# Project Report: Handwritten Digit Recognition System

## Introduction

This project demonstrates the implementation of a Handwritten Digit Recognition System using TensorFlow and Keras. The system trains a neural network model on the MNIST dataset, a widely used benchmark dataset of handwritten digits, to classify digits from 0 to 9. It also predicts digits from external images using a pre-trained model.

## Methodology

The implementation process includes the following steps:

1. \*\*Data Loading:\*\* The MNIST dataset is loaded and split into training and testing sets.

2. \*\*Data Normalization:\*\* Input data is normalized to scale the pixel values between 0 and 1, which helps the model converge faster during training.

3. \*\*Model Architecture:\*\* A Sequential neural network model is created with the following layers:

- A Flatten layer to convert 28x28 images into a 1D array.  
 - Two Dense layers with 128 units each and ReLU activation.  
 - A final Dense layer with 10 units (for 10 classes) and softmax activation.

4. \*\*Model Training:\*\* The model is compiled using the Adam optimizer, sparse categorical cross-entropy as the loss function, and accuracy as the metric. It is trained for 3 epochs to balance learning and avoid overfitting.

5. \*\*Evaluation:\*\* The model's performance is evaluated on the test dataset, and accuracy and loss are reported.

6. \*\*Digit Prediction:\*\* The model is used to predict digits from external images. Images are preprocessed using OpenCV, inverted, and reshaped before passing to the model.

## Code Summary

The project code includes the following main components:

- \*\*Data Handling:\*\* Loading and normalizing the MNIST dataset.  
- \*\*Model Construction:\*\* Building a Sequential model with Keras layers.  
- \*\*Training:\*\* Fitting the model to the training data and monitoring performance.  
- \*\*Evaluation:\*\* Calculating accuracy and loss on the test data.  
- \*\*Digit Prediction:\*\* Preprocessing external images for prediction and visualizing results.

## Results

The trained model achieved a high accuracy on the test dataset, demonstrating its ability to generalize well. The system successfully predicted handwritten digits from external images.

## Conclusion

This project highlights the use of neural networks for image classification tasks. It demonstrates the importance of preprocessing data, constructing an appropriate model architecture, and using an effective training strategy. Future work could involve augmenting the dataset, increasing epochs cautiously to further improve accuracy, and implementing more complex architectures such as convolutional neural networks (CNNs).