

**Paper Title:**

**MNIST Handwritten Digit Classification Based on Convolutional Neural Network with Hyperparameter Optimization**

**PaperLink:**

[https://www.researchgate.net/profile/Shengjie-Zhai/publication/369265604\\_MNIST\\_Handwritten\\_Digit\\_Classification\\_Based\\_on\\_Convolutional\\_Neural\\_Network\\_with\\_Hyperparameter\\_Optimization/links/64127a5c66f8522c38aae328/MNIST-Handwritten-Digit-Classification-Based-on-Convolutional-Neural-Network-with-Hyperparameter-Optimization.pdf](https://www.researchgate.net/profile/Shengjie-Zhai/publication/369265604_MNIST_Handwritten_Digit_Classification_Based_on_Convolutional_Neural_Network_with_Hyperparameter_Optimization/links/64127a5c66f8522c38aae328/MNIST-Handwritten-Digit-Classification-Based-on-Convolutional-Neural-Network-with-Hyperparameter-Optimization.pdf)

**1. Summary:****1.1 Motivation/purpose/aims/hypothesis:**

Imagine the diverse complexities of handwriting styles, a complex thing that is challenging the realm of computer vision. The traditional static feature of text photos sometimes fails to capture the individual writing style. Moreover, it limits accurate recognition. However, there is a hope for machine learning, particularly neural networks, and CNNs. These developments brought some changes that improved handwriting recognition and accuracy. The focus is to create a deep-learning CNN model which will be essential to achieve higher recognition. Also, this model is made for effective handwriting styles and it is specially designed for the MNIST handwritten digit dataset.

**1.2 Contribution:**

The focus is to set to make a deep convolutional neural network which is designed for the MNIST dataset. The structure of this part is a multi-layer deep arranged structure that belongs to two fully accurate connected layers for classification after three convolution and activation layers which are designed for the feature extraction. Moreover, they have improved the recognition performance by tuning all the parts of the hyperparameters. With great accuracy on the training dataset and 99.40% on the dataset testing, it becomes error-free.

**1.3 Methodology:**

At the core of it is a designed carefully Convolutional Neural Network which belongs to three layers focused on feature extraction and the other two layers which are fully connected are optimized for the accuracy of classification. The focus is also on the complexities of improving the hyperparameters which also includes batch and kernel sizes, batch normalization, and the activation function tuning for the accuracy in classification. Here also used a technique which is for stability in training. Also, the system was completed with good testing and evaluation for the dropout layers. Also, this model's validation and all the evaluations are being guided by a cross-entropy loss function and a compass steering for accuracy.

#### **1.4 Conclusion:**

With the successful creation of a deep convolutional neural network design for MNIST digit classification by balancing the hyperparameters, the recognition performance improved. Also, the methodology has a high accuracy rate so that the system gains both the training and testing datasets. Also not only are the numbers recognized but also the handwritten digit bar recognition performance increased.

#### **2 Limitations:**

##### **2.1 First Limitation/Critique:**

There are many complexities involved in handwritten which is a close form of communication. Moreover, besides these complexities, some features are here that are specific and unique, rare also. In our goal to accurate digit recognition, they are facing some difficulties regarding capturing this diversity from the perspective of digit recognition. Traditional methods face the difficulties of these individualistic styles.

##### **2.2 Second Limitation/Critique:**

There are some drawbacks of manual feature extraction which is encountered. This is a method that depends on human-defined features. Even with its long history, this manual feature extraction technique also faces challenges in maintaining the exceptional quality of handwriting. The intricate dance of stroke trajectory points is one of them. Moreover, the lack of glyph information for Arabic numerals causes the problems.

#### **3 Synthesis:**

The paper comes up with a deep Convolutional Network which is not just a model but also a progress in MNIST digit recognition. The exploration of this paper's intricate world of hyperparameter optimization, tuning the elements that define the essence of this model along with batch sizes, kernel sizes, batch normalization, activation functions, learning rate, etc. Moreover, on the training dataset, the result was average with a classification accuracy of 99.82%. Though it is not just like a figure but also evidence of the performance of machine learning, more accurately Convolutional Neural Networks overcome the difficulties which are along with handwritten digit recognition. This is not like that the journey ends here. The opportunities are huge by machine learning's creativity to overcome these problems strongly.