🖋️ Handwritten Digit Recognition (MNIST)

This is a **Machine Learning + Deep Learning project** that recognizes handwritten digits (0–9) using a **Convolutional Neural Network (CNN)** trained on the **MNIST dataset**.

The app is built with **Streamlit**, allowing users to:

- ✒️ Draw digits directly in the browser canvas

- 📁 Upload single-digit images

- 🔢 Upload images containing multiple handwritten digits

…and get instant predictions!

📊 Project Overview

🎯 Objective

To identify handwritten digits from user input using a CNN model trained on the MNIST dataset.

⚙️ Technologies Used

- **Python**

- **TensorFlow / Keras**

- **Streamlit**

- **Pillow (PIL)**

- **NumPy & Pandas**

- **streamlit-drawable-canvas**

🧠 How It Works

1. **Model Training**

  - A CNN is trained on MNIST dataset (60,000 training, 10,000 testing samples).

  - Model achieves around **98–99% accuracy**.

  - The trained model is saved as `mnist_cnn.h5`.

2. **Web App**

- Built using Streamlit.
- Loads the trained model.
- Supports three input modes:
  - Draw a digit
  - Upload a single digit image
  - Upload an image with multiple digits
- Automatically preprocesses input to match MNIST format (28×28 grayscale).

3. **Prediction**

- The model outputs probabilities for digits 0–9.
- The highest probability determines the predicted digit.

🧩 Features

Feature	Description
🖌️ Draw Digit	Draw any digit 0–9 directly on screen
📷 Upload Image	Upload a single digit photo for recognition
🔢 Multi-digit Support	Upload an image containing multiple digits (like “2025”)
📊 Probabilities	See confidence scores for each digit
🧮 Real-time Processing	Instant predictions through Streamlit interface

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🚀 How to Run Locally

1 Clone the repository

```bash
git clone https://github.com/koushik21-design/mnist-digit-recognition.git

cd mnist-digit-recognition
```

2 Create a virtual environment

```bash
python-m venv venv
venv\Scripts\activate
```

3 Install dependencies

```bash
pip install-r requirements.txt
```

4 Run the Streamlit app

```bash
streamlit run app.py
```

🧩 Project Structure

```
mnist_digit_recognition/
|
├── app.py              # Streamlit web application
├── mnist_train.py      # CNN training script
├── mnist_cnn.h5        # Trained CNN model file
├── requirements.txt    # Required dependencies
├── README.md           # Project documentation
└── .gitignore          # Ignore unnecessary files
```

📦 Dependencies

```
streamlit
tensorflow
Pillow
numpy
pandas
streamlit-drawable-canvas
```

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