Devanagari Handwriting Recognition using Neural Networks

Abstract

Devanagari is an ancient script used for over 120 spoken Indo-Aryan languages, including Hindi, Nepali, Marathi, Maithili, Awadhi, Newari and Bhojpuri. This script is used by millions of people in India to write documents in Marathi and Hindi . Most of the Indian mythology is written in this script. Handwritten Devanagari character recognition has gained popularity over the years due to such importance of the script. Although significant research has been made in full character recognition of Devanagari characters using Convolution neural networks for both feature extraction and classification, the report experiments different classifiers for classifying and predicting the handwritten characters while using CNN and DNN for feature extraction. The scope of report has been widened by making the model to predict partial Devanagari characters while been trained on full characters and vice versa.

Introduction

Handwriting recognition is an art of identifying characters from handwritten images. Recognition of hand written images is getting more and more attention due to its wide range of applications. Conversion of handwritten characters is significant for preserving several historical documents related to our history such as manuscripts, into machine editable form. This script (Devanagari) has various characteristics like complex shape,

presence of modifiers, similarity between characters which makes recognition of Devanagari characters, a difficult task. Hence, this topic is one of the fascinating topics in the field of image processing and pattern recognition.

Character recognition techniques associate a symbolic identity with the image of a character. These character images are preprocessed and then features are extracted from them. Features extracted from character encode the structural characteristics of character shape..

The field of handwriting character recognition is broadly divided into two parts:

1) Online character recognition:

In this the characters are recognized at real time as soon as it is written. Online character recognition gives little better performance than offline recognition as they do not need to locate the character and also have time information.

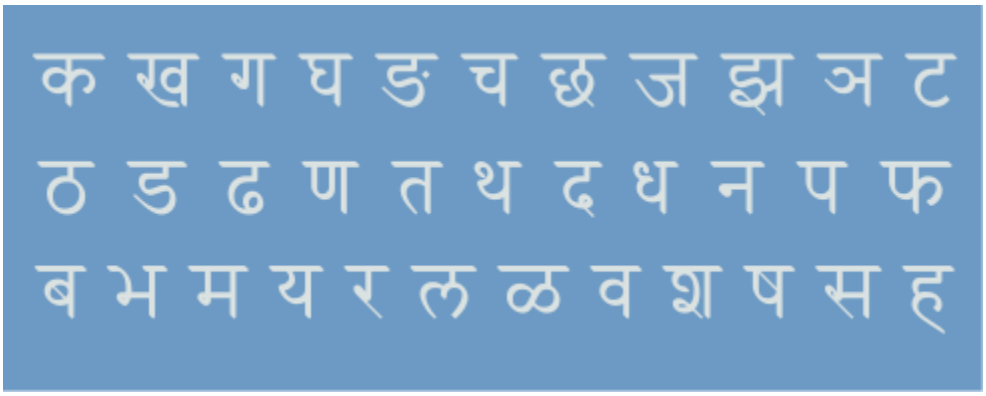
2) Offline character recognition:

Offline character recognition can be classified further into following:

1. Printed characters recognition.
2. Handwritten character recognition.

Classification of handwritten character recognition is more challenging due to shape of characters, great variation of character symbol and image quality. Thus, this topic is chosen as the focus of this report.

What is Devanagari?



Goals

1. Training the model on full character image and making it predict the Devanagari character given full image of the character.
2. Training the model on full character image and making it predict the Devanagari character given partial or half image of the character.
3. Training the model on half character image and making it predict the Devanagari character given full image of the character.

