Bengali sign language translator with location tracking system

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ABSTRACT

Designing an embedded system to convert sign language to sound forms to communicate with the outside world can be a challenging yet rewarding project, especially for mute people. To convey a speaker's thought through sign language, hand shapes, hand orientation and movement, and facial expressions must be combined concurrently. This research is intended to design a system that translates sign language into sound forms to establish communication with the outside world for people who are deaf, those who can hear but cannot physically speak, or have trouble with spoken languages due to some other disabilities. They can thus receive prompt assistance and stay out of uncomfortable circumstances. Additionally, this system incorporates a tracking system that uses a global system for mobile communications (GSM)/ global positioning system (GPS) module to locate a person using a tracking device and send the location to previously saved emergency contact numbers so that someone nearby can quickly locate and assist the person. Typically, each nation has its own native sign language. This project will create a few essential and typical sentences and phrases in Bengali.

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1. INTRODUCTION

The sign language recognition system is a system that collects sign language used by people with difficulty talking. This project proposes a device for interpreting sign language using a portable smart glove. It will convert the gestures or hand movements of the individual wearing the glove into sound, allowing the mute person to be heard by the outside world. It will convert Bengali sign language into voice and will also track the location of the individual wearing the glove.

A lot of research has been done to develop sign language translators, and many are still going on today. A convolutional neural network (CNN) model-based sign language recognition system is used to recognize letters in Indian sign languages (ISL) [1]. Abdulhamied *et al.* [2], proposed an approach to recognize American sign language (ASL) using the long short-term memory (LSTM) method and achieved 99.35% accuracy. Bejuri *et al.* [3] proposed a system to detect hand movements and translate the movements into proper information. They used the CNN model for this purpose. Another CNN-based systematic literature review (SLR) system is proposed in [4]. A computer vision-based approach is proposed to identify the Bengali numeric sign language [5]. Shaheen and Mehmood [6] explains the importance of a vision-based SLR system dynamic time wrapping based system is proposed to recognize Indonesian sign language which is user independent [7]. Sign language translator devices are usually built using three approaches, which are glove-based, vision-based, and hybrid-based [8]. In a few review articles on SLR, they have discussed other vision-based methods such as hidden markov model (HMM), CNN, LSTM, and recurrent neural network (RNN) [9]. Different sensors are used by glove-based techniques, including flex sensors, MPU6050, gyroscopes, and accelerometers. The gloves have all these required sensors attached to them. The bending of these sensors creates the required voltages, which are then converted to sound or voice. Cameras are used to gather the input data for the vision-based approach. Many review articles have compared both glove and vision-based technology. They have mentioned the benefits and limitations of both systems [10]–[12]. A sensor-based glove was designed for translating ASL using a flex sensor and MPU6050 sensor [13]–[15]. Another project named "Talking Gloves" was made to translate Pakistan sign language (PSL) [16]. With an accuracy of 93.4%, it converts the English alphabet and numbers to PSL. The device has been implemented with a unique feature to switch to its sleeping mode to save power when it is not being used. Another similar project named "Talking Hands" in [17] was made by using Arduino UNO to translate ISL. Here the sensor readings are mapped using a smartphone. Rosero-Montalvo *et al.* [18] intelligent electronic gloves were developed with an accuracy of 85% for translating the numbers 0 to 9. Anupama *et al.* [19] explained K-nearest neighbor (KNN) algorithm along with the flex sensor and other sensors were used to develop the data gloves. Li *et al.* [20] ASL translator has been designed using Microsoft Kinect technology. The Microsoft Kinect is a horizontal sensor bar that consists of a monitored pivot that contains an infrared depth sensor, and red, green, and blue (RGB) camera, and a multi-array microphone. The Kinect is connected to the computer. Once the motion is detected and captured pre-processing and pattern matching begin. When a match is found the associated gesture corresponding phrase or word is displayed on the monitor screen. Another vision-based device was introduced in [21] using the CNN and Microsoft Kinect sensors. It translates ISL with an accuracy of up to 99.3%. Using the hybrid method in [22] a complete dialogue box was made in Japanese sign language (JSL). A pair of colored gloves along with a stereo camera were used to track the movement of the signer. An artificial intelligent (AI)-based SLR system is approached in [23]. A machine learning based approach to detect Bangla sign language is proposed in [24]. Ahmed and Akhand [25] a fingertip-based system is developed to detect Bengali sign language.

This area of SLR is still very lagging and in difficulties, especially in the case of Bengali sign language recognition. Some work has been done to find the accuracy of detecting the gestures, but no glove-based work has been done for translating Bengali sign language. Therefore, this project aims to create an economical, low-cost glove to translate Bengali sign language for the deaf and mute people in Bangladesh, taking into consideration the cost and portability to carry the device anywhere. It also utilizes the global policy and strategy (GPS) tracking system to track down the lost person.

The following section describes the paper's structure: the latest developments in sign language detection can be found in this section. Section 2 explores the research methodology of the proposed system. Section 3 depicts the proposed system's experimental setup. Section 4 analyzes the system's outcomes. Section 5 closes with a theory, shortcomings, and possible study directions.

