

LITERATURE SURVEY

A Novel Method for Handwritten Digit Recognition System

Kaliappan, A. V. and et al. in [9] have designed the combination of convolution neural network (CNN) and weighted contribution of feature point-based methods, Which are used to recognize the Tamil alphabet in this paper. Also various CNN configuration and feature point methods BRISK, ORB, KAZE are put into test. In the feature point based method K-nearest neighbor, decision tree, regression and multi-layer perceptron classifiers are used. So the best point based configuration and CNN configuration is combined in this hybrid approach. The KAZE MLP is found to be the best feature point based classifier and CNN 15 is the best classifier. By getting 95.6% accuracy the hybrid model performed better than CNN and Point based methods. k means clustering is the algorithm used. In this approach, evaluation has focused on 12 classes of Tamil vowels only.

Gnanasivam P. and et al. in [7] proposed a convolutional neural network model is used for converting digitized handwritten tamil words to readable format. Initially the input image needs to be preprocessed. Preprocess includes image resizing, formatting etc. Then using filters of convolutional layers, the features such as corners, edges are extracted. It uses handwritten data sets to train the module. Also using the Google cloud translation API the audio is created from the recognised characters by the module. Algorithm used is CNN. Only certain Tamil characters are used to train the model so not all Tamil characters are recognized.

Hossain, M. T. and et al. in [8] recognized the Bangla handwritten words. This paper proposes a method in which first the images are preprocessed and characters are isolated by finding the "matra" and then segmenting each character from it. 3 zones are created. The upper zone is the one above the "matra" and the lower zone is created by making pixels white to a certain thickness beyond the minimum character height below the upper zone. after these preprocessing a temporary decision about each character is made and final decision is made by combining all 3 zones. Results show that there is an 82% accuracy using CNN algorithm. Accuracy for consonants are less than the consonants without the

vowel modifiers also show better results than the consonants with the vowel modifiers
Main reason for this is to managing the vowel modifier containing consonants with separate logic.

Kowsalya and et al. in [10] focused to increase the efficiency of Tamil character recognition. Various image processing techniques are applied in order to finally get each character separately and then the character is recognized using a modified neural network and weights are updated using elephant herding optimization. On the basis of these metrics the proposed method is evaluated and the results were also compared to existing classifiers. The comparative results showed that the proposed MNN method provides better accuracy results than classifiers. Algorithm used is the Modified Neural Network using elephant herding optimization. Accuracy is less when compared to other existing works for Tamil character recognition. Not all Tamil characters are recognized with this model as only few are used to train the model.

Chung, J. and et al. in [3] proposed a less computationally expensive framework for recognizing the full page handwritten text. Text localization is done first by identifying to find out the handwritten passage and then line segmentation-conversion of words to lines using clustering algorithm. Next Text recognition takes place which also has 2 stages first Handwriting recognition which is done using CNN and bi-LSTM, CNN is useful for extracting features from images and downsampled images. These features are given as input to the bidirectional LSTM and it generates the output then Language modeling the noisy input is given, it denoises and produces the candidate strings (using beam search algorithm). This methodology uses less time and memory and it has CER of 8.50. Algorithm used is the combination of Convolutional Neural Network and Long Short Term Memory. Several short words, typically less than three characters, are not detected properly. Only the English language is considered.

Dixit, U. D. and et al. in [5] focus to achieve the accurate word image recognition for handwritten word using SVM and K-NN classification methods. Each word in the input is segmented into characters of images. Histogram of Oriented Gradients (HOG) features of image character dataset is used to train the classifiers. The method used in this paper

consist of pre-processing where the noise in the image is removed using median equation. Followed by segmentation of the word happens then extraction of feature for segmented characters is done using HOG. Using the obtained features classification is done by K-NN ($k=1$) and SVM algorithm. Finally combining all the identified characters the word is recognized. Using the HOG features combined with K-NN or SVM classifiers, SVM gives a good recognition rate of 75%. Algorithm used is the Histogram of Oriented Gradients (HOG), K-NN, SVM. The recognition approach is done only for words and not for the entire document. Also the recognition rate is less.

Ayyadevara and et al. in [1] recognized the handwritten character is recognized using a combination of three different feature extraction techniques and MLP BP the MLP neural network using LevenbergMarquardt algorithm and the CNN. The three feature extraction methods used here are gradient, geometric, zone based hybrid feature extraction. These techniques are applied individually as well as in the combination form. The results obtained implies that the feature extraction technique will affect the accuracy of character recognition. The combined feature extraction technique gives the best accuracy and CNN gives best accuracy rate compared to the other neural networks such as MLP BP and MLP LM.

Prakash and et al. in [16] used the Convolutional Neural Network for the classification of image and text can be extracted by using Tesseract. The CNN is used to overcome the overfitting problem. The character pattern recognition and line recognition can be done by using the LSTM. The CNN gives better accuracy compared to the SVM.

