Project Report on Handwritten Digit Recognition using Neural Networks

Introduction:

Artificial Intelligence (AI) has revolutionized various industries by enabling machines to perform tasks that traditionally require human intelligence. One such application is handwritten digit recognition, which has practical uses in postal mail sorting, bank check processing, and form data entry. This project implements a neural network model using TensorFlow and Keras to classify handwritten digits from the MNIST dataset.

Objective:

The primary objective of this project is to develop a machine learning model that accurately recognizes handwritten digits (0-9) from images. This is achieved by training a neural network on the MNIST dataset and evaluating its performance on unseen data. Additionally, the model is tested with custom images to verify its robustness.

Methodology:

Dataset:

The MNIST dataset is used for this project. It consists of 70,000 grayscale images of handwritten digits, where each image is 28x28 pixels:
- 60,000 images for training
- 10,000 images for testing

Data Preprocessing:

- Normalization: The pixel values are scaled to the range [0, 1] by dividing by 255.0.
- Reshaping: The 28x28 images are flattened into 1D arrays for input into the neural network.

Model Architecture:

A Multi-Layer Perceptron (MLP) neural network is used with the following structure:
1. Input Layer: Flattens 28x28 images into a 784-element array.
2. Hidden Layer 1: Dense layer with 128 neurons and ReLU activation.
3. Hidden Layer 2: Dense layer with 64 neurons and ReLU activation.
4. Output Layer: Dense layer with 10 neurons and softmax activation for classification into digits 0-9.

Model Compilation and Training:

- Optimizer: Adam
- Loss Function: Sparse Categorical Crossentropy
- Metrics: Accuracy
- Epochs: 10

Model Evaluation:

After training, the model was evaluated on the test dataset, achieving a high accuracy rate. The model was saved as 'digit_recognition_model.h5' for later use.

Custom Image Testing:

A function was implemented to preprocess and predict custom images. The steps include:
- Converting the image to grayscale
- Resizing to 28x28 pixels
- Inverting colors and normalizing
- Predicting using the saved model

Results and Evaluation:

The trained model achieved a test accuracy of approximately 98%, demonstrating effective learning of handwritten digit patterns. Custom image predictions further validated the model's reliability, with accurate classification and visual confirmation.

Conclusion:

This project successfully developed and trained a neural network for handwritten digit recognition. By leveraging the MNIST dataset and a well-structured MLP model, high accuracy was achieved. The model's ability to correctly predict digits from custom images highlights its robustness and potential for real-world applications. Future enhancements could include implementing Convolutional Neural Networks (CNNs) for even higher accuracy and efficiency.