2. METHOD

In our system, we focus on helping disabled people receive immediate support as well as informing family members of the person's actual location when he or she is experiencing difficulty. So, in this case, we've combined a sign language translator with GPS tracking. Disabled people might receive fast assistance by using the sign language translator. The GPS tracker allows family members of disabled people to know the person's exact location and rush to them as quickly as possible. The Arduino Nano is the central component of the entire system. The flex sensor and the MPU6050 sensor are connected to the Arduino Nano in order to send the values obtained when the hand and fingers are moved. The values are then compared to the gesture values stored on the SD card. The power supply connector supplies the Arduino Nano with the energy it needs to run the entire device. Those gesture values that match are relayed to the amplifier, and the amplified sound is then played through the speaker. During the tracking process, the global system for mobile communications (GSM) module is directly attached to the Arduino Nano to send and receive signals. Figure 1 depicts the system's block diagram.

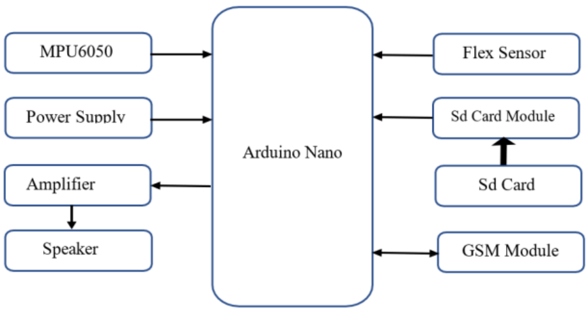


Figure 1. Block diagram of the system

The flowchart describes the total workflow of the syetem. The left side of the chart depicts the sign language-to-sound translation. When the glove is put on, the flex sensors attached to the glove above each finger provide resistance when the wearer bends the fingers. The MPU6050 sensor includes an accelerometer and a gyroscope sensor. The accelerometer detects the rotation of the hand, and the gyroscope detects angular movement. The system records the readings from these sensors and compares them with the recorded data. When the reading matches the stored data, the system generates the linked gesture's word or sentence as a sound. The operation of the location tracking system is depicted on the right side of the chart. When the user hits the button, it examines the network of the inserted SIM and determines the SIM's location using this network. After the location has been identified with the help of GPS/GSM module, a message is sent to the saved emergency cell phone number. The system flowchart is depicted in Figure 2.

