrained network, and the rest of the training takes place, as usual, using the new dataset.

Fixed Feature Extractor

In this technique, the weights of different convolutional layers are frozen that acts as feature extractor while the weights of the fully connected layer are updated. In this way only fully, connected layer is trained.

Transfer learning gives way better and faster results. In this process the following models we can use for better accuracy.

Inception V3 Model

It is used to factorize the characters and reduce the number of connections without decreasing the network efficiency. Here, the model extracts general features from input images in the first part and classifies them based on those features in the second part.

VGG 11, 16, 19

VGG representations are also used for accurate results but computationally expensive in comparison to Inception. The main use of VGG shows that the deep (means number of layers) of a convolutional neural network is the critical component of high recognition or classification accuracy. Here, two convolutional layers are used consecutively with ReLU activation function followed by single max-pooling layer, several fully connected layers with ReLU and soft-max as final layer. The 3×3 convolutional filters and 2×2 with stride 2 is applied for subsampling operation in VGG-E version [7]. There are three types of VGGNet depending upon the architecture of the network k. The three network contains 11, 16 and 19 layers. Depending on the number of layers, the VGGNet is named as VGG-11, VGG-16, and VGG-19, respectively.

DenseNet 121 and 201

In DenseNet each layer relates to all the other layers of its successor [8]. Therefore, it is formed very dense connectivity between the layers so called “DenseNet”. The DenseNet consists of several dense blocks, and the layers between two adjacent blocks go through transaction layers. DenseNet 121 and 201 are pertained convolutional neural networks which classifies the concatenated features of compound characters. It performs three successive operations: Batch-Normalization (BN), followed by a rectified linear unit (ReLU) and a 3 × 3 convolution [9].

AlexNet

AlexNet is a convolutional neural network that is trained on more than a million images from the ImageNet database [2]. The alexnet network is 8 layers deep and can classify images into 1000 object categories. It gives good accuracy and faster speed. In this method Divide the data into training and validation data sets. Use 70% of the images for training and 30% for validation splits the images of characters datastore into two new datastores. This model extracts the features of convolution layers and trained the fully connected layers for Devanagari Marathi compound character identification.

CONCLUSION

The paper has presented a new method of handwritten Marathi compound character recognition using DCNN. The handwritten Marathi compound character recognition is indeed a tough task which can be easily done with the help of the methodology described here. A high efficiency reflects the accuracy of segmentation ,feature extraction as well as the recognition using the deep convolution neural network that has been optimized by using pertained model and different models like Inception, VGG, DenseNet and AlexNet. The concept here has abridged handwriting recognition completely with artificial intelligence after the application of CNN and DCNN.

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