# Digit Recognition Using Deep Learning

## Table of Contents

| Chapter Number | Title | Page Number |  
|---------------|------------------------------|------------|  
| | Abstract | 6 |  
| 1 | Introduction | 7 |  
| | 1.1 Overview of the Project | 7 |  
| | 1.2 Scope and Objective | 7 |  
| 2 | Literature Survey | 8 |  
| | 2.1 Introduction | 8 |  
| | 2.2 Literature Survey | 8 |  
| 3 | System Design | 15 |  
| | 3.1 Image Processing Techniques | 15 |  
| | 3.2 Advantages of Deep Learning in Digit Recognition | 16 |  
| | 3.3 Disadvantages of Deep Learning in Digit Recognition | 16 |  
| | 3.4 Architecture Diagram | 17 |  
| | 3.5 Hardware Requirement | 17 |  
| | 3.6 Software Requirement | 17 |  
| 4 | Implementation and Analysis | 18 |  
| | 4.1 Python Libraries Used | 18 |  
| | 4.2 Dataset Description | 20 |  
| | 4.3 Software Description | 20 |  
| | 4.3.1 Python | 20 |  
| | 4.3.2 Flask | 21 |  
| | 4.3.3 HTML, CSS, JavaScript | 21 |  
| | 4.4 Sample Code | 22 |  
| | 4.5 Sample Output | 25 |  
| 5 | Conclusion | 27 |  
| | References | 28 |

## Abstract

Digit recognition is a fundamental problem in computer vision and pattern recognition. This project aims to develop a digit recognition system using deep learning techniques, specifically a Convolutional Neural Network (CNN) trained on the EMNIST dataset. The model is deployed as a web application using Flask, allowing users to upload handwritten digits for real-time classification. The system preprocesses images by resizing, normalizing, and correcting orientation before feeding them into the trained model for prediction. The project demonstrates the effectiveness of deep learning in recognizing handwritten digits and has applications in digitized document processing, postal automation, and banking systems.

## 1. Introduction

### 1.1 Overview of the Project

Handwritten digit recognition is a crucial task in machine learning and computer vision. It involves classifying handwritten digits from images and is widely used in applications such as automatic number plate recognition, bank check processing, and postal address recognition. This project employs deep learning techniques to build a robust digit recognition system. We trained a CNN model using the EMNIST dataset, which consists of handwritten digits. The trained model is integrated into a web-based application using Flask, allowing users to upload digit images and obtain predictions.

### 1.2 Scope and Objective

The main objectives of this project are:  
- To develop a machine learning model capable of accurately classifying handwritten digits.  
- To preprocess input images to match the EMNIST dataset format.  
- To deploy the trained model as a user-friendly web application using Flask.  
- To provide a practical demonstration of deep learning’s application in real-world scenarios.

## 5. Conclusion

This project successfully demonstrates the application of deep learning in handwritten digit recognition. By utilizing a Convolutional Neural Network (CNN) trained on the EMNIST dataset, we achieved accurate classification of handwritten digits. The integration of Flask enabled seamless deployment as a web application, making it accessible to users for real-time predictions. Despite minor challenges such as image preprocessing and model optimization, the project highlights the power of deep learning in pattern recognition tasks. Future improvements may include optimizing the model for better accuracy and expanding it to recognize alphanumeric characters or multiple handwriting styles. The project showcases the potential of AI-driven solutions in document digitization, banking automation, and postal services.