A Novel Method For Handwritten Digit Recognition

ZAMIN HAMID	1905123
NISHANTHINI.A.M	1905101
PRIYANKA.S	1905108
SANJANA.S.MENON	1905112

LITERATURE SURVEY

S.No.	TITLE	MODEL / TECHNIQUES USED	MERITS	OUTCOMES/ METHODOLOGY
1.	**TITLE:** Effective Handwritten Digit Recognition using Deep Convolution Network **AUTHORS:** Yellapragada SS Bharadwaj , Rajaram P , Sriram V., Sudhakar S ,Kolla Bhanu Prakash **PUBLISHED:** MARCH-APRIL 2020 **AVAILABLE:** http://www.warse.org/IJATCSE/static/pdf/file/i jatcse66922020.pdf	• Neural Networks. • SVM • SOM • CNN	**Merits:** • 98.51% accuracy for real-world handwritten digit prediction	• The performance of CNN for handwritten recognition performed significantly. • The proposed method obtained 98% accuracy and is able to identify real-world images.

| 2. | **TITLE:**
A Comparative Analysis on Bangla Handwritten Digit Recognition with Data Augmentation and Non-Augmentation Process.

AUTHORS:
Md. Abdullah Al Nasim , Refat E Ferdous , Mahim Anzum Haque Pantho and Atiqul Islam Chowdhury

PUBLISHED:
JULY 2020

AVAILABLE:
https://ieeexplore.ieee.org/document/9152905 | • Bangla digit, NumtaDB, handwritten,
• CNN
• augmentation,
• DenseNet121 | **Merits:**
• 99.46% of classification accuracy for non augmented datasets. | • Experimented on the NumtaDB dataset for recognizing Bangla digit both with augmentation and non-augmentation. |

3.	TITLE: Bangla Handwritten Digit Recognition And Generation AUTHORS: Md Fahim Sikder PUBLISHED: 14 MARCH 2021 AVAILABLE: https://www.researchgate.net/publication/350086999_Bangla_Handwritten_Digit_Recognition_and_Generation	• Semi-Supervised Generative Adversarial Network SGAN	**Merits:** • 99.44% accuracy on BHAND dataset and outperforms Alexnet and Inception V3 architecture	• In this paper, a Semi-Supervised Generative Adversarial Network or has been applied to generate Bangla handwritten numerals and it successfully generated Bangla digits.
4.	TITLE: Handwritten Text Recognition using Deep Learning AUTHORS: Nikitha ,Dr. Geetha J,Dr. JayaLakshmi PUBLISHED: November 2020 AVAILABLE: https://ieeexplore.ieee.org/document/9315679	• Deep Learning algorithm • LSTM, • Convolutional Neural Network	**Merits:** • achieves sufficient accuracy for both printed as well as the handwritten text.	• Experimentation has been performed on the IAM handwritten text data set to evaluate the performance of the two well-known approaches namely, CNN-1DLSTM-CTC and 2DLSTM. • This paper reported that the LSTM based model for

5.	**TITLE:** Handwriting Personality Recognition with Machine Learning: A Comparative Study **AUTHORS:** Ahmed Remaida ,Aniss Moumen ,Benyoussef Abdellaoui ,Younes El Bouzekri El Idrissi **PUBLISHED:** May 2021 **AVAILABLE:** https://ieeexplore.ieee.org/abstract/document/9314529	• Deep learning • Artificial neural networks • personality analysis • graphology, handwriting analysis.	**Merits:** • The accuracy for different architecture is found and compared for analysis.	• In this paper , analysis for the potential of deep neural networks when applied to personality prediction based on handwriting features is done. • Proposed a system's architecture for detecting the Big Five personality traits from handwriting and intend to explore its performances in a future work.
6.	**TITLE:** Handwritten Digit Recognition using OpenCV and CNN **AUTHORS:** Swetha, Hithaishi, L. Tejaswini, Parthasaradhi,V. Venkateswara Rao **PUBLISHED:** JUNE 2021	• CNN • LR • KNN • SVM	**Merits:** • The accuracy for CNN is 99.63%.	• CNN gets trained from the real-time data and makes the model very simple by reducing the number of variables and gives relevant accuracy. • In this project, we use CNN with some libraries like Keras, Matplotlib, CV2, Tensorflow to get the maximum accuracy.