Mishra, P. and et al. in [12] In this paper, the deep Convolutional Neural Network architecture is proposed to recognise the isolated tamil characters in offline mode. The proposed network contains 2 convolutional layer followed by Max pooling layer and 2 fully connected layer followed by an output layer. 124 (unique symbols) classes considered for classification. Achieved training accuracy is 88.2% and the achieved testing accuracy is 71.1%. The main disadvantage found was that highly similar symbols were misclassified regularly that leads to the reduction of testing accuracy.

Goria and et al. in [6] recognized the handwritten text by using the OCR and convergence of CNN and RNN. The Handwritten Text Recognition divided into two parts: 1. Character Recognition 2. Word Recognition. Input image consists of a sentence that will have several words. To recognize a particular word, you need to identify each character in the word. The letters will be used to predict the word. To implement the handwritten character recognition, two kinds of Neural Network model is used: 1. 5 layer of Convolutional Neural Network (CNN)- to extract features from the image . 2. 2 layers of Recurrent Neural Network (RNN) – to determine the word . CER and WER acts as performance metrics to judge the accuracy of the model.

Adrian MLOISE and et al. in [13] developed a system which takes the computer written text as input and outputs the converted braille to a device which is used by blind to read embedded text. Where a FSM finite state machine is implemented using a software approach. The finite state machines states are considered with corresponding output. Which is then implemented in a software approach as code. The system is divided into two units hardware and software. In which the hardware contains a microcontroller and a usb connected to the computer. When a key is pressed in the keyboard its ascii value is stored in the buffer and its sent to the finite state machine which sends the signal to the 6 needles that are touched by the blink to read. The software will control the 6 pins activation according the finite state machine result and the code build in by the concepts mentioned above. The system is tested against various inputs from alphabets to special characters, which gave a braille result with a delay of 2 sec between each characters.

Mainkar and et al. in [11] implemented an android application which captures an image of the hand written text and in return an editable text document as an output. Main objective is to bring the conversion in offline and mobile application. This is done by 5 steps which are image acquisition, preprocessing, segmentation, feature extraction and postprocessing. In the image acquisition step the image is captured using the mobile application camera and in a gray scale. Its followed by the preprocessing on the gray scale image that are binarization, skewing, normalization and thinning. Then the segmentation of the each individual characters is done from the sentence and then in words. After the segmentation the OCR does the feature extraction where the characters are recognized according to their

slant,height and curve.The classified characters are then written to a text document and are stored in the mobile application.This stored application can be edited latter also can be viewed. It gives a significant result of the scanned image as a text.

Deepa and et al. in [4] used the Convolutional Neural Network for the classification of image and text can be extracted by using Tesseract.The CNN is used to overcome the overfitting problem.The character pattern recognition and line recognition can be done by using the LSTM.The CNN gives better accuracy compared to the SVM.

Sarika and et al. in [18] gives the description of OCR and the CNN layers ,architecture and its implementation. OCR is used to convert the text in an image to text format .OCR has different phases like digitization,pre processing,segmentation,feature extraction.CNN is used for recognizing the handwritten telugu characters.CNN layers are convolutional layer ,pooling layer,ReLu layer and fully connected layer.The CNN architectures discussed in this paper are LeNet,AlexNet and ZFNet. VGG-16 architecture which consists of one input layer, one output layer and other six layers is used and trained with telugu character dataset here. Survey made on several CNN techniques which are used for classification of handwritten character recognition.

Vaidya and et al.in [20] developed the system for recognising the handwritten character based on image segmentation.The convolutional neural network model is used here.The Neural network is trained using a tensorflow and the image processing operations are carried out by open source library OpenCV.The steps involved in the process are preprocessing,conversion of gray scale ,thresholding and image segmentation.Finally the recognition of characters happens through the neural network.Limitations of this paper are the recognition of cursive handwriting is not possible,this system only supports for the English language and the recognition of letters and digits are possible whereas the recognition of special symbols is not possible.

Vinjit and et al. in [21] reviewed the task involved in identification of the handwritten characters and Digitizing manually written text.It is known as Handwritten Character Recognition.The various techniques have been discussed to recognize different handwritings.The exact recognition of letters is directly depends on the nature and quality

of the material. Choosing the relevant characteristic feature extraction and classification techniques is the key to get good recognition rate. This paper will help to know the methodologies used in the field of handwritten character recognition till now along with their advantages, limitations and accuracy rate. Similar Characters like '1' and '7', '4' and '9' are difficult to recognise. To overcome this larger training data set and better neural network designs are to be used. Although there are several techniques proposed but none of the methods is fully perfect and still improvement have to be done in the system.

The related works were surveyed and the limitations were identified to propose an organised work for our research, as described in the following elaborative headings. Keeping the challenges face by the previous researches, the model to be developed has been carefully designed, which would be cost effective as well.

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