



Maharshi Karve Stree Shikshan Samstha's
Cummins College of Engineering For Women, Pune
(An autonomous Institute affiliated to Savitribai Phule Pune University)
Department of Computer Engineering



SIGN LANGUAGE ALPHABETS RECOGNIZER

Submitted By

1. UCE2023531 : Aditi Joshi
2. UCE2023537 : Mitva Gami
3. UCE2023569 : Vibhuti Ugale

Course Instructor: Dr. Mahendra Deore
Course: Artificial Intelligence and Machine Learning Laboratory
23PCCE501L



INTRODUCTION

American Sign Language (ASL) is the primary mode of communication for the deaf and hard-of-hearing community, with over 500,000 users. However, **there exists a significant communication barrier between ASL users and non-signers**, limiting accessibility in education, healthcare, and daily interactions.

This project presents **ASL Connect**, a **real-time sign language interpreter that uses deep learning and computer vision to recognize ASL hand gestures and translate them into text**. The system enables seamless communication by detecting static hand signs for letters (A-Z), and essential words like "space" and "nothing" through a webcam interface, making ASL more accessible to the general population.



OBJECTIVES



Primary Objectives:

- Develop a real-time ASL alphabet recognition system with high accuracy
- Create an intuitive web-based interface for continuous sign language interpretation
- Implement a deep learning model capable of classifying 28 ASL classes (A-Z , "space" and "nothing")

Secondary Objectives:

- Achieve minimum 89% validation accuracy on the test dataset
- Ensure response time of 1-2 seconds per prediction for real-time usability
- Build a scalable system architecture that can be extended to full ASL vocabulary
- Implement confidence thresholding to handle uncertain predictions gracefully



DATASET DESCRIPTION

- **Dataset Source:** GitHub - Sign Language Alphabet Recognizer Dataset

- **URL:** [Link](#)

- **Dataset Characteristics:**

Total Classes - 28 (26 letters A-Z + "space" + "nothing")

Images per Class - 3,000 high-quality images

Total Images - ~82,924 images

Image Format - JPG/PNG color images

Image Resolution - Variable (standardized to 224×224 during preprocessing)

- **Background** - Diverse backgrounds to improve model generalization

- **Data Distribution:**

Training Set: 80% (~66,340 images)

Validation Set: 20% (~16,584 images)



METHODOLOGY

Phase 1: Data Preparation

- Organized dataset into 28 classes (A-Z, space, nothing)
- Image preprocessing + resizing to 224×224
- Data augmentation for generalization
- 80-20 stratified train-validation split

Phase 2: Model Architecture

- **Base model:** MobileNetV2 (ImageNet pretrained)
- **Transfer Learning:**
 - Frozen initial layers
 - Added custom head: GAP → Dropout(0.3) → Dense(256, ReLU) → Dropout → Dense(28, Softmax)
- **Total params:** 2.59M (Trainable: 0.33M)

Phase 3: Model Training

- **Initial training:** 8 epochs, Adam LR=0.001, Early Stopping
- **Fine-tuning:** Unfroze last 30 layers, LR=0.0001
- **Final Accuracies:**
 - Train: 99.35%
 - Validation: ~90%

Phase 4: Backend

- Flask REST API (/predict)
- Base64 image handling
- Real-time preprocessing & inference
- CORS enabled

Phase 5: Frontend

- Webcam integration
- Real-time predictions + confidence scores
- 60% threshold filtering
- Session mode for sentence building

Phase 6: Integration & Testing

- End-to-end integration
- Latency optimization (~1.5s/prediction)
- Cross-browser testing
- Stable error handling

RESULT

Model Performance

- Train Accuracy: 99.35%
- Validation Accuracy: 89.69%
- Validation Loss: 0.4152
- Model Size: 9.89 MB
- Inference Time: ~1.5 seconds

