SURVEY ON DEVANAGARI CHARACTER RECOGNITION USING DEEP LEARNING TECHNIQUES

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ABSTRACT

Since the past few years, character recognition is gaining attention of most of the researchers because of its various applications in different sectors like automatic recognition of vehicle number plate, data entry for business documents for example cheque, bank statement, passport, invoice and receipt, in airports for passport recognition and information extraction. There are many variations in writing styles from individual to individual which makes character recognition challenging. Deep learning techniques can be used to find solutions for recognition of characters using different algorithms. A single letter or digit can be written in many ways and styles which increases the size of the dataset to be utilized.The goal of this work is to join AI methods to enhance and improve the character recognition process.

Keywords : *Deep Learning, Optical Character Recognition(OCR), Transfer Learning, Inception v1, CNN, image segmentation, feature extraction*

INTRODUCTION

Out of a few significant uses of Machine Learning and profound Learning, picture and example acknowledgment empowers distinguishing proof of pictures and examples for various use cases or applications. Picture acknowledgment method centers around removing fundamental highlights from pictures to sort pictures into various gatherings. Due to such assortment of utilizations, Optical Character Recognition(OCR) has acquired a lot of significance as it perceives text from some random picture or report. It can likewise be utilized to distinguish characters from transcribed contents. Acquiring high acknowledgement correctly on manually written character datasets is a difficult issue on the grounds that there can be various ways or styles to compose the various characters. Because of this high assortment, the immediate utilization of pixel powers is kept away from on the grounds that there is once in a while little cover between two pictures showing a similar character. Figure beneath exhibits the various ways or styles to compose characters in Devanagari content.Along these lines there are a large number of potential outcomes that vary from individual to individual to compose characters in any language. For this reason distinctive datasets are to be created which are trying because of various composing styles, various ages, schooling, and so on In this paper we have considered diverse datasets and distinctive character acknowledgment methods yield better exactness and results that are expected.

Few architectures used are as follows :

a) Vgg representations also provide accurate results; however are computationally expensive in comparison to Inception et al[1].

b) DenseNet representations did not show better accurate results but can possibly show better accuracy over other datasets et al[1].

c) AlexNet is fastest and also provides reasonably good accuracy et al[1].

d)Inception v1 i.e GoogLeNet is designed very deeply yet slim, with a total 19 layers (counting for all convolutional layers, pooling layers, fully connected layers and softmax output layer)[2].

Fig 1: Devanagari Alphabets [3]

The following diagram shows the proposed architecture which represents the modules data pre-processing, segmentation, feature extraction and recognition.

