

# Literature Review

## **ABSTRACT:**

Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing. It is the capability of the computer to identify and understand handwritten digits or characters automatically. Because of the progress in the field of science and technology, everything is being digitised to reduce human effort. Hence, there comes a need for handwritten digit recognition in many real-time applications. The MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. We use Artificial neural networks to train these images and build a deep learning model. Web application is created where the user can upload an image of a handwritten digit. this image is analysed by the model and the detected result is returned on to UI

**PAPER 1:**A Fast and Accurate Object Detector for Handwritten Digit String Recognition

**AUTHOR:**Jun Guo; Wenjing Wei; Yifeng Ma; Cong Peng

**YEAR:**2021

## **ABSTRACT:**

Focusing on handwritten digit string recognition (HDSR), we propose an anchor-free object detector called ChipNet, where a novel encoding method is designed. The input image is divided into columns, and then these columns are encoded by the ground truth. The adjacent columns are responsible for detecting the same target so that it can well address the class-imbalanced problem while reducing the network computation. ChipNet is composed of convolutional and bidirectional long short term memory networks. Different from the typical detectors, it doesn't use region proposals, anchors or regions of interest pooling. Hence, it can overcome the shortages of anchor-based and dense detectors in HDSR. The experiments are implemented on the synthetic digit strings, the CVL HDS database, and the ORAND-CAR-A & B databases. The high accuracies, which surpass the reported results by a large margin (up to 6.62%), are achieved. Furthermore, it gets 219 FPS speed on  $160 \times 32$  px resolution images when using a Tesla P100 GPU. The results also show that ChipNet can handle touching, connecting and arbitrary length digit strings, and the obtained accuracies in HDSR are as high as the ones in single handwritten digit recognition.

**PAPER 2 :** A novel method for Handwritten Digit Recognition  
with Neural Networks

**AUTHOR:** MALOTHU NAGU, N VIJAY SHANKAR,K.ANNAPURNA

**YEAR:**2021

Character recognition plays an important role in the modern world. It can solve more complex problems and makes humans' job easier. An example is handwritten character recognition. This is a system widely used in the world to recognize zip code or postal code for mail sorting. There are different techniques that can be used to recognize handwritten characters. Two techniques researched in this paper are PatternRecognition and Artificial

Neural Network (ANN). Both techniques are defined and different methods for each technique are also discussed. Bayesian Decision theory, Nearest Neighbour rule, and Linear Classification or Discrimination are types of methods for Pattern Recognition. Shape recognition, Chinese Character and Handwritten Digit recognition using Neural Network to recognize them. Neural Network is used to train and identify written digits. After training and testing, the accuracy rate reached 99%. This accuracy rate is very high.

**PAPER 3:** Bayanno-Net: Bangla Handwritten Digit Recognition using Convolutional Neural Networks

**AUTHOR:** Mohammad Shakirul Islam; Md. Ferdouse Ahmed Foysal; Sheak Rashed Haider Noori

**YEAR:** 2019

**ABSTRACT:**

Handwritten digit recognition is one of the most novel topics from the last few years. The complexity of recognition handwriting differs in languages because of their shapes, character numbers and streak. Albeit Bangla is the 7th most popular language in terms of the number of first language speakers. Remaining approaches use discrete feature expulsion methods and algorithms to recognize handwritten digits. Recently, Deep learning and convolutional neural networks are used to solve classification problems. It gives better accuracy for image classification with its distinct features. In this paper, we have proposed a Convolutional Neural Network referred as “ByannoNet”, to identify Bangla hand-written digits. We worked with the richest and most popular dataset called NumtaDB generated and published by the Bengali.ai community. Our proposed model has achieved 97 percent accuracy with a very low cross-entropy rate.

**PAPER 4:** Handwritten Words and Digits Recognition using Deep Learning Based Bag of Features Framework

**AUTHOR:** Najoua Rahal; Maroua Tounsi; Tarek M Hamdani; Adel M Alimi

**YEAR:** 2019

**ABSTRACT:**

Unconstrained handwriting text recognition is a stimulating field in the branch of pattern recognition. This field is still an open search due to the wide variability of human writing. Recent trends show a potential improvement of recognition by adopting a novel representation of extracted features. In the present paper, we propose a novel feature extraction model by learning a Bag of Features Framework for handwritten text recognition based on Deep Sparse Auto-Encoder. The Hidden Markov Models are then used for sequence modelling. For features learned quality evaluation, our proposed system was tested on two handwritten text datasets IFN/ENIT word images benchmark and MNIST handwritten digits. Our method achieves promising recognition on both datasets.

**PAPER 5:** Improved Handwritten Digit Recognition Using Convolutional Neural Networks (CNN)

**AUTHORS:** Savita Ahlawat , Amit Choudhary , Anand Nayyar , Saurabh Singh and Byungun

**YEAR:**2020

**ABSTRACT:**

Yoon Customised features and a vast quantity of past knowledge have been used in traditional handwriting recognition systems. It is difficult to train an optical character recognition (OCR) system based on these conditions. Deep learning approaches have enabled significant performance in the field of handwriting recognition research in recent years. Nonetheless, the increasing increase in the amount of handwritten data, along with the availability of vast computing capacity, necessitates improvements in recognition accuracy and warrants additional exploration. Convolutional neural networks (CNNs) are extremely excellent in perceiving the structure of handwritten characters/words in ways that aid in the automatic extraction of distinguishing features, making CNN the best solution for solving handwriting recognition challenges. The proposed work aims to investigate several design alternatives for CNN-based handwritten digit recognition, such as the number of layers, stride size, receptive field, kernel size, padding, and dilution. Furthermore, we intend to assess the effectiveness of several SGD optimization techniques in enhancing the performance of handwritten digit recognition. Using ensemble architecture improves the recognition accuracy of a network. In this case, we want to obtain equal accuracy by employing a pure CNN design without ensemble architecture, because ensemble structures increase computational overhead and testing complexity. As a result, a CNN design is developed in order to obtain higher accuracy than ensemble systems while reducing operational complexity and expense. Furthermore, we demonstrate an appropriate combination of learning parameters in the design of a CNN that leads us to a new absolute record in categorising MNIST handwritten digits. We conducted extensive trials and achieved 99.87% recognition accuracy for an MNIST dataset.