	AVAILABLE: https://ijcrt.org/papers/IJCRT2106267.pdf			
7.	**TITLE:** Handwritten Digit Recognition using Machine and Deep Learning Algorithms **AUTHORS:** Ritik Dixit ,Rishika Kushwah ,Samay Pashine **PUBLISHED:** 23JUNE 2021 AVAILABLE: https://arxiv.org/pdf/2106.12614.pdf	• SVM • CNN • Multilayered perceptron	**Merits:** • The accuracy for SVM is 99.26% • The execution time is minimum in SVM **Demerits:** • It is not possible to classify complex and ambiguous images as accurately	• In this paper, three models for handwritten digit recognition using MNIST datasets, based on deep and machine learning algorithms has been implemented. • Comparison based on their characteristics to appraise the most accurate model among them was done.
8.	**TITLE:** Handwritten Digit Recognition Using CNN **AUTHORS:** Mayank Jain ,Gagandeep Kaur ,Muhammad Parvez Quamar . **PUBLISHED**: MARCH 2021 AVAILABLE: https://ieeexplore.ieee.org/document/9388351	• CNN	**Merits:** • The accuracy is 99.26%	• It is found that CNN gave the most accurate results for handwritten digit recognition. • In future, various designs of CNN, in particular, cross breed CNN, viz., CNN-RNN and CNN-HMM models, and space explicit acknowledgment frameworks, can be researched.

| 9. | **TITLE:**
A Novel Softmax Regression Enhancement for Handwritten Digits Recognition using Tensor Flow Library

AUTHORS:
Aman Arora ,Teaba Wala ,Aldeen Khairi Omar Hisham Alsadoon,Tarik A. Rashid

PUBLISHED:
MAY 2020

AVAILABLE:
https://ieeexplore.ieee.org/document/9371821 | • CNN
• SVM
• Bayesian classifier | **Merits:**
The accuracy is 95.67% | • This paper has led to an increase in the Classification Accuracy of Handwritten Digits under the Evaluation Phase using Root Mean Square Error (RMSE) as the comparison error.
• The main feature of this research is the bias probability function that has been added to the Softmax Classifier Main Algorithm to take away any negative or positive bias that exists in the data set as the main feature of this work. |

10.	**TITLE:** A Novel Handwritten Digit Classification System Based on Convolutional Neural Network Approach **AUTHORS:** Ali Abdullah Yahya , Jieqing Tan 2 and Min Hu 2 **PUBLISHED**: 2021 AVAILABLE: https://www.researchgate.net/publication/354755659_A_Novel_Handwritten_Digit_Classification_System_Based_on_Convolutional_Neural_Network_Approach	• CNN • Data augmentation • Batch normalisation	**Merits:** CNN algorithm achieves state-of-the-art results in handwritten digit recognition, with a recognition accuracy of 99.98%, and 99.40%	• In this paper, we presented a novel convolutional neural network architecture based on data preparation, receptive field, data augmentation, optimization, normalization, and regularization techniques for handwritten digit recognition.
11.	**TITLE:** A New Type Method of Adhesive Handwritten Digit Recognition Based on Improved Faster RCNN. **AUTHORS:** Zuo Huahong,Tang Junyi,Han Ping **PUBLISHED**: 2020 **AVAILABLE:** https://ieeexplore.ieee.org/document/	• Fast regional convolution-al neural network (Faster RCNN)	**Merits:** • The average detection accuracy of the proposed model is good. • The model reduces the scale of parameters. • The model ensures high recognition accuracy of handwritten adhesive digits.	• In this paper, according to the characteristics of handwritten digit string images, the current mainstream target detection algorithm faster RCNN framework is extended to design a network model which is consistent with the characteristics of the detection object, and