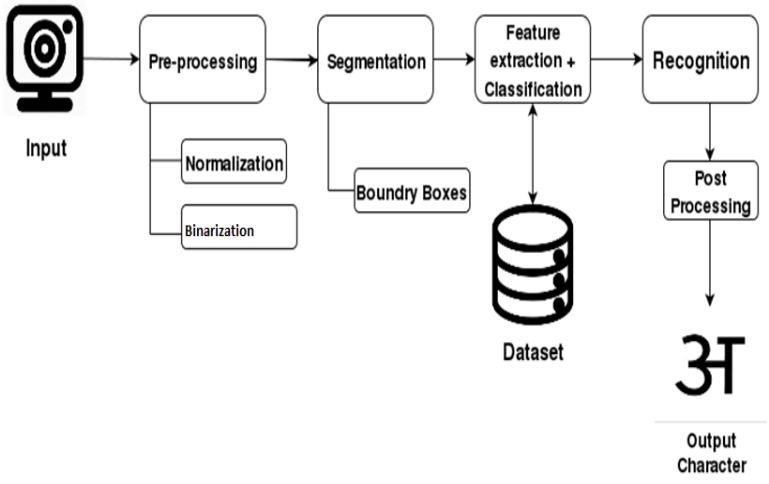

Fig 2: Proposed Architecture

LITERATURE SURVEY

Sr No	Published Year	Published by	Research Topic	Advantages	Limitations
1	2009	Ujjwal Bhattacharya, B.B. Chaudhary	Handwritten Numeral Databases of Indian Scripts and Multistage Recognition of Mixed Numerals	Implemented for recognition of handwritten numerals in mixed script situations. Like Marathi, Bengali, English.	If we ignore misclassification within the shape-similar classes, recognition accuracies will increases.
2	2013	Ms. Neha Sahu, Mr. Nitin Kali Raman	An Efficient Handwritten Devanagari Character Recognition System Using Neural Network	Accuracy of the recognition of characters will increase if we train network with more number of sets.	This system can be implemented for recognition of words with more characters, with matras and for sentence and documents. The segmentation shortcomings of the system can be reduced.
3	2014	Ashwini Navghane, Adwait Dixit	Handwritten Devanagari Character Recognition using Wavelet Based Feature Extraction and Classification Scheme	Wavelet features for classification and recognition is used which provide an elegant tool for multi resolution analysis.	Scope of recognition of characters was limited to 20 characters.accuracy can be improved further by using multistage feature extraction schemes.
4	2014	Pranali K Misal, Prof.M.M. Pathan	Design & Implementation of ANFIS System for Hand Gesture to Devanagari Conversion	System uses ANFIS (Adaptive Neuro Fuzzy Inference System) to convert Devanagari gestures into voice using audio database	System uses fuzzy logic which requires lot of mathematical calculations and audio dataset is also limited.
5	2015	Shailesh Acharya, Ashok Kumar Pant, Prasanna Kumar Gyawali.	Deep Learning Based Large Scale Handwritten Devanagari Character Recognition	Introduce a new public image dataset for Devanagari script: Devanagari Handwritten Character Dataset (DHCD).	From the results, it can be concluded that the transfer learning is better option for faster training with fewer training samples.
6	2015	Wong Yoong Xiang, Patrick Sebastian	Designed a image segmentation based Handwritten character recognition system.	This paper presents development of system that is robust enough to recognize numerical handwritings with lowest error.	The first test was done with a neural network trained with only the Character Vector Module as its feature extraction method.

7	2015	Sushama Shelke, Shaila Apte	A Fuzzy based Classifica-tion Scheme for Uncon-strained Handwritten Devanagari Character Recognition.	Three layers of CNNs are used. Devanagari handwriting can also be classified via fuzzy based classification.	The classification is done using two stages, first stage is based on fuzzy inference system and second stage is based on structural parameters.
8	2016	Hubert Cecotti	Deep Random Vector Functional Link Network for Handwritten Character Recognition.	evaluated impact of architecture on system. results confirmed that increasing size of hidden layers has a significant impact on performance.	Further work will include convolutional RVFL(Random Vector Functional Link)/EML(Extreme machine Learning) models to evaluate the choice of pooling and convolution techniques.
9	2018	Aarti Mohite, Sushma Shelke	Handwritten Devanagari Character Recognition using Convolutional Neural Network	In this paper they used transfer learning of pretrained architectures like Alexnet, Googlenet, and ResNet.Used pre-trained architecture saves time to develop CNN architecture from scratch.	Accuracy can be improved, by implementing more preprocessing algorithms like image cropping, before applying to deep learning network.Scope of recognition is limited to characters only.
10	2018	Neha & Deepti Ahlawat	Handwritten alphanumeric character recognition and Comparison of classification techniques.	It contains an linear transformation. It provides a good generalization capability. The problem of overfitting is eliminated. Reduction in computational complexity.	system can be implemented for recognition of words with more characters, with matras and for sentence and documents. segmentation shortcomings of system can be reduced.
11	2018	Rohan Vaidya, Darshan Trivedi , Sagar Satra, Prof. Mrinalini Pimpale	Handwritten Character Recognition Using Deep-Learning	Offline handwritten character detection using Deep Neural Networks. A image segmentation based character recognition system using OpenCV.	The amount of computational power needed to train a neural network has increased due to the availability of GPUs and other cloud based services like Google Cloud platform and Amazon Web Services which provide resources to train a Neural network on the cloud.
12	2018	Prasad Sonawane. Sushma Shelke	Handwritten Devanagari Classification using Deep Learning	Successfully tried to classify handwritten Devanagari characters using transfer learning mechanism with the	From the results, it can be concluded that the transfer learning is better option for faster training with fewer training samples.