System Performance

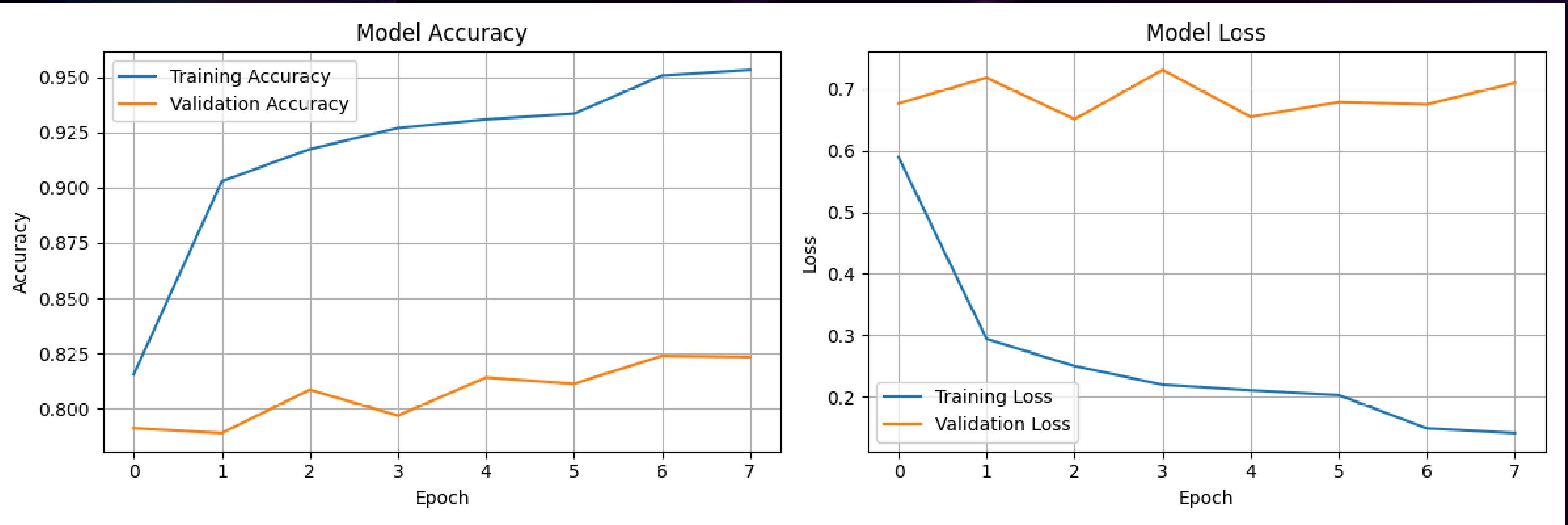
- Real-time detection: 1–2 predictions/sec
- Strong robustness: lighting, angle, skin tone variations
- “Nothing” class reduces false positives
- Sentence & word formation achieved