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12.	**TITLE:** Handwritten Digit String Recognition using Deep Autoencoder based Segmentation and ResNet based Recognition Approach **AUTHORS:** Anuran Chakraborty, Rajonya De, Samir Malakar, Friedhelm Schwenker and Ram Sarkar **PUBLISHED**: 2020 **AVAILABLE:** https://ieeexplore.ieee.org/abstract/document/9412198/	• Deep autoencoder based segmentation technique. • Residual Network • Computer Vision Lab (CVL) Handwritten Digit Strings (HDS) database	**Merits:** • Handwritten digit strings, which are commonly found in bank cheques, postal documents, filled-in forms, etc., are mostly written in a cursive way. Hence, the performance of conventional segmentation and recognition-based approach suffers in most of the cases. It is overcome in this model. **Demerits:** • when the entire digit string is written at one	• In this paper, a deep autoencoder is applied (U-Net), and then it is recognized as isolated digits using a standard deep learning model (ResNet). • Applying on the CVL HDS database, it is found that the proposed approach can produce results comparable with state-of-the-art techniques;still there are some rooms for improvement.

			go, the segmentation approach fails to isolate some digits.	
13.	**TITLE:** Combined Convolutional and Perceptron Neural Networks for Handwritten Digits Recognition **AUTHORS:** Zufar Kayumov,Dmitrii Tumakov,Sergey Mosin **PUBLISHED**: 2020 **AVAILABLE:** https://ieeexplore.ieee.org/document/9213301	• convolutioal neural network • multilayer perceptrons	**Merits:** • The accuracy of the F-metric is about 0.99 for each digit. • Can be easily implemented in hardware.	• In this paper ,a combined convolutional neural network for pattern recognition is proposed. • The first neural network selects two digits out of ten, the next (perceptrons) neural networks select one out of two digit.

14.	**TITLE:** High-Accuracy handwriting recognition based on improved CNN algorithm. **AUTHORS:** Xian Wu ,Yanhan Ji Xiao Li **PUBLISHED**: 2021 **AVAILABLE**: https://ieeexplore.ieee.org/document/9213301/	• CNN • SVM	**Merits:** • Improved generalization of the model and reduce over-fitting. • Accuracy of 99.60%.	• In this paper, a CNN model is used to train handwritten digits, with an advanced activation function PRELU. • The Adam optimizer is used for network training, and the cross-entropy function is used to measure the loss. • In gradient descent, the adaptive learning rate method is used, which makes the optimizer converge faster and closest to the global minimum loss value • Finally, the output is sent to the SoftMax layer for classification.
15.	**TITLE:** Handwritten Digit Recognition of MNIST dataset using Deep Learning state-of-the-art Artificial Neural Network (ANN) and Convolutional Neural Network (CNN) **AUTHORS:** Drishti Beohar,Akhtar Rasool	• Artificial Neural Network • Convolution al Neural Network	**Merits:** • The average error of CNN is less than ANN. • CNN gave better performance for image classification. **Demerits:** • Convolutional Neural Network takes more time and CPU power.	• CNN and ANN both are trained and tested with the MNIST dataset. • The models used the ReLU activation function for the backpropagation algorithm. • Softmax activation function for the probabilistic values of the output.