				help of AlexNet. Use of AlexNet, A convolution neural Network, shows impressive results.	
13	2018	Aarti Mohite Sushma Shelke	Handwritten Devanagari Character Recognition using Convolutional Neural Network	In this paper they used transfer learning of pretrained architectures like Alexnet, Googlenet, and ResNet.	Accuracy can be improved, by implementing more preprocessing algorithms like image cropping, before applying to deep learning network.
14	2019	Nagender Aneja Sandhya Aneja Sushma Shelke, Shaila Apte	Transfer Learning using CNN for Handwritten Devanagari Character Recognition.	In proposed model, Inception v3 performed better in terms of accuracy.	Scope is limited to recognition of devanagari alphabets.
15	2019	Yamini Patil. Amol Bhilare	Digits Recognition of Marathi Handwritten Script using LSTM Neural Network	Connectionist Temporal Classification layer of RNN approach reliably beats other ML approaches as far as expectation of complex digits of Marathi.	despite fact described model indicated great outcomes, it is difficult to induce performance of analysed techniques.
16	2019	Shivansh Gupta,.Ramesh Mohapatra	Performance Improvement in Handwritten Devnagari Character Classification	The proposed Capsule network extracts spatial information and improves the capabilities of traditional CNN(i.e. pooling operation in CNN ignores spatial information). Described model uses capsules to describe features in multiple dimensions and dynamic routing to increase the performance of network.	This CapsNet has inner looping which makes the computation time quite large, so reducing the time can be done by finding other technique that has less computational load.
17	2020	Yash Gaura ,Rajeshri Jadhav ,Swati sinha ,Priyanka Bhagat	Devanagari Handwritten Character Recognition using Convolutional Neural Networks	In the proposed model , They used consecutive convolution layers which brings added advantage in the process of extracting higher-level features and finally resulted into high accuracy.	In the System, segmentation is done character-wise instead of breaking a word into several modifiers which is standard approach. Accuracy and proper contextual conversion need to be checked for satisfying successful implementation.

LIVE SURVEY

A) Optical Character Recognition by C-DAC(Centre for Development of Advanced Computing)[21] -

- C-DAC developed an oriya OCR which provides conversion of text from scanned images of oriya script and supported formats are .tiff, .png, .bmp.
- For Malayalam OHR, classifier has been developed which are capable of incremental learning for classification and recognition.
- C-DAC has also undertaken research in the challenging areas of Online Hand Written Recognition(OHWR).
- Go-Write from C-DAC is an online handwritten system which is able to run on Tablets as well as Smart phones.
- C-DAC GIST (Graphic and Intelligence based Script Technology) lab's research seeks to develop an OCR Engine, which will enable highest levels of accuracy in converting Indian language images to text. The basic OCR for Devanagari script named 'Chitrankan'.

B) Technology Development for Indian Languages, the premier R&D organization of Ministry of Electronics and Information Technology(MeitY)-

- This organization has also done many projects for OCR.
- Their projects include OCR for Malayalam, odia, Punjabi, Telugu and Devanagari script.
- SanskritOCR, E- aksharayan and Chitankan are the examples of OCR system.

C) OCR System for Bharati Script [22]-

- Dr srinivasa chakravathy and his team at IIT Madras has developed a method for reading documents in Bharati Script by using multi-lingual optical character recognition scheme.
- Bharati script is unified script for 9 Indian languages includes Devanagari, Bengali, Gurmukhi, Gujarati, Oriya, Telugu, Kannada, Malayalam and Tamil.

