PHASE-2

RECOGNIZING HANDWRITTEN DIGITS]WITH DEEP LEARNING FOR SMARTER AI APPLICATIONS

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o   Github Repository Link:
    [https://github.com/Jothiga1711/Recognizing-handwritten-digits-with-deep-learning-for-smarter-AI-applications.git]

🧩1. PROBLEM STATEMENT:

✔ In many industries including finance, education, and logistics, there is

a growing need to convert handwritten numeric data into machine-readable formats quickly and accurately. Manual transcription is inefficient and error-prone. This project aims to build a deep learning-based system that can automatically recognize handwritten digits (0–9) using Convolutional Neural Networks (CNNs). By training the model on the MNIST dataset, the system demonstrates real-time digit recognition capabilities with high accuracy, suitable for smart OCR applications.

✔ Problem Type: Classification (multi-class)

✔ Why it matters: Enables smarter, automated systems for processing

handwritten forms, checks, exam sheets, and more, reducing errors and increasing efficiency.

🧠 2. PROJECT OBJECTIVES:

- ✔ Develop a CNN model to classify handwritten digits (0–9) from image data.

- ✔ Achieve a classification accuracy of >98% on the MNIST test set.

- ✔ Ensure the model is generalizable and applicable in real-world OCR scenarios.

- ✔ Compare performance with traditional ML models like Logistic Regression and Random Forest.

- ✔ Provide visual explanations (e.g., confusion matrix, activation maps) to interpret model behavior.

📊 3. FLOWCHART OF THE PROJECT WORKFLOW

Start

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Data Collection (MNIST Dataset)

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Data Preprocessing & Normalization

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Exploratory Data Analysis (EDA)

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Feature Engineering (if applicable)

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Model Building:

→ **CNN**

$\rightarrow$ Logistic Regression (for comparison)

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Model Evaluation (Accuracy, Precision, Recall)

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Visualization of Results

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Conclusion & Deployment Ready

🧪4.DATA DESCRIPTION:

Dataset: MNIST Handwritten Digits Dataset

- ✔ Source: Available via Keras Datasets or Kaggle

- ✔ Type: Image (grayscale, 28x28 pixels)

- ✔ Records: 70,000 images (60,000 for training, 10,000 for testing)

- ✔ Features: Pixel intensity values (0–255)

- ✔ Static/Dynamic: Static

- ✔ Target Variable: Digit label (0 to 9)

📈5. DATA PREPROCESSING:

Normalize pixel values to range [0, 1] using x/255.0

- ✔ Reshape images to fit CNN input shape: (28, 28, 1)

- ✔ Convert labels to one-hot encoding using to_categorical()

✔ No missing values or outliers due to clean dataset

✔ Ensure data type consistency (float32 for pixel values)

🚀 6. EXPLORATORY DATA ANALYSIS(EDA):

Univariate: Count plots of digit distribution (balanced dataset)

✔ Image Samples: Visualize sample digits for clarity

✔ Pixel Intensity Histogram: Understand grayscale distribution

✔ Insights:

- Dataset is balanced for all digit classes
- Images are uniform size and quality
- No missing or corrupt entries

🧱 7. FEATURE ENGINEERING:

Not applicable for CNN model (feature learning is automatic)

✔ For traditional models:

- Flatten images to 1D (784 features)
- Apply PCA (optional) for dimensionality reduction

📦 8.MODEL BUILDING:

✔ Models Implemented:

✔ Convolutional Neural Network (CNN):

- Layers: Conv2D → MaxPooling → Dropout → Flatten → Dense

- Activation: ReLU, Softmax

- Optimizer: Adam

- Metrics: Accuracy

✔ Logistic Regression (for baseline comparison):

- Flattened pixel features

- Evaluated with accuracy and confusion matrix

✔ Train-Test Split:

✔ 80:20 on training data (for validation)

✔ Use standard MNIST test set for final evaluation

✔ Metrics Used:

✔ Accuracy, Precision, Recall, F1-Score

📥9. VISUALIZATION OF RESULTS & MODEL INSIGHTS:

✔ Confusion Matrix: Shows classification performance across digits

✔ Accuracy & Loss Curves: Monitors training vs validation

✔ Sample Predictions: Visual comparison of correct and incorrect classifications

✔ Feature Importance (Logistic Model): Visualize pixel influence (optional)

🛠️10.TOOLS AND TECHNOLOGIES USED:

Programming Language: Python

> ✔ **IDE: Jupyter Notebook / Google Colab**

> ✔ **Libraries:**

- **mpy, pandas**
- **matplotlib, seaborn**
- **tensorflow.kerasnu**
- **scikit-learn**

11.TEAM MEMBERS AND CONTRIBUTIONS:

Name	Contribution
S.Sangdeena	Project Lead, Model Architecture Design (CNN), Training & Optimization
P.Vaishnavi	Data Preprocessing, Data Normalization, One-Hot Encoding
S.Jothiga	Exploratory Data Analysis (EDA), Data Visualization, Insight Generation
R.pradhish	Model Evaluation, Metrics Analysis, Confusion Matrix, ROC Curve
T.Aligesh	Documentation, GitHub Repository Management, Report Formatting and Submission