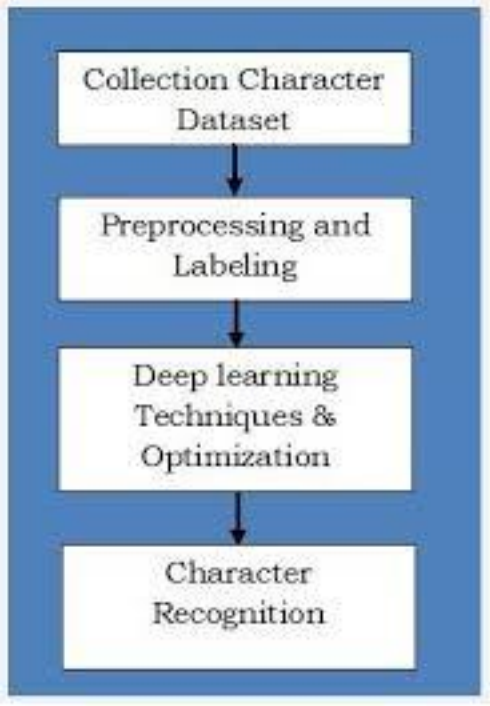
Data Source and Datasets:

- Data Source :
  - https://archive.ics.uci.edu/ml/datasetsDataset
    - Number Of Rows: 720000
    - Number Of Columns: 1025
- Handritten Images:
    - Test Data
    - Sample Data
- Dataset Link :

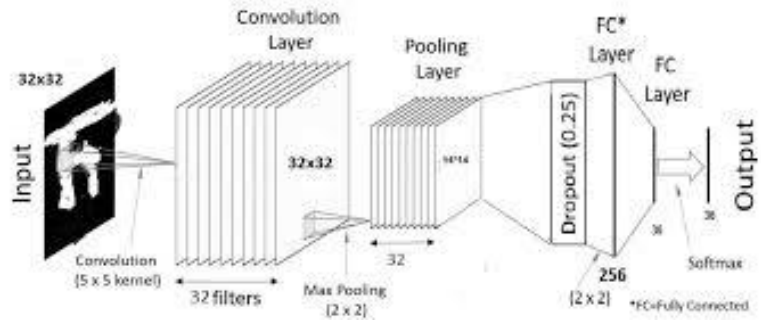
- https://archive.ics.uci.edu/ml/datasets/Devanagari+Handwritten+Character+Dataset

Convolutional neural network

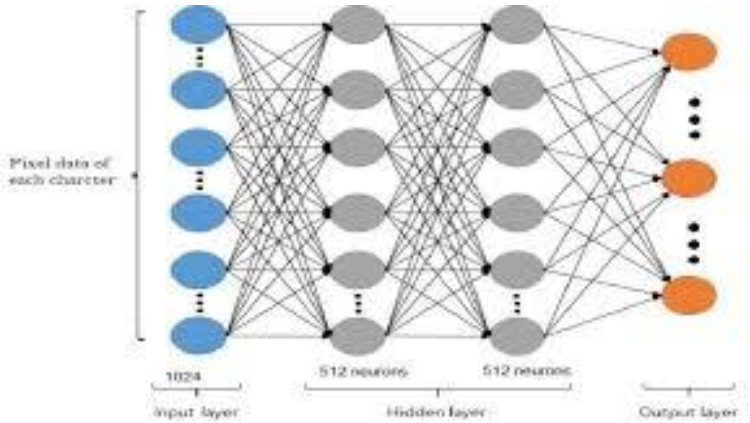
Computer Vision and pattern recognition is a major growing field in area of image processing. In that Convolutional Neural Network (CNNs) plays major role in computer vision. CNN is working on many applications in Image Classification and it is the core of most Computer Vision and pattern recognition systems today, from automatic tagging of photo in Face books to self-driving cars, recognizes digits, alpha-numerals, traffic signal boards, and the other object class[7]. We used five layered Convolutional Neural Networks (CNN) model. On them one layers for convolutional, one layers for max pooling or sub sampling, one Flatten layer which converts 2D array into 1D array and finally two fully connected layers for classification. The initial layer is convolutional (Conv2D) layer has 32 output mapping and the next max pooling layer has 14 output mapping.



Block diagram proposed handwritten digit recognition system



The overall structural design of the CNN Model of our proposed system with different layer.



The overall structural design of the DFFNN Model of our proposed system with different layer.

Code Requirements

1. you can install Conda for python which resolves all the dependencies for machine learning.