D) OCR System Based Modified Google Lens -

- Google announced the process of introducing new features in google lens that will allow us to search our google photos library for text that appears within photos and screenshots.
- This feature is available now on most of the android devices although it is not quite active on IoS devices.

E) Microsoft Introduced Character Recognition In Excel for IoS [23]-

- For the purpose of conversion of snap photos of data presented in columns and rows into an editable Excel spreadsheets, Microsoft introduced Google-Lens like Character recognition System.
- Image Recognition tool in Microsoft Excel Android and iOS apps is available through a button called 'Insert Data from Picture'.
- Beyond Excel, Microsoft is also providing ability to users that they can convert handwritten notes to digital text quickly.

ALGORITHMIC/ACCURACY SURVEY

Handwritten Devanagari character recognition has been examined by various features extraction methods and classifiers. Different factors like handwriting styles, image quality and clarity, affects the efficiency of the recognition system. Some algorithms like R-CNN gives accuracy upto 97% but not 100% accuracy. Following table shows the accuracy of different algorithms used in character recognition systems and research gap.

Sr No	Paper Title	Publication Details	Algorithm	Accuracy	Research Gap
1	Comparative study of Devanagari Handwritten Character Recognition using Different Features and Classifiers	ICDAR, U. Pal, T. Wakabayashi, F. Kimura, 2009	Mirror Image Learning (MIL)	94.94%	Mirror Image Learning (MIL) is a corrective learning algorithm proposed to improve the learning effectiveness of class conditional distributions but works less accurately for confusing classes.
2	Comparative Study of Devanagari Handwritten Character Recognition using Different Feature and Classifiers	ICDAR,U. Pal, T. Wakabayashi, F. Kimura,2009	Modified Quadratic Discriminant Function (MQDF)	94.42%	A lot of mathematical computation is required as X is the feature vector of an input character; M is a mean vector of samples; T i is the i th eigen vector of the sample covariance matrix.
3	Comparative Study of Devanagari Handwritten Character Recognition using Different Feature and Classifiers	ICDAR,U. Pal , T. Wakabayashi , F. Kimura,2009	SVM	93.96%	SVM is defined for two-class problem and it finds the optimal hyper-plane which maximizes the distance, the margin, between the nearest examples of both classes.
4	A Fuzzy based Classification Scheme for Unconstrained Handwritten	ICCICT, Sushma Shelke , Shaila Apte ,2015	Fuzzy based classification	96.95%	Classification is done using 2 stages, first based on fuzzy inference system and second based on structural parameters.

	Devanagari Character Recognition				
5	Handwritten Character Recognition Using Deep-Learning	ICICCT, Rohan Vaidya, Darshan Trivedi, Sagar Satra, Mrunalini Pimpale, 2018	R-CNN	97.1%	The amount of computational power needed to train a neural network has increased due to the availability of GPUs and other cloud based services like Google Cloud platform.
6	Handwritten Devanagari Character Classification using Deep Learning	ICICET, Prasad K. Sonawane , Sushama Shelke, 2018	CNN-AlexNet	95.46%	It can be concluded that transfer learning is the better option with fewer training samples and not large.

CONCLUSION

The main purpose of this paper is to study GoogLeNet in recognition of the Devanagari characters in comparison with other techniques .

We also observed that techniques for identifying and detecting Devanagari characters from pictures, as well as handwriting are valid.

GoogLeNet architecture consists of 22 layers (27 layers including pooling layers), and part of these layers are a total of 9 inception modules.

It was the winner of the ILSVRC 2014 competition was from Google.GoogleNet trains faster than VGG.

Size of a pre-trained GoogleNet is comparatively smaller than VGG. A VGG model can have > 500 MBs, whereas GoogLeNet has a size of only 96 MB.

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