INTERNATIONAL MULTI DISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
eISSN 2394-6334 Impact factor: 8.854 Volume 13, issue 04 (2026)

REAL-TIME SIGN LANGUAGE TRANSLATION AND SENTENCE CONSTRUCTION USING AI: THE "INCLUSION-BOT" FRAMEWORK

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Annotation.

This article presents the development and practical impact of Inclusion-Bot, a new AI-based system that translates sign language into spoken language in real time. Rather than recognizing signs letter by letter like most traditional systems, Inclusion-Bot uses a semantic approach that identifies complete words and automatically builds meaningful sentences. Developed with Next.js, MediaPipe, and TensorFlow.js, the platform offers a fast, low-latency solution that runs directly in any web browser, removing the need for costly hardware. The study highlights how this technology improves accessibility for people with hearing impairments, explains the gesture-to-sentence logic, and explores the future of inclusive digital communication in Uzbekistan.

Keywords: Artificial Intelligence, Sign Language Translation, Inclusion-Bot, Accessibility, Next.js, Computer Vision, Semantic Recognition.

Introduction

In today's fast-changing digital world, creating truly inclusive communication remains one of the biggest challenges. People with hearing and speech impairments often face serious difficulties when dealing with government services, education, healthcare, and everyday interactions. Traditional methods are usually not enough, and professional interpreters are not always available when needed.

The Inclusion-Bot project was created as a technological solution that uses Computer Vision and Machine Learning to convert sign language gestures into clear speech and text. Focused on the Uzbek context while using widely recognized international gestures, the system aims to make communication easier and more equal for everyone.

Beyond Fingerspelling: A Semantic Approach. Most existing sign language recognition systems utilize "fingerspelling," where each letter is represented by a specific hand shape. While accurate, this method is slow and does not reflect how sign language is used in daily life.

Inclusion-Bot introduces a Word-Based Recognition model. By recognizing entire concepts—such as *"Hello" (Assalomu alaykum)*, *"Help" (Yordam)*, and *"Thank you" (Rahmat)*—the system allows for a more natural and fluid communication flow. This approach reduces the cognitive load on the user and significantly speeds up the translation process.

Technical Architecture and Implementation. The system is built on a modern web-based stack to ensure maximum accessibility:

- Hand Tracking: Utilizing MediaPipe Hands, the system tracks 21 distinct 3D landmarks on the human hand with high precision.

```
const hands = new Hands({
  locateFile: (file) => `https://cdn.jsdelivr.net/npm/@mediapipe/hands/${file}`,
});
hands.setOptions({
  maxNumHands: 1,
  modelComplexity: 1,
  minDetectionConfidence: 0.5,
  minTrackingConfidence: 0.5
});
```

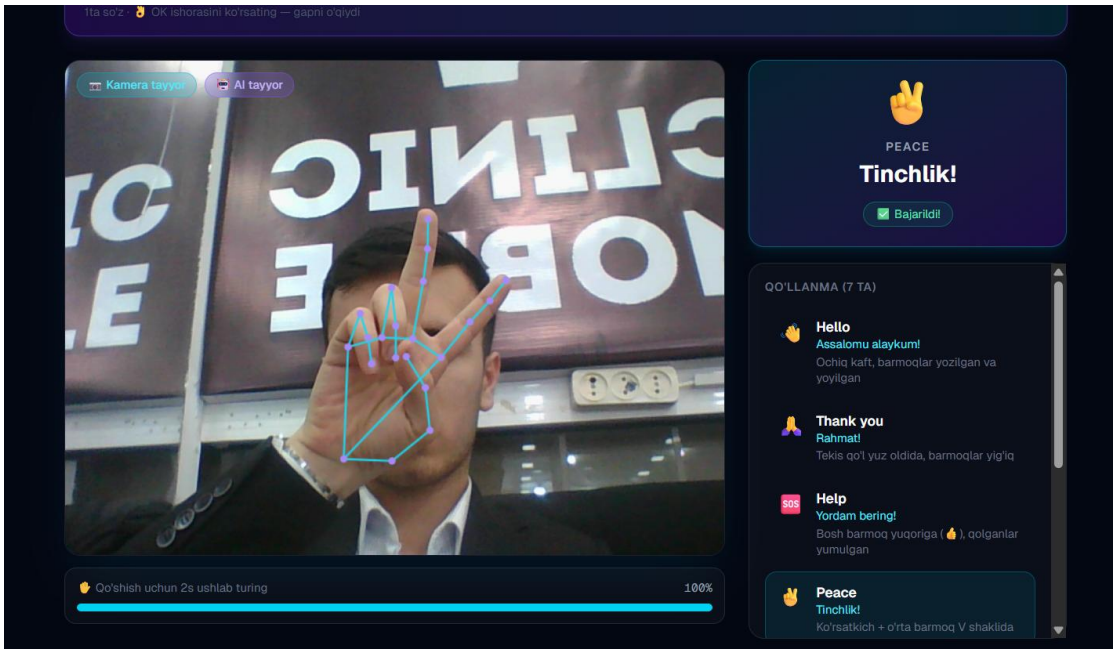
- Heuristic Logic: To ensure real-time performance on low-end devices, we implemented geometric algorithms that calculate distances between finger landmarks to classify gestures.
- Sentence Builder: A unique feature of this project is the Contextual Buffer. Recognized gestures are stored in a temporary array. When a "Confirmation" gesture (e.g., the "OK" sign) is detected, the system compiles these words into a grammatically coherent sentence and triggers the Web Speech API for vocalization.