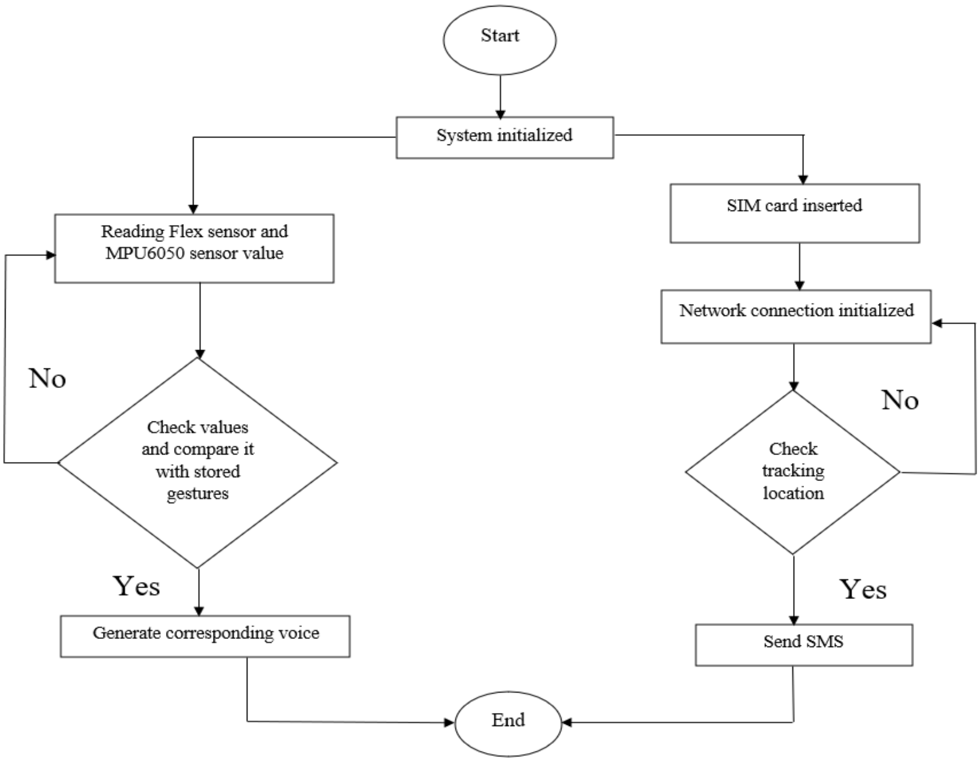


Figure 2. Flowchart of the system

3. IMPLEMENTATION

As we know, there are two modules in the system. One of them is the glove, that understands the movement of fingers and plays respective voice signal. The glove contains the sensors that will take the readings. An Arduino Nano, a battery, two flex sensors, two resistors, a gyro sensor, one SD card module, an audio amplifier, and a speaker create the circuit. The battery's negative end connects to the GND pin of the Arduino Nano, and its positive end to 5 volts. One flex sensor's left terminal connects to pin A3 on the Arduino board and resistor R4. The other flex sensor's left terminal connects to Arduino pin A2 and resistor R3. Along with the two resistors, the right terminal of both flex sensors is connected to the ground. The gyro sensor's int pin and the Arduino's D2 pin are connected. We link the SD card module to Arduino's D10, D11, and D12 pins. The sda and scl pins of the gyro sensor connect to the Arduino Nano's pins A4 and A5. We link the audio amplifier to the Arduino's D9 pin. The speaker connects appropriately to the positive and negative terminals of the amplifier. Figure 3 describes how we designed the circuit diagram for the glove.

Another module is location tracking. The circuit diagram for location tracking includes an Arduino Nano, a battery, and a GSM/GPS module (SIM 800L). The GSM/GPS module's RX and TX pins are linked to the Arduino Nano's TX/D1 and RX/D0 pins. The Arduino Nano and the GSM/GPS module are powered by a 5-v battery. We connect the device's emergency button to the Arduino Nano's D4 pin. This button will share the location of the person who is seeking assistance. Figure 4 shows circuit diagram of location tracker.

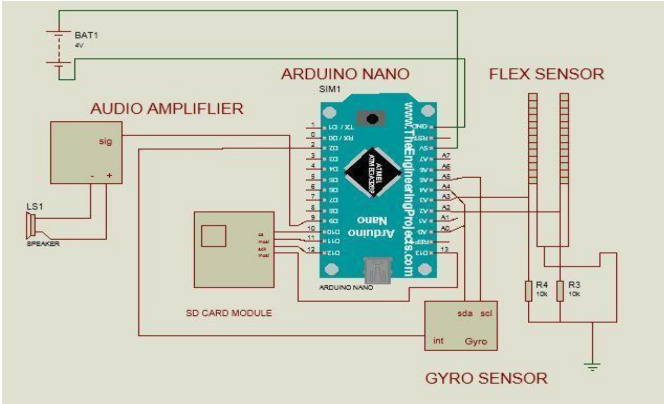


Figure 3. Circuit diagram of the glove

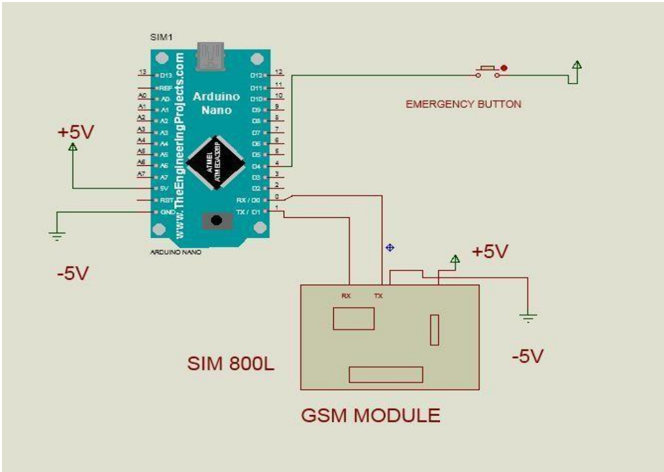


Figure 4. Circuit diagram of the location tracker

The x and y axes are measured by the gyro sensor (MPU6050 sensor), and the flex sensor measures the movement of the fingers. When we connect the Arduino to the personal computer (PC) through a data cable, in the serial monitor of the Arduino IDE software, the readings of the x-axis, y-axis, and fingers are shown on the screen depending on the device's position. So, as we change the device's position, the readings of the x-axis, y-axis, and both fingers change accordingly. After taking the readings, the values are inserted into the program with the recording's name from the SD card. As the user moves hand or finger, the system would record 8 hand or finger actions on the axis X and Y. Table 1 shows the values on which the training data are recorded.

Table 1. Data training

S/L	X Axis	Y axis	Finger 1	Finger 2	Action	Result
1	47	17	18	20	salam.wav	Yes
2	-17	-45	18	20	osus.wav	Yes
3	41	-20	17	20	name.wav	Yes
4	5	-45	37	17	help.wav	Yes
5	50	-5	64	54	apor.wav	Yes
6	10	-48	30	17	emer.wav	Yes
7	6	-48	72	15	trac.wav	Yes
8	43	-25	62	54	loca.wav	Yes

In this research, we looked at eight sign languages from different semantic perspectives. These sign languages employ just one hand. The 8 dynamic sign languages are shown in Figure 5. Those sign languages are Figure 5(a) greeting – *Assalamu Alaikum* (আসসালামু আলাইকুম), Figure 5(b) introduction – *my name is*

XYZ (আমার নাম XYZ), Figure 5(c) introducing team member – *my team member name is* (আমার টিম মেম্বার এর নাম PQR), Figure 5(d) introducing project name – *our project name is sign language translator with location tracking system* (আমাদের প্রজেক্টের নাম সাইন ল্যাঙ্গুয়েজ ট্রান্সলেটর উইথ লোকