Project Report

Author: Zain ul Abdin Ghani
Intern ID: ARCH-2508-0376
Task 2: MNIST Digit Recognition

Introduction

Handwritten digit recognition is one of the classic problems in the field of machine learning and computer vision. The MNIST dataset, which contains thousands of images of digits from 0 to 9, has been widely used by researchers and developers for building and testing recognition models.
The goal of this task was to design and train a machine learning model that can correctly identify digits from handwritten images. This project uses a Convolutional Neural Network (CNN) because CNNs are highly effective for image classification problems.

Objectives

1. To preprocess the MNIST dataset so that it is suitable for training. 2. To design a CNN model for digit classification. 3. To train the model and achieve high accuracy on both training and test data. 4. To evaluate the model’s performance and confirm its reliability. 5. To demonstrate predictions in a simple and user-friendly way.

Dataset

The MNIST dataset consists of:
- Training set: 60,000 grayscale images of handwritten digits. - Test set: 10,000 grayscale images for model evaluation. - Image size: 28 × 28 pixels. - Classes: 10 (digits 0 through 9).
Each image is labeled with the correct digit. The dataset is clean and well structured, making it ideal for machine learning experiments.

Methodology

1. Data Preprocessing - The images were normalized so that pixel values lie between 0 and 1. - Each image was reshaped into 28 × 28 × 1 format for the CNN model. - Labels were converted to categorical form for multi-class classification.
2. Model Architecture The CNN model was designed with the following layers: - Convolutional layers to detect edges, shapes, and patterns. - Max-pooling layers to reduce spatial size and prevent overfitting. - Dropout layers for regularization. - Fully connected dense layers to combine extracted features. - Output layer with softmax activation to classify digits into 10 categories.
3. Training - Optimizer: Adam - Loss function: Categorical cross-entropy - Epochs: 10–15 (depending on hardware) - Batch size: 128

4. Evaluation The model was tested on the MNIST test dataset after training. The results showed very high accuracy, proving that the CNN learned to recognize the digits effectively.

Results

- Training Accuracy: Above 99% - Test Accuracy: Around 98% - Loss: Low loss values indicating strong generalization
Sample predictions confirmed that the model correctly recognized most handwritten digits with high confidence.

Applications

This project demonstrates the core concept of handwritten digit recognition, which can be extended to many real-world applications such as: - Optical character recognition (OCR) systems. - Automated reading of bank checks and forms. - Postal code and address recognition. - Educational tools for practicing handwriting recognition.

Conclusion

In this task, a Convolutional Neural Network was successfully trained on the MNIST dataset to classify handwritten digits. The model achieved high accuracy and demonstrated reliable performance. The project highlights the effectiveness of CNNs for image classification and sets the foundation for more advanced recognition systems.

Author’s Note

This report is submitted as part of the internship program. The task provided an excellent opportunity to apply machine learning concepts, practice model building, and understand how digit recognition systems are developed and deployed.