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Various Approaches of Convolutional Neural Network-Based Recognition of Handwritten Devanagari Characters

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***Abstract*-- In the past, handwriting recognition systems based on handmade qualities and a great deal of historical data. An OCR system that depends on these specifications is challenging to train the HR research that has produced ground-breaking results recently is centered on deep learning techniques. However, the rapid expansion in the volume of written data and the accessibility of massive computing resources call for an improvement in detection performance and call for further research. The most effective approach to solve the handwriting identification problem challenges is to use CNNs, which are particularly adept to address the issue of handwriting recognition automated extraction of distinctive traits. The goal of the proposed study is to investigate different design choices for handwritten digit recognition using CNN, such as the quantity of layers, phase size, facility available, kernel size, padding and dispersion. Our objective is to achieve comparable accuracy using a pure CNN architecture. As a result, a CNN design is suggested to attain accuracy that is even greater than ensemble systems while also reducing operational complexities and expense.**

***Keywords*--Convolutional neural networks, handwritten character recognition, deep learning and Devanagari characters.**

I. INTRODUCTION

Deep learning converts the manual process of creating & transforming features for a particular problem into an automated procedure that calculates the good features for that issue. Multiple convolutional layers are used in a deep convolutional neural network to select knowledge automatically. While deep learning models use many convolutional layers to repeatedly extract distinguishing traits, most shallow deep learning only retrieves the characteristics once. It is only one of the numerous factors the deep learning models are successful. The LeNet [4] is an illustration of a DCNN used for character recognition. VGGNET, GoogleNet, RESNET, AlexNet, and ZFNet are examples of networks. These models have been used to classify images and recognize characters with great effectiveness. Many prominent businesses have used deep models as a result of their tremendous success. With 22 layers of alternating convolutional and pooling layers, The GooLeNet was created by Google. In addition to this approach, Google has also created Tensorflow, an open source software library for deep learning research. In 2015, Microsoft unveiled ResNet, a proprietary DCNN architecture. This DCNN model differed from the previous one in that it added the concept of residual learning, which sped up the optimization and back-propagation procedures. The following highlights our work's main contributions:

1. This is the first time a deep learning technique has been used on a database that we have built. The most important addition is a thorough assessment of different DCNN models.

2. Deep learning is a fast growing area that is producing fresh methods that have potential to greatly improve DCNN performance. In order to better understand how adaptive gradient techniques work in deep convolutional neural network models, a variation in recognition accuracy was demonstrated.

3. To obtain the greatest recognition accuracy and a quicker convergence rate, a layer-wise DCNN method is suggested.

II. LITERATURE SURVEY

A Deep Learning Concept: Using CNN to identify written Devanagari and Bangla characters online. Online handwriting recognition for Devanagari using CNN, a deep learning method. Two convolution and pooling layers make up our suggested model, which is a fully connected network. The CNN model generates features instead of doing it manually, automatically minimizes feature dimension, and then sends characteristics of a completely interconnected network for classification. 1800 Devanagari characters and 10,000 basic Bangla characters total 10,000 in the current study. Devanagari characters written by hand are recognised using convolutional neural networks [2]. A technique for recognizing Devanagari letters written by hand many Indian languages utilize Devanagari, one of the most widely used scripts. The Devanagari script is also used to

write the Hindi language. This research aimed to categorize Devanagari letters using six layers of neurons. This method was able to attain a 95.6 % accuracy rate.

Kannada Handwritten Character Recognition Using DCNN [3]. There are 46 classes and 92000 total images in Devanagari character set. The Kannada character set, on the other hand, consists of 81654 images for training and 9401 for testing. In all, 1,23,654 data samples are used in the training of VGG19 NET. 9401 samples from 188 classes totaling between 40 and 100 samples each were used for the testing. The precision was over 90%. After 10 assessments utilizing the VGG19 NET. Odia Handwritten Character Recognition Using Machine Learning in Noise [4]. It has been used to create a data preparation. Using Convolutional Neural Networks to Recognize Devanagari Handwriting [5]. When a consonant is followed by a vowel, the letters of the alphabet are changed. Like Latin languages, there is no capitalization of letters. To extract characteristics and identify letters in a picture, deep learning methods are used. To extract characteristics from the input images and classify them, they used a Deep Convolutional Neural Network (DCNN). This method employs consecutive convolutional layers, which provides an advantage in the extraction of higher-level features. The trained model has a 99.65 % accuracy rate.

DeepNet Devanagari [6] is a deep learning system for recognizing Devanagari ancient characters. The authors recommend employing a deep learning model as a feature extractor and a classifier to identify 33 kinds of essential characters in ancient Devanagari texts. An experimental investigation that used a dataset of 5484 characters was carried out. Numerous studies show that using CNN as a feature extractor increases accuracy in comparison to other cutting-edge techniques. The accuracy is 93.73%. Utilizing semi-automatic labeling based on density and multi-feature representations to create ground truth for handwritten character recognition [7]. The technique uses an iterative process to examine samples in various feature spaces using the closest neighbor graph. Then, using sample density and multi-views, the manually annotated label is spread to neighboring samples under safe circumstances. Repeat the process until all unlabeled samples have been labeled. The results show that the suggested strategy outperforms existing labeling techniques and achieves the highest level of labeling accuracy.

