



Design of a Real-Time Sign Language Recognition System Using Artificial Intelligence

A two-stage AI pipeline performing real-time ASL fingerspelling recognition at 34.6 FPS on Android devices with secure LLM-based text correction.

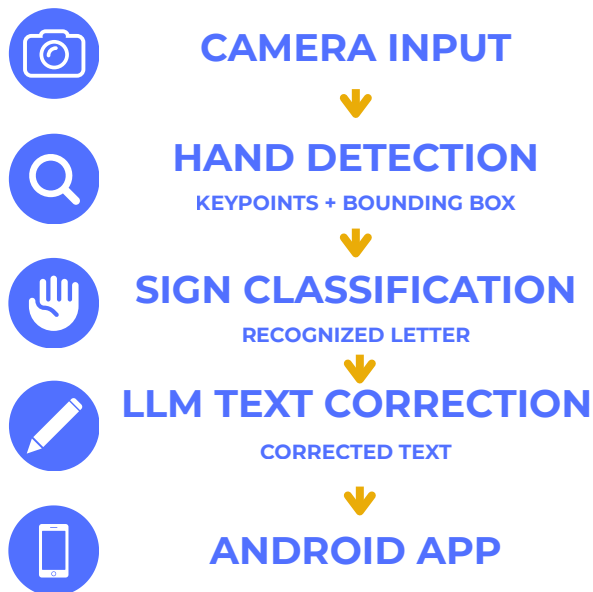
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MOTIVATION

- **1.56B people** have hearing loss worldwide - reaching 2.45B by 2050 [1]
- Most hearing people **do not know sign language**
- Existing ASL systems are either **slow or inaccurate**
- We built a **real-time mobile solution**

SYSTEM ARCHITECTURE



METHODOLOGY

- HAND DETECTION - YOLO11n-pose**
 - >**750,000 samples** — 8 public datasets + custom data (6 environments)
 - Augmentation: flip, Gaussian blur, brightness
 - TFLite Int8 quantization
- SIGN CLASSIFICATION - MobileNetV2**
 - Bounding box only vs. **keypoint overlay**
 - ASL dataset: ~750 samples/class · 28 classes + ~16,800 custom samples · test set from 3 users (840 samples)
 - TFLite Int8 quantization
- TEXT CORRECTION - Gemini 2.5 Flash**
 - Gemini 2.5 Flash via **Firestore AI Logic**
 - Secure two-part prompt against **prompt injection attacks**
 - RAGAS evaluation: 20 correction + 10 malicious inputs
- MOBILE APPLICATION**
 - Developed in **Flutter** framework
 - 4 screens: welcome, model loading, camera translation, text→ASL display
- USABILITY EVALUATION**
 - **SUS** methodology · 10 participants · aged 23–35 · no prior sign language experience

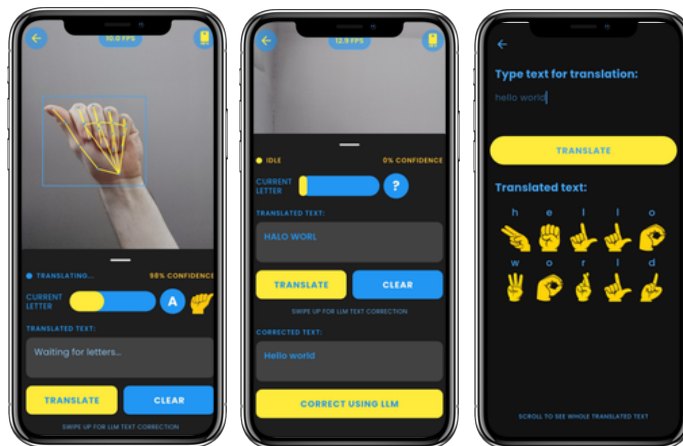
REFERENCES

[1] Zhang et al., "Worldwide burden of hearing loss across childhood and adolescence, 1990–2021," World J. Otorhinolaryngol., 2024.

RESULTS

HAND DETECTION · YOLO11n-pose		
0.9790	0.9487	34.6
Box mAP 50-95	Pose mAP 50-95	FPS
TFLite Int8 · Samsung Galaxy A71 · Snapdragon 730		

TEXT CORRECTION · Gemini 2.5 Flash		
	Exact Match	Sem. Similarity
Correction	0.900	0.981
Injection	0.833	0.852



SIGN CLASSIFICATION · MOBILENETV2		
0.9850	0.9371	69.3
AUC SCORE	G-MEAN	FPS
TFLite Int8 · Samsung Galaxy A71 · Snapdragon 730		

USABILITY · SUS SCORE	
88.75	

KEY TAKEAWAYS

- 📱 Runs entirely on Android
- ⚡ 34.6 FPS on Snapdragon 730
- 🎯 98.5 % AUC Score with keypoints overlay
- 🛡️ Secure LLM correction
- ✅ Exceeds good usability by +20.75