

# SIGNLENT User Manual

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## I. Introduction

SIGNLENT is an IoT-based smart glove designed to enable deaf individuals to communicate more effectively. The system translates sign language gestures into text and speech in real time using flex sensors and a gyroscope (MPU6050) mounted on an ESP32 microcontroller. The glove captures finger and hand movements, processes them using Machine Learning, and outputs both readable text and audible communication through a connected web app.

Intended Users:

- Individuals who are deaf or hard of hearing
- Sign language interpreters
- Healthcare professionals
- Educational institutions
- Family members and caregivers

## II. System Overview

### II.I. System Architecture

SIGNLENT is a comprehensive communication system consisting of three integrated components:

#### 1. Hardware Component (Smart Glove)

- Wearable glove equipped with five flex sensors for finger bend detection
- MPU6050 inertial measurement unit (IMU) for hand orientation and motion tracking
- ESP32 microcontroller for data processing and wireless communication
- Rechargeable battery power system
- LED status indicators and haptic feedback motor

#### 2. Software Component (Web Application)

- Cross-platform web interface accessible via smartphone or computer
- Real-time gesture recognition display
- Text-to-Speech (TTS) output engine
- Gesture history logging and analytics

### 3. AI/Machine Learning Component

- LSTM (Long Short-Term Memory) neural network for gesture recognition
- Edge AI inference capability on ESP32 for reduced latency
- Adaptive calibration algorithms
- Continuous learning from user-specific gesture patterns

## II.II. System Workflow

The SIGNLENT system operates through the following sequence:

```
User Makes Gesture
↓
Sensors Detect Movement (Flex Sensors + MPU6050)
↓
ESP32 Processes Raw Sensor Data
↓
Data Transmitted via Bluetooth Low Energy (BLE)
↓
Web App Receives Data
↓
AI Model Recognizes Gesture
↓
Output Generated (Text Display + Speech Synthesis)
```

## II.III. Technical Specifications

### Data Transmission Protocol:

- Protocol: Bluetooth Low Energy (BLE)
- GATT Characteristic UUID: 7094fd70-4532-4d73-a118-473a0a63701a
- Packet Size: 50 bytes per transmission
- Data Format (Big-Endian):
  - 5 × 16-bit integers (flex sensor values: little finger → thumb)
  - 4 × 32-bit floats (quaternion rotation: x, y, z, w)
  - 3 × 32-bit floats (acceleration in g-forces: x, y, z)
  - 3 × 32-bit floats (gyroscope angular velocity in deg/s: x, y, z)

### Performance Metrics:

- Gesture Recognition Latency: < 200ms
- Recognition Accuracy: Up to 95% (after calibration)
- Battery Life: 4-6 hours continuous use
- Wireless Range: Up to 10 meters
- Supported Gestures: Extensible vocabulary (base model: 100+ common signs)

## III. Installation / Setup

### III.I. Hardware Requirements

#### Glove Device:

- ESP32 microcontroller (pre-installed)
- 5 × flex sensors
- 1 × MPU6050 gyroscope/accelerometer

#### User Device (for Web App):

- Smartphone or tablet with:
  - Operating System: iOS 12.0+ or Android 8.0+

- Bluetooth 4.0 or higher (BLE compatible)
- Modern web browser (Chrome, Safari, Firefox, Edge)
- Internet connection (for initial setup and updates)
- **OR** Computer with:
  - Operating System: Windows 10+, macOS 10.14+, or Linux
  - Bluetooth 4.0 adapter
  - Modern web browser with BLE support
  - Internet connection

### **III.II. Software Requirements**

- Web browser with JavaScript enabled
- Bluetooth permissions enabled
- Microphone/speaker access (for TTS features)