Handwritten Marathi numbers can be recognized using a stacked ensemble neural network [8]. For the purpose of detecting Marathi handwritten numbers, a stacked ensemble meta-learning technique for customized CNN is presented. Multi-head meta-learning classifiers are created by stacking the pre-trained base pipelines, and they provide the final target labels. It was found after performance evaluation and analysis on a dataset of Marathi handwritten numerals that the apparatus is frequently better than the solutions that are currently advised. From [9] the H2TR system uses DNN and the Seq2Seq method to recognize handwritten text. This hybrid model combines the greatest qualities of RNN and CNN. The handwritten image's attributes are extracted using CNN. The IAM and RIMES handwritten datasets are used to validate the present model, which produces competitive results for letter and word accuracy.

Using CNN and Transfer Learning to Recognize Handwritten Devanagari Characters [10].CNNs and transfer learning are used to recognize Devanagari characters in handwriting. They contrast transfer learning performance of VGG16 and DenseNet121 to recognize handwritten Devanagari characters.. Models are trained in various circumstances, and their outcomes are compared to other techniques. The research found that DenseNet121 outperformed other pre-trained models and supplementary learning methods using a deep fine-tuning approach. Based on ANN, An Effective Method for Recognizing Handwritten Devanagari Characters [11]. A technique for reading handwritten Devanagari characters Devanagari script's fluctuation in curves reveals the character's changing shape. During training, the suggested method can identify various handwritten Devanagari characters with a maximum classification accuracy of 99.27% and an average recognition accuracy of 97.06%.

Recognition of Handwritten Devanagari Character Using CNN [12].Any pattern recognition task's categorization and feature extraction phases are essential for accurately describing the patterns. CNN [13] is used to transform handwritten Devnagari script into a format that can be edited in Word. The accuracy rate for Devanagari numerals was 89%, while the recognition rate for the English set was 78.5%, with a perplexity frequency of 4.6% with an 18 % risk of confusion. CNN Handwritten Digit Recognition [14]. The CNN is a kind of neural network. The results show that the CNN classifier outperformed the Neural Network in computing efficiency without sacrificing execution. The fundamental structure of my project development is based on the KAGGLE both a CNN compilation and database. We will therefore require libraries like NumPy, Pandas, TensorFlow, and Keras in order to execute the model.

III. PROPSOED SYSTEM DESIGN

For the job of reading handwritten numbers, accuracy and processing speed are crucial. To maximize recognition, a CNN model is created and assessed for optimal variable learning parameters. We recommend investigating four-layer CNN architectures (CNN 4L) as well as three-layer CNN designs (CNN 4L). For CNN architecture with 3 layers, six examples were examined, whereas five examples were examined for CNN

architecture with four layers. The number of strides sizes, padding, and received receptive fields vary for each instance.

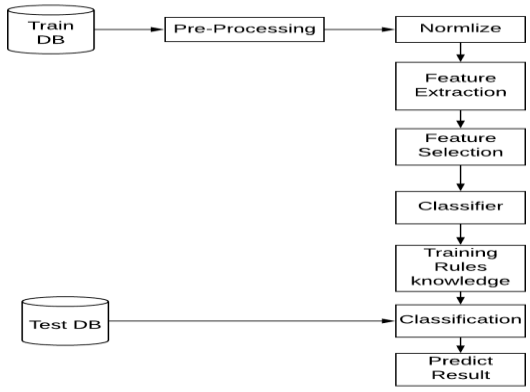

Fig. 1 Proposed system architecture

The following stages are involved in the recognition of handwritten character of our proposed model. The all phases we describe in below paragraphs. To get or gather written digit pictures from KAGGLE and separate the input pictures into 2 groups: training and test. The pre-process both the training and test datasets using the pre-processing method. After preprocessing data normalize the data such that it falls between 0 and 1 and split the training dataset into manageable chunks. Using the tagged data, train the CNN model and its variations and then classify data using a trained model. The time processing and accuracy for each version should then be calculated.

Data pre-processing is crucial to all recognition processes. Pre-processing techniques like scaling, noise reduction, centering, slanting, and skew estimation were utilized to get the input images ready for segmentation. Once the data has been generally standardized and whitened, several algorithms perform better. The correct settings for data pre-processing must be determined by experimentation with a variety of methodologies. Each filter includes an image's structural information. A filter of locally linked neurons from the original image is used in this layer to alter the input data. In a nutshell, the current work looks at how handwritten digit recognition is affected by the quantity of parameters, gradient descent optimization methods, and CNN architectures.