2. install tensorflow , in conda -> $ conda install tensorflow

3. install keras , in conda -> $ conda install keras

4. install opencv , in conda -> $ conda install opencv

5. Devanagari_Character_Recoginition1.ipynb require data set for training and test

Technique Used

I have used convolutional neural networks. I am using Tensorflow as the framework and Keras API for providing a high level of abstraction.

Architecture

CONV2D --> MAXPOOL --> CONV2D --> MAXPOOL -->FC -->Softmax--> Classification

Method

The model uses CNN and DNN for feature extraction and various classifiers mentioned in above sections for Classifying the images.

The following approach has been made for the proposal

1) Build and configure a CNN network to extract features
2) Feature extraction using Convolutional and Deep Neural Networks.
3) Classification of the 36 unique characters using following classifiers:
   a.) Random Forest
   b.) Multi-layer perceptron
   c.) KNN

Training model on 36 unique characters with 1700 images of each character. Predicting the character given the full or partial image of the character.

Training model on few unique characters. Predicting the character given the partial and full image of the character.

Visualizing the accuracy of each classification model

Visualizing the actual and predicted character.

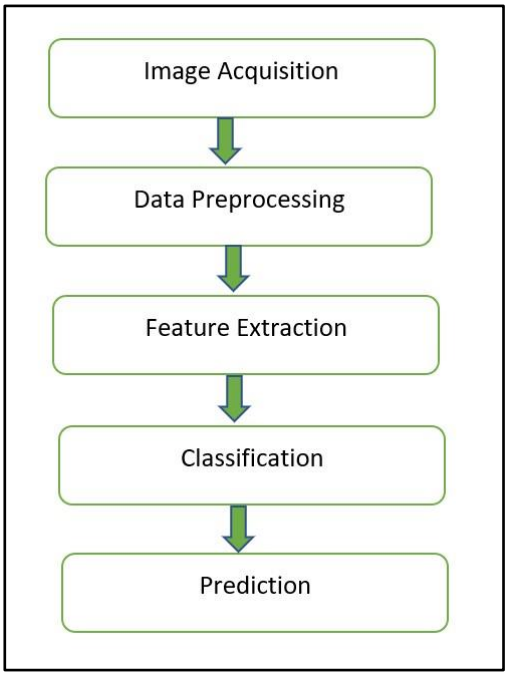


Figure 1: Handwriting recognition system approach

Experimental Outcomes :

Results discussion

Following were the key points noted during the prediction of printed characters by models trained on handwritten chracter images:

- It was observed that mostly the classifers accuracy depended on the data that they were trained on.
- A large number of label classes caused a decreased performance of the models due to large number of similar looking characters.
- Restricting the training of the models to a limited number of characters improved the performance.
- The features extracted from the CNN and used by classifiers to predict the printed characters affected the prediction accuracy of classifiers.
- It was observed that **KNN Classifier** generally showed better accuracy as compared to **Random Forest and MLP Classifiers**.

- Certain misclassifcations were observed among similar looking characters, like 'ka' being classified as 'ba' or 'ma' being classified as 'ga' due to simliarity in structures of characters.
- This can be improved by training the CNN model on large amount of data and then extracting the features so that the classifiers accuracy can be improved.
- Cross-validation can be also implemented to if sufficiently large data is available.

Results discussion about cropped images training and prediction

Key points about the above implementation are:

- The model was trained on cropped character images and then used to predict the full character images.
- On this setup the model was able to predict atleast some characters correctly if not all.
- Model was then trained on full character images and then used to predict the cropped images of characters.
- This caused the degraded model performance due to increased misclassification.
- It is an expected result since croppping of the images may alter their characteristics to transform them into similar looking other characters thereby causing the model to predict them incorrectly.
- For eg. if character 'ka' is cropped vertically into exact half then left half is exactly same as the character 'waw' this causes the misclassificatio degrading the model performance.

CONCLUSION:

- It was found that model prediction was good when trained on cropped character images and used to predict full characters since the model could look for the features in cropped images and locate them in the full images.
- However if the model was trained on full character images and then a cropped character image was given to it, the accuracy of the model was hampered with possible reason being that the cropped image may look similar to some other character.