## **IV. Getting Started**

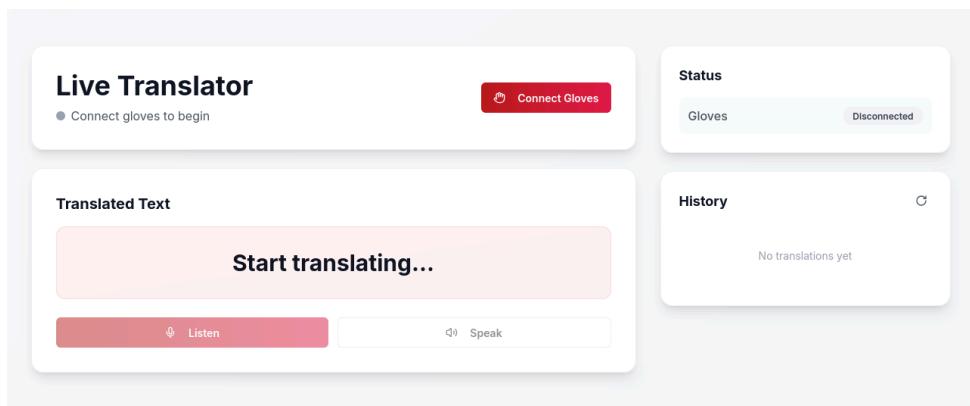


Figure 1: The SIGNLENT Web UI.

### **IV.I. Step 1: Web Application Access**

#### **Method A: Smartphone Access**

1. Open your device's web browser (Chrome recommended)
2. Navigate to the Web UI
3. Grant necessary permissions when prompted

#### **Method B: Desktop/Laptop Access**

1. Launch a Bluetooth-compatible browser:
  - Google Chrome (version 90+)
  - Microsoft Edge (version 90+)
  - Opera (version 76+)
2. Navigate to the Web UI
3. Grant necessary permissions when prompted

**Note:** Safari and Firefox have limited Bluetooth Web API support. Chrome is strongly recommended for optimal compatibility.

### **IV.II. Step 2: Device Pairing Configuration**

#### **1. Prepare the glove:**

- Plug in your gloves
- Relax your hand and allow it to fall towards gravity, in its natural position flush with your torso.

- Allow up to 15 seconds for the glove to calibrate.
- 2. Initiate pairing from web app:**
    - Click “**Connect Gloves**”
    - The app will scan for available BLE devices
  - 3. Select your device:**
    - Identify your glove in the list: “**SignGoGlove**”
    - Click on your device name
  - 4. Complete pairing:**
    - Browser will request permission to connect, click “**Pair**”
    - Wait for connection confirmation (typically 5-10 seconds)
    - Web app will display: “**Device Connected Successfully**”

## V. Features and Functions

### Real-Time Gesture Recognition

- Continuous translation of sign language gestures into text and speech
- LSTM-based machine learning for accurate pattern recognition
- Recognition latency: <200ms
- Accuracy: 85-95% (up to 98% with adaptive learning)

### Gesture History & Logging

- Chronological record of all recognized gestures

### Confidence Meter

- Real-time accuracy indication (0-100%)
- Color-coded feedback (green/yellow/orange/red)
- Configurable minimum threshold

### Bluetooth Connectivity

- BLE (Bluetooth Low Energy) wireless connection
- Range: Up to 10 meters
- Auto-reconnect capability
- Single-connection pairing for security

### Sensors

- 5 flex sensors (one per finger)
- MPU6050 gyroscope + accelerometer (IMU)
- Real-time hand position and orientation tracking

### Power

- 4-6 hours continuous use (standard mode)
- USB rechargeable battery
- 2-3 hour full charge time
- 48-hour standby time

### Design

- Comfortable wearable glove
- Lightweight and ergonomic

## VI. Troubleshooting & FAQ

Problem	Solutions
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Device not appearing in pairing list	<ul style="list-style-type: none"> <li>Verify Bluetooth is enabled on your phone/computer</li> <li>Move closer to the device (within 1 meter during pairing)</li> <li>Restart both glove and browser</li> <li>Clear browser cache and refresh page</li> </ul>
Browser doesn't support Bluetooth	<ul style="list-style-type: none"> <li>Switch to Google Chrome or Microsoft Edge</li> <li>Update browser to latest version</li> <li>Enable experimental web platform features (chrome://flags)</li> <li>Use a different device if compatibility issues persist</li> </ul>
Calibration fails or shows low quality	<ul style="list-style-type: none"> <li>Ensure glove fits</li> <li>Check that flex sensors are properly aligned with fingers</li> <li>Perform calibration in a stable position (standing, arm flush with torso)</li> <li>Avoid excessive movement during calibration capture</li> </ul>

## VII. Support & Contact

If you need assistance with using SIGNLENT, Please contact the appropriate team members for your issue.

### General Support

- 66991026@kmitl.ac.th - Pradubfah Thanataweerat
- 66991027@kmitl.ac.th - Worawalan Woradee

### Software Support

- 66991035@kmitl.ac.th - Thad Choyrum
- 66991023@kmitl.ac.th - Ekburut Dongsaensuk