# LITERATURE SURVEY

## 1. HANDWRITTEN CHARACTER RECOGNITION WITH MNIST AND EMNIST [Alejandro Baldominos, Yago saez, et al, 2019]

This paper summarizes the top state-of-the-art contributions reported on the MNIST dataset for handwritten digit recognition. This dataset has been extensively used to validate novel techniques in computer vision, performance of convolutional neutral networks (CNNs) and other deep learning techniques over this dataset. This paper is the first exhaustive and updated review of this dataset; there are some online rankings, but they are outdated, and most published papers survey only closely related works, omitting most of the literature. This paper makes a distinction between those works using some kind of data augmentation and works using the original dataset out-of-the-box. CNNs are becoming the state-of-the-art approach for solving this problem. By mid-2017, a new dataset was introduced: EMNIST, which involves both digits and letters, with a larger amount of data acquired from a database different than MNIST's. In this paper, EMNIST is explained and some results are surveyed.

## 2. PATTERN RECOGNITION-RECOGNITION OF HANDWRITTEN DOCUMENT USING CONVOLUTION NEURAL NETWORK [M. Rajalakshmi, P. Saranya, et al, 2019]

This review paper is about handwritten documents recognition which is a challenging task in the field of pattern recognition. It has an array of applications wherein recognition of words, alphabets, digits and other characters are the mandate. This review article mainly focuses review on Convolutional Neural Network (CNN). Basically, the handwritten recognition is divided into two different types: online and offline recognition. The difficulty of this system is dealing with huge variety of handwritten styles written by different writers. The system wants to recognize and identify such characters in effective manner. The scope of this review paper is to represent the merits and limitations of different techniques and strategies used in the development of recognition system and for high accuracy. The major bottlenecks in this system are the issues of recognizing unconstrained handwritings like cursive, block, and tilt that cause huge variation in writing styles, the overlapping and the interconnections between characters. The work of this paper is to implement a robust technique providing more accuracy and less error rate.

# 3. MULTI-LANGUAGE HANDWRITTEN DIGIT RECOGNITION BASED ON NOVEL STRUCTURAL FEATURAL [Jaafar M. Alghazo, Ghazanfar Latif, 2019]

Automated handwritten script recognition is an important task for several applications. In this article, a multi-language handwritten numeral recognition system is proposed using novel structural features. A total of 65 local structural features are extracted and several classifiers are used for testing numeral recognition. Random Forest was found to achieve the best results with an average recognition of 96.73%. The proposed method is tested on six different popular languages, including Arabic Western, Arabic Eastern, Persian, Urdu, Devanagari, and Bangla. In recent studies, single language digits or multiple languages with digits that resemble each other are targeted. In this study, the digits in the languages chosen do not resemble each other. Yet using the novel feature extraction method a high recognition accuracy rate is achieved. Experiments are performed on well-known available datasets of each language. A dataset for Urdu language is also developed in this study and introduced as PMU-UD. Results indicate that the proposed method gives high recognition accuracy as compared to other methods. Low error rates and low confusion rates were also observed using the novel method proposed in this study.

# 4. HANDWRITTEN DIGIT RECOGNITION USING ENSEMBLE LEARNING [Kuppa Venkata Padmanabha Nandan, Manoj Panda, S. Veni, 2020]

This paper is mainly focused on Ensemble learning. In pattern recognition, the recognition of handwritten digits has always been a very challenging and tedious task. In this work, a simple novel approach is proposed to recognize the handwritten digits. The primary goal of this work is recognition of the handwritten digits by using ensemble learning. Ensemble learning improves convergence by decreasing the complexity of the model to facilitate accurate and improved decision. This is also helpful to know about distribution of data in the random split and class-wise split. It's about analysis of how the load is distributed among the base learners and how it impacts the model accuracy and training time. The overall trends of the ensemble model have also been analysed in this paper.

## 5. A NOVEL APPROACH FOR HANDWRITTEN CHARACTER RECOGNITION USING K-NN CLASSIFIER [Abhay Mishra, Krishan Kumar, et al, 2020]

In this digital era, it is crucial to identify the authenticity of the words where the writer identification becomes a big challenge. This paper highlights an efficient approach to recognize the character from hand written document using k-nearest neighbour algorithm. Then, a supervised-learning algorithm is employed to recognize the character. From the experimental results, it is observed with our proposed model, we achieved about 92% accuracy for the digits and about 94.15% accuracy for English alphabets. To see the merits of the proposed model, comparison is made against the state-of-the-art models.

## 6. A NOVEL HANDWRITTEN DIGIT CLASSIFICATION SYSTEM BASED ON CONVOLUTIONAL NEUTRAL NETWORK APPROACH [Ali Abdullah Yahya, Jieqing Tan, et al, 2021]

An enormous number of CNN classification algorithms have been proposed in the literature. Nevertheless, in these algorithms, appropriate filter size selection, data preparation, limitations in datasets, and noise have not been taken into consideration. As a consequence, most of the algorithms have failed to make a noticeable improvement in classification accuracy. To address the shortcomings of these algorithms, our paper presents the following contributions: Firstly, after taking the domain knowledge into consideration, the size of the effective receptive field (ERF) is calculated. Calculating the size of the ERF helps us to select a typical filter size which leads to enhancing the classification accuracy of our CNN. Secondly, unnecessary data leads to misleading results and this, in turn, negatively affects classification accuracy. To guarantee the dataset is free from any redundant or irrelevant variables to the target variable, data preparation is applied before implementing the data classification mission. Thirdly, to decrease the errors of training and validation, and avoid the limitation of datasets, data augmentation has been proposed. Fourthly, to simulate the real-world natural influences that can affect image quality, we propose to add an additive white Gaussian noise with $\sigma = 0.5$ to the MNIST dataset. As a result, our CNN algorithm achieves state-of-the-art results in handwritten digit recognition, with a recognition accuracy of 99.98%, and 99.40% with 50% noise.

# 7. A NOVEL APPROCH FOR HANDWRITTEN DIGIT RECOGNITION USING MULTILAYER PERCEPTION NEUTRAL NETWORK [Toufik Datsi, Khalid Aznag, Ahmed El Oirrak, 2022]

This paper is focused on field of Optical Character Recognition. It is also based on Artificial Neural Networks which are proved their effectiveness in the areas of image processing. It is about minimize the number of pixels by using as input the data extracted and calculated from the initial image. The approach consists of transforming the image of the digit in the binary format then encode each column by value. The architecture of Artificial Neural Network used in this research is based on a multilayer perceptron neural network in order to recognize and predict the handwritten digit from 0 to 9. For better training and testing dataset, we have used the backpropagation as a learning algorithm. A dataset of 6000 samples was obtained from the MNIST database. For better training and testing dataset, we have used the backpropagation as a learning algorithm.