ALGORITHM

CNN Training

Input: Training data as Train Data [], number of activation functions [], and Threshold Th

Output: Extracted Features Feature set [] for trained module.

Step 1: Set input block of data d[], activation function, epoch size,

Step 2: Features.pkl←Extract Features(d[])
Step3:Feature set[] ← optimized(Features.pkl)
Step 4 : Return Feature set[].

IV. RESULTS AND DISCUSSION

The prose implementation has been done python 3.7 including jupyternotebooks, with RESNET-100 deep learning framework. The handwritten Devanagari image dataset from KAGGLE has been tested with the suggested CNN. Almost 5800 instances are available with this dataset including 100 samples of each. In the below section we describe a proposed system accuracy and efficiency with various input parameters.

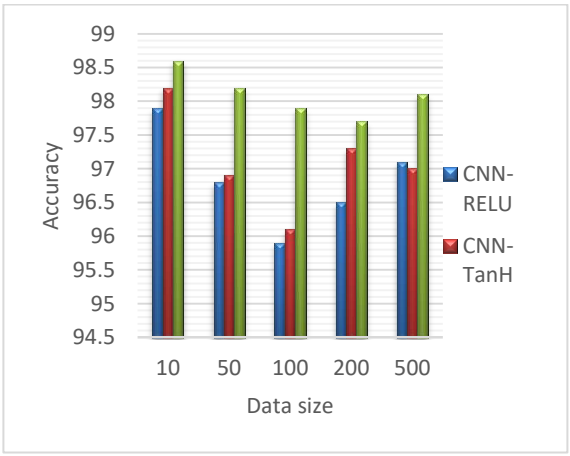

Fig. 2 Classification accuracy of proposed system with various activation functions in CNN.

Figure 2 shows how the system changed the accuracy with three distinct activation functions and various datasets. During module training and classification, several parameters were fine-tuned. In general, CNN with sigmoid activation outperforms the other two techniques of RELU and TanH.

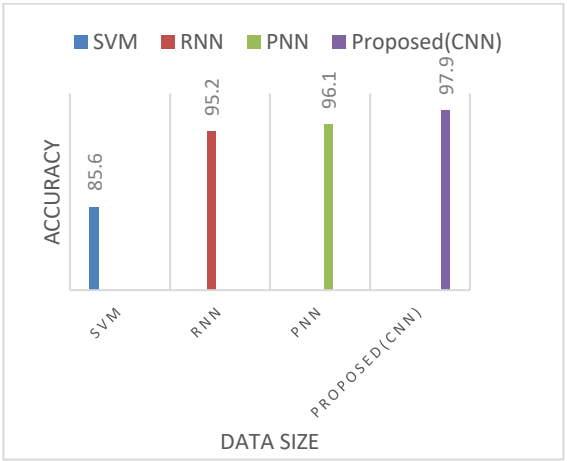

Fig. 3 Comparative analysis of proposed system with various classification algorithms

According to Figure 3 we have evaluated our proposed system with three existing classification

algorithms such as SVM, RNN and PNN. The machine learning associated SVM provides 85.6% accuracy while RNN and PNN deep learning based classification algorithm provides 95.2% and 96.1% accuracy respectively. The proposed CNN produces 97.7% average accuracy on similar dataset.

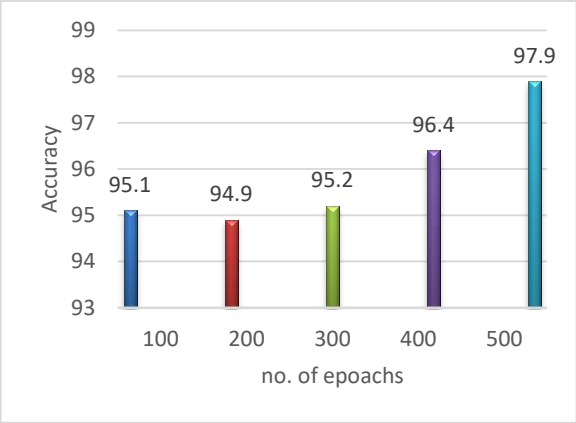

Fig. 4 Classification and detection accuracy of proposed system with different epoch of CNN

Figure 4 depicts the detection accuracy of CNN with various epochs during execution. The CNN builds the multiple convolutional when generate the training rules, it takes input number of epochs, activation function, convolutional size and dense layer etc. According to these experiments we conclude the highest epochs provide highest accuracy but it also increased the computation cost.

V. CONCLUSION

One of the most well-known technologies, deep learning has been tested in a number of industries, including content analysis and machine learning. In this study, to distinguish between printed and handwritten Devanagari letters, we used regenerator methods and a DCNN. We were able to dynamically locate and identify the most beneficial traits with the help of the DCNN. We assessed six alternative DCNN network topologies and six different optimizers on a set of handwritten Devanagari characters. The highest average accuracy of 97.9% for recognition was produced by the RESNET-100 network design.

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