# Summary of Existing Work in American Sign Language Detection Systems

## 1. Introduction to ASL Detection Systems

American Sign Language (ASL) detection systems play a crucial role in bridging communication gaps between Deaf and hearing individuals. These systems are used in various applications, such as digital accessibility and education. ASL detection is complex, involving not only hand gestures but sometimes facial expressions and body movements.

## 2. Existing Work and Key Approaches

### Hand Gesture Recognition

Early research in ASL detection focused on recognizing individual hand gestures using computer vision techniques, such as contour detection and hand segmentation. These methods allowed for the recognition of static ASL signs, laying foundational work for future developments.

### Machine Learning and Deep Learning Advances

#### CNN-based Approaches

Convolutional Neural Networks (CNNs) have become popular in ASL recognition, particularly for recognizing static hand gestures. Pre-trained models like VGG and ResNet have been applied to ASL alphabet datasets to improve recognition accuracy.

#### RNN and LSTM for Sequential Data

Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks have been employed to detect dynamic ASL signs that require sequential hand movements. These approaches are particularly effective for temporal data, allowing the recognition of dynamic, continuous sign language.

#### Transformer and Attention Mechanisms

Recent research has explored Transformer architectures and attention mechanisms to improve ASL detection, especially for complex sequences. These methods enhance the ability to focus on relevant parts of the sequence, aiding in continuous sign language recognition.

## 3. [Dataset Link](https://www.kaggle.com/datasets/kapillondhe/american-sign-language)

## 4. Challenges and Limitations in ASL Detection

Despite advances, ASL detection faces several challenges:  
• Distinguishing between similar gestures.  
• Variations due to lighting, background, and occlusion.  
• Handling continuous detection versus isolated signs.  
• Limited datasets, as some do not cover the full ASL vocabulary.

## 5. Recent Developments and Trends

Recent developments include multi-modal learning, which combines vision and audio cues for contexts that involve spoken language. Additionally, advancements in 3D pose estimation are helping to improve gesture recognition accuracy.

## 6. Model Used in Our ASL Detection System

For this project, we implemented two Convolutional Neural Network (CNN) models: a simple CNN and an improved CNN with added layers and batch normalization. Both models are designed to recognize American Sign Language gestures from images by categorizing them into 28 classes.

### Simple CNN Model

The simple CNN model is structured with the following layers:  
- An input layer accepting images of shape (64, 64, 1), representing grayscale images.  
- Two convolutional layers with 32 and 64 filters respectively, each followed by a max-pooling layer.  
- A flattening layer to convert the 2D matrix data into a 1D vector.  
- A dense layer with 128 neurons, followed by a dropout layer for regularization.  
- An output layer with softmax activation, producing a probability distribution over the 28 classes.  
This model is compiled with categorical cross-entropy loss and the Adam optimizer.

### Improved CNN Model

The improved CNN model incorporates additional layers and techniques to enhance performance:  
- An input layer with the same (64, 64, 1) image shape.  
- Four convolutional layers, with filters of increasing size (32, 64, 128, 256), each with batch normalization to stabilize learning.  
- Max-pooling layers after each convolutional layer, and global average pooling to reduce the spatial dimensions.  
- A dense layer with 128 neurons and a dropout layer to reduce overfitting.  
- The output layer uses softmax activation for classification across the 28 classes.  
This model is also compiled with categorical cross-entropy loss and the Adam optimizer.