	PUBLISHED: 2021 **AVAILABLE:** https://ieeexplore.ieee.org/document/9396870			• The training was done with the categorical cross-entropy loss; ADAM optimizer was used for decreasing the loss.
16	**TITLE:** Handwritten Digits Identification Using Mnist Database Via Machine Learning Models **AUTHORS:** Birjit Gope,,Nikhil Karale,Shivani Dharmale, Pooja Umekar **PUBLISHED:** 2021 **AVAILABLE:** https://iopscience.iop.org/article/10.1088/1757-899X/1022/1/012108	• Machine Learning • Deep Learning	• The important challenge in every identification method is to resolve the extraction of features and valid classification approaches. • Using SVM accuracy of 95.88% is achieved.	• The key goal of this paper is to find a representation that makes for successful identification of isolated hand-written digits. • Support Vector Machine, Multilayer Perceptron, Decision Tree, Naïve Bayes, K-Nearest Neighbor, and Random Forest are being used.
17	**TITLE:** An Off-line Handwriting Recognition Employing Tensorflow **AUTHORS:** Hao Zeng	• Tensorflow	**Merits:** • The average detection accuracy of the proposed model is good. • MNIST handwriting accuracy 0.9195	• This paper illustrates handwriting recognition based on MNIST dataset using Tensorflow with high accuracy. • The factor of index value is ignored and

	PUBLISHED: 2020 **AVAILABLE:** https://ieeexplore.ieee.org/document/9196493			accuracy can be higher in a great extend by labeling it. • The algorithm in experiment is effective and generalized, making it compatible with other machine learning package capable of recognizing handwriting digits.
18	**TITLE:** Handwritten Form Recognition Using Artificial Neural Network **AUTHORS:** Narayana Darapaneni Malarvizhi Subramaniyan Aafia MariamAnwesh Reddy Paduri Nandini Ravi Sai Venkateshwaran Sumathi Gunasekaran Asha **PUBLISHED**: 2020 **AVAILABLE:** https://ieeexplore.ieee.org/document/9342638	• CNN • OpenCV	**Merits:** • Accuracy 91% **Demerits:** • Accuracy was less than expected and can be improved if we train the model on more samples with space between the characters.	• The handwritten forms are scanned, preprocessed to remove noise and handwritten fields are extracted. • OpenCV is used to get the contours of the characters in the extracted images. • The model was trained using EMNIST dataset, it was observed that the model was able to predict the numbers better than the alphabets.

| 19 | **TITLE:** Augmentation Based Convolution Neural Network for Recognition of Handwritten Gujarati Characters **AUTHORS:** Pritesh Borad,Parth Dethaliya Anand Mehta **PUBLISHED**: 2020 **AVAILABLE:** https://ieeexplore.ieee.org/document/9298192 | • CNN
• MATLAB
• Deep Learning
• MLP | **Merits:** • The proposed system has achieved maximum training accuracy of 98.6% and testing accuracy of 94.8%. | • The CNN, augmentation and dropouts based handwritten character recognition system is introduced in this paper.
• For training the model, new Gujarati characters' data set is generated by the students and teachers of primary school, Amreli.
• It is observed that despite having small data set, the algorithm has achieved the 94.8% accuracy.
• The proposed model can be applied for recognition of any Indian script and can be made more robust with additional dataset. |

| 20 | **TITLE:** Hierarchical Recurrent Neural Network for Handwritten Strokes Classification **AUTHORS:** Illya Degtyarenko, Ivan Deriuga, Andrii Grygoriev, Serhii Polotskyi, Volodymyr Melnyk, Dmytro Zakharchuk and Olga Radyvonenko **PUBLISHED:** 2021 **AVAILABLE:** https://ieeexplore.ieee.org/document/9413412 | • Hierarchical Recurrent Neural Network | **Merits:** • Accuracy 97.25% **Demerits:** • Major DLA challenges arise due to a wide diversity of handwritten content, various writing styles, a lack of contextual knowledge, and the complicated structure of freeform handwritten documents. | • In this paper, a hierarchical recurrent neural network (RNN) architecture to address the hierarchical structure inherent to the handwritten document is proposed. • Stroke classification is an important step in automatic document layout analysis (DLA) in handwritten document recognition systems. |