Key Achievements

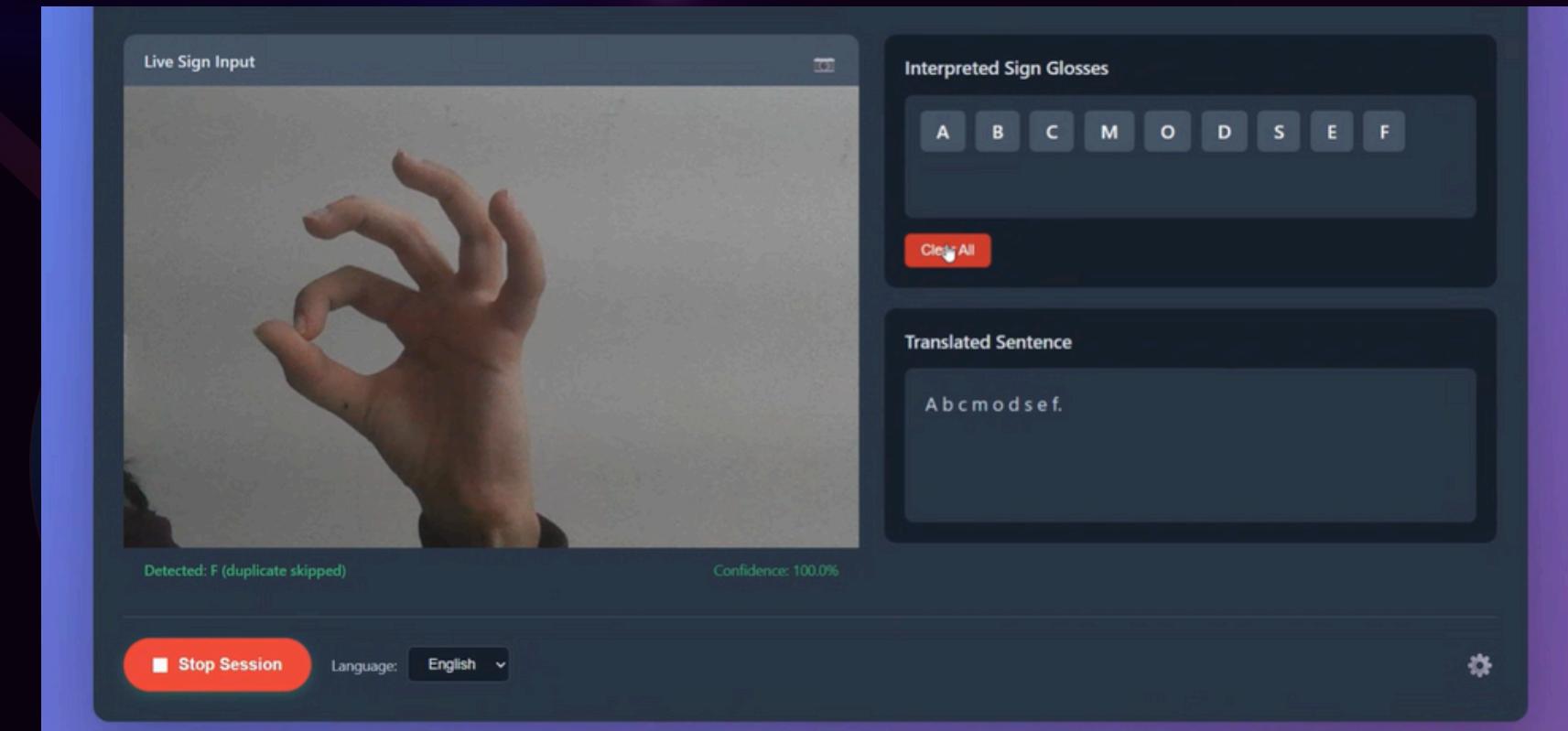
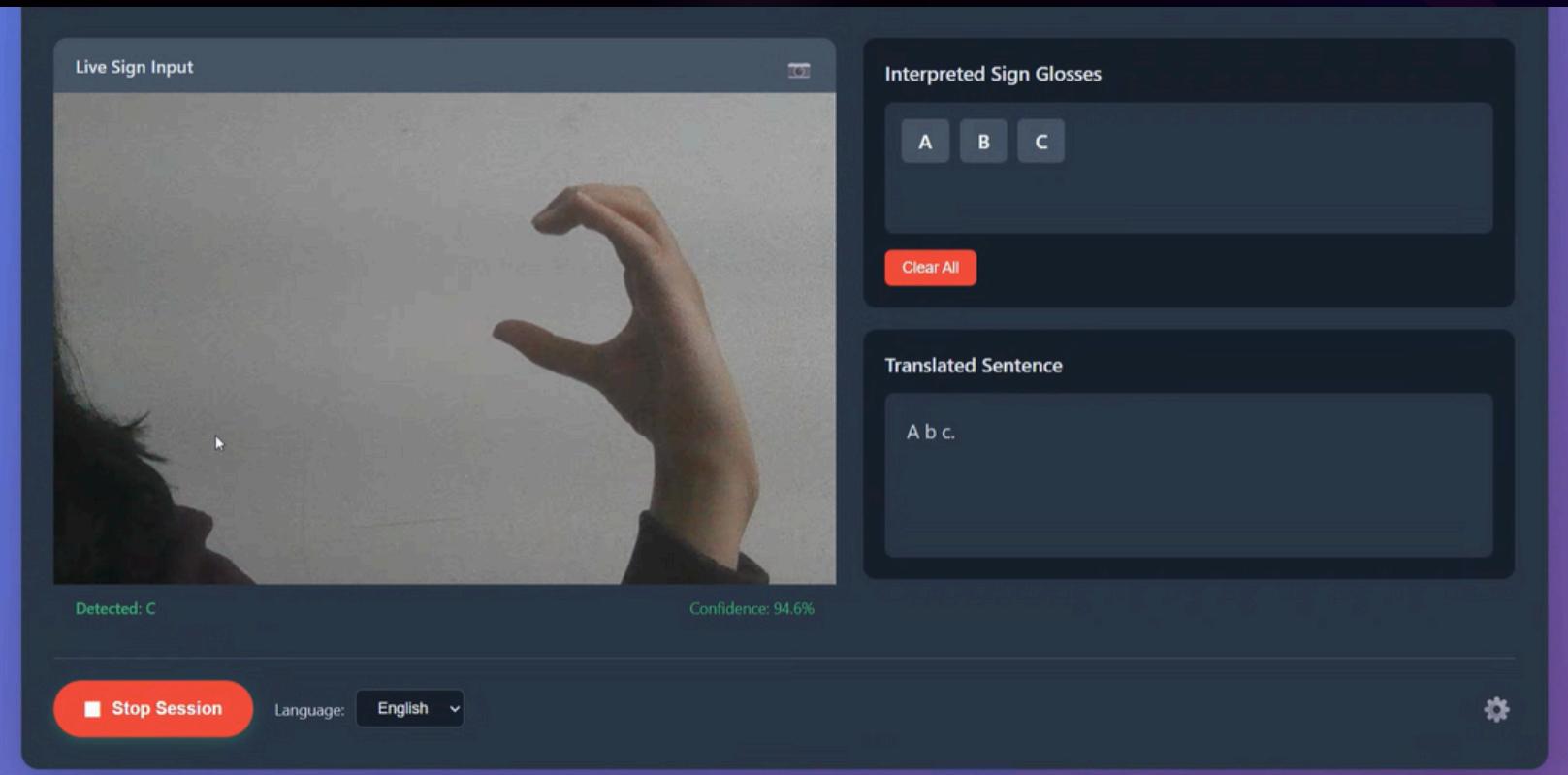