Developing a sign language translator for Uzbekistan involves several difficulties, especially the shortage of large Uzbek Sign Language datasets. Inclusion-Bot solves this issue by:

1. Using American Sign Language (ASL) as a base for common gestures.
2. Adapting and mapping these gestures to their Uzbek language equivalents.
3. Offering a simple web-based solution that works on any device (computers, Android, and iOS) through a regular browser link, avoiding the need to install separate applications.

The Future of Inclusive AI In the coming stages, Inclusion-Bot will move from rule-based heuristic logic to advanced Deep Learning models, particularly LSTM networks, which will better handle complex and dynamic gestures. Future development will focus on:

Integration: Connecting the system to government platforms (such as DXM) and banking applications. **Crowdsourced Data:** Enabling users to contribute their own signs to help create the first large-scale digital dataset for Uzbek Sign Language.



Conclusion

Inclusion-Bot represents a transformative step in making digital spaces accessible to everyone. By combining real-time gesture tracking with an intelligent sentence construction engine, we have moved beyond simple detection toward true communication. As AI continues to evolve, tools like Inclusion-Bot will ensure that no one is left behind in our increasingly vocal digital world.

Resources

1. MUNIROV, J. (2025). TRANSFORMING SOFTWARE DEVELOPMENT WITH AI-POWERED CODE GENERATION TOOLS. *ИКРО журнал*, *15*(01), 230-232.

2. MUNIROV, J. (2025). ORGANIZING PRACTICAL LEARNING PROCESSES USING VIRTUAL REALITY TECHNOLOGIES. *PEDAGOGIK TADQIQOTLAR JURNALI*, *3*(2), 74-77.

3. Munirov, J. J. (2025). CREATING TELEGRAM BOTS WITH JAVASCRIPT. Recent scientific discoveries and methodological research, 2(6), 8-13.

4. Munirov, J. J. (2025). THE ROLE OF VERSION CONTROL SYSTEMS IN MODERN SOFTWARE DEVELOPMENT: TOOLS, PRACTICES, AND FUTURE DIRECTIONS. Recent scientific discoveries and methodological research, 2(6), 25-32.

5. Munirov, J. J. (2025). GIT VA GITHUB: ZAMONAVIY DASTURLASHNING ASOSI. Science, education, innovation: modern tasks and prospects, 2(6), 19-25.

6. Munirov, J. J. (2025). NESTJS VS EXPRESS. JS: A COMPREHENSIVE COMPARISON. Modern World Education: New Age Problems–New solutions, 2(6), 33-39.

7. Munirov, J. J. (2025). JAVASCRIPT LIBRARIES FOR WORKING WITH ARTIFICIAL INTELLIGENCE. Modern World Education: New Age Problems–New solutions, 2(6), 10-16.

8. MUNIROV, J. (2025). VIRTUAL TEXNOLOGIYALARNING TIBBIYOTDAGI O ‘RNI: INNOVATSIYALAR, IMKONIYATLAR VA KELAJAKNING YO ‘NALISHLARI. ИКРО журнал, 15(02), 812-815.