American Sign Language (ASL) Detection Using Deep Learning

1. Introduction

American Sign Language (ASL) is a visual language used by the deaf and hard-of-hearing community. Translating ASL gestures into readable text using artificial intelligence can significantly improve accessibility and human–computer interaction.

This project focuses on building a deep learning–based image classification system that recognizes ASL hand signs from images and predicts the corresponding alphabet or symbol.

2. Objective

The main objectives of this project are:

- To build a CNN-based image classification model
- To classify ASL hand sign images into their corresponding labels
- To support multiple ASL classes dynamically
- To design a scalable and reusable pipeline
- To enable future extension to real-time gesture recognition

3. Dataset Description

Source: Kaggle – ASL Alphabet Dataset

Dataset Structure (Actual Used)

ASL_Dataset/

└── asl_alphabet_train/

  └── asl_alphabet_train/

    ├── A/

    ├── B/

    ├── C/

    ├── ...

Key Points:

- Images are organized into folders by class name
- Each folder represents one ASL sign
- Current dataset subset contains 14 classes
- The system automatically adapts to any number of classes

4. Technology Stack

Category	Tools
Programming Language	Python
Deep Learning	TensorFlow, Keras
Image Processing	OpenCV
Data Handling	NumPy
Visualization	Matplotlib
Environment	Anaconda

5. Methodology

5.1 Data Preprocessing

- Image resizing to 64×64
- Pixel normalization (0–1)
- Batch loading using ImageDataGenerator
- Automatic label encoding from folder names

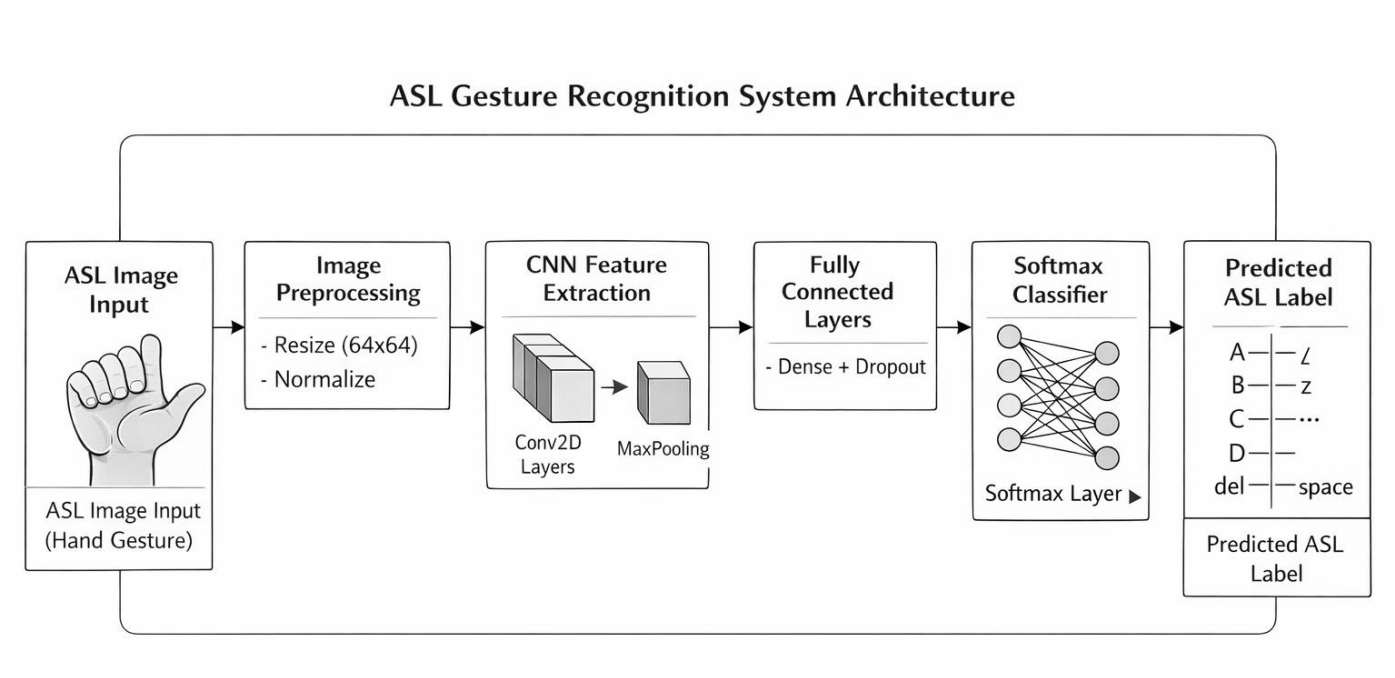
5.2 Model Architecture

A Convolutional Neural Network (CNN) is used to learn spatial features of hand gestures.

5.3 Training

- Optimizer: Adam
- Loss function: Categorical Crossentropy
- Epochs: 15
- Batch size: 32

6. System Architecture



7. Results

- Model successfully trained for 15 epochs
- Correctly classifies ASL signs from test images
- Produces high confidence predictions for known classes
- Model saved as reusable artifact: asl_model.h5

8. Advantages of the System

- Dynamic class detection (no hardcoding)
- Robust to partial or full datasets
- Easy to retrain with new gestures
- Can be deployed as:
    - Desktop app
    - Web application
    - Real-time webcam system

9. Limitations

- Works on static images only (current version)
- Accuracy depends on lighting and hand position
- Requires further optimization for real-time use

10. Conclusion

This project demonstrates the effective use of Convolutional Neural Networks for visual gesture recognition. It provides a strong foundation for accessibility-focused AI systems and showcases real-world application of deep learning in computer vision.