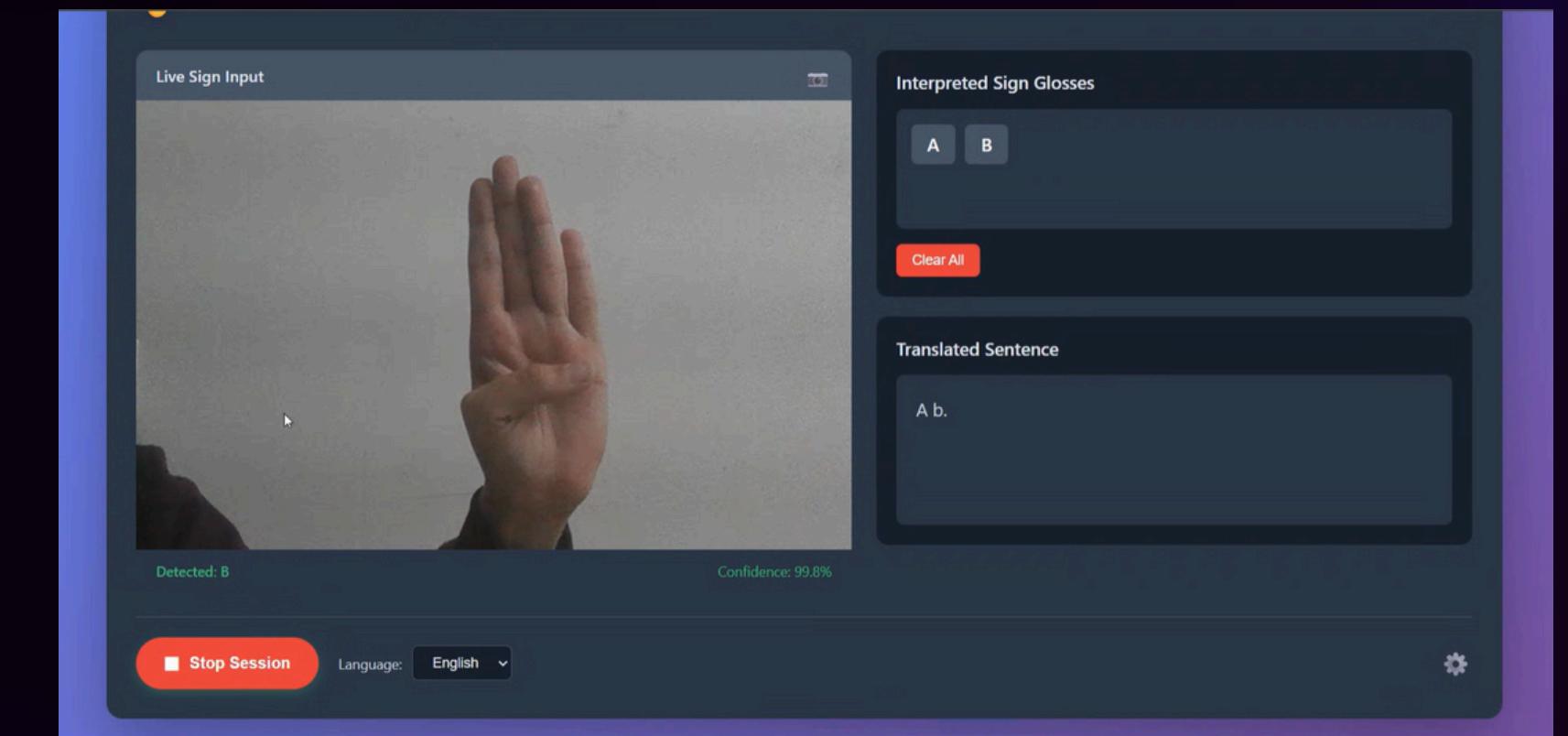
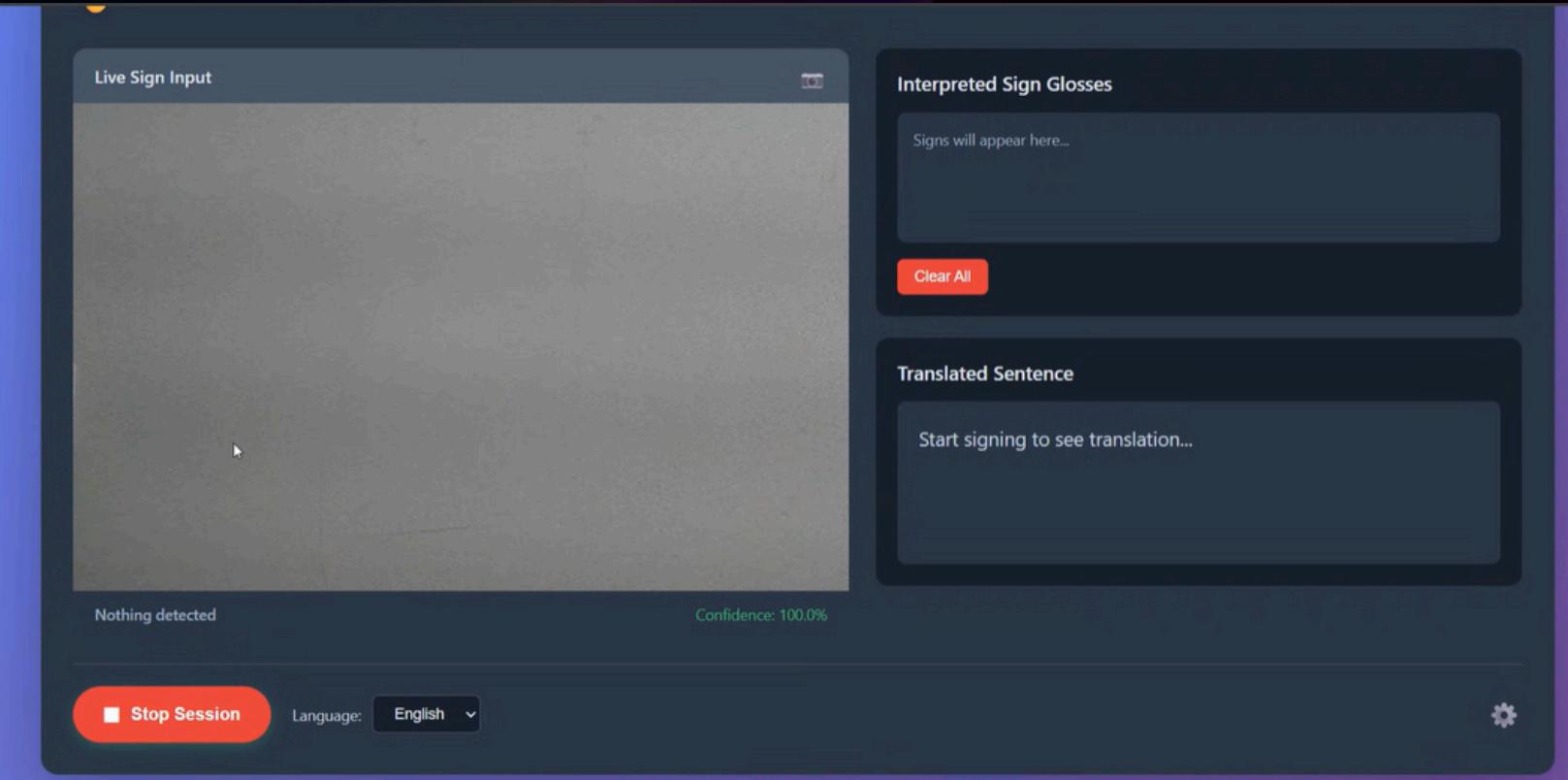
- Accurate recognition across 28 classes
- Real-time hands-free predictions
- High-confidence filtering
- Works smoothly in browser (Chrome/Edge/Firefox)



TRAINING HISTORY GRAPHS



SYSTEM DEMO



FINGERSPELLING

Live Sign Input



Detected: B (duplicate skipped)

Confidence: 99.8%

Stop Session

Language: English

Interpreted Sign Glosses

B O B

Clear All

Translated Sentence

B o b.

FUTURE ENHANCEMENT

Short-term

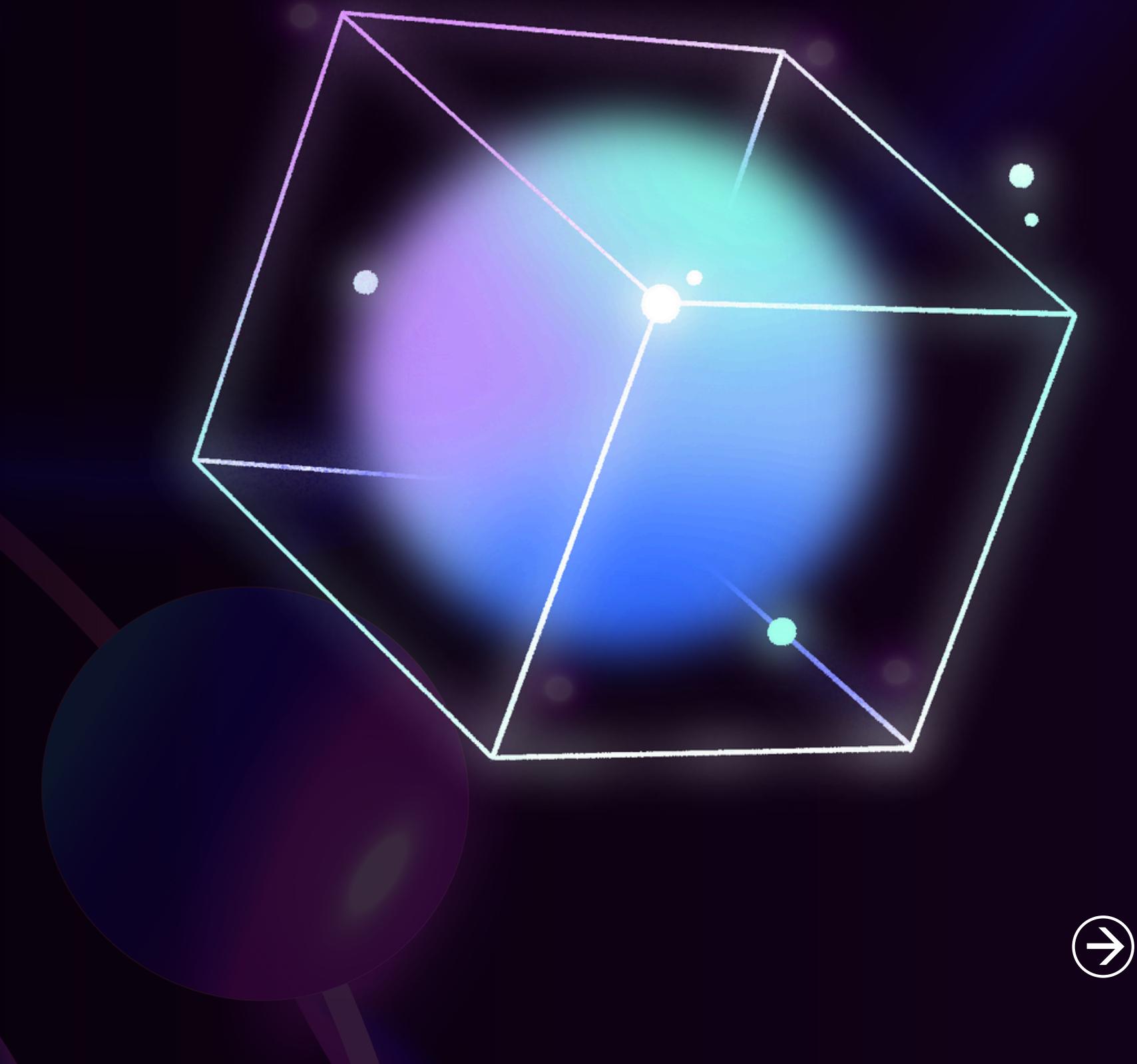
- Add more ASL words & dynamic gestures
- Mobile app development
- Two-hand gesture support
- Voice output integration

Medium-term

- NLP-based sentence correction
- User profiles & offline mode
- Better low-light performance
- Background removal (MediaPipe)

Long-term

- Full ASL video-to-text translation
- 3D avatar-based reverse translation
- Multi-user support
- Educational interactive platform
- Faster prediction (<0.5s)



CONCLUSION

- ASL Connect proves deep learning can enable accessible, real-time sign language interpretation.
- Achieved **~90% validation accuracy** with efficient **MobileNetV2**.
- Web-based interface allows smooth, hardware-free usage.
- Sentence creation possible through “**space**” gestures.
- With further improvements, the system can evolve into a full ASL communication and learning tool.



REFERENCES

- [1] C. Szegedy et al., "Rethinking the Inception Architecture for Computer Vision," in Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR), 2016, pp. 2818-2826.
- [2] M. Sandler, A. Howard, M. Zhu, A. Zhmoginov, and L. Chen, "MobileNetV2: Inverted Residuals and Linear Bottlenecks," in Proc. IEEE/CVF Conf. Computer Vision and Pattern Recognition, 2018, pp. 4510-4520.
- [3] K. He, X. Zhang, S. Ren, and J. Sun, "Deep Residual Learning for Image Recognition," in Proc. IEEE Conf. Computer Vision and Pattern Recognition (CVPR), 2016, pp. 770-778.
- [4] J. Deng, W. Dong, R. Socher, L. Li, K. Li, and L. Fei-Fei, "ImageNet: A large-scale hierarchical image database," in Proc. IEEE Conf. Computer Vision and Pattern Recognition, 2009, pp. 248-255.
- [5] L. Marie, "Sign Language Alphabet Recognizer Dataset," GitHub repository, 2023. [Online]. Available: <https://github.com/loicmarie/sign-language-alphabet-recognizer>



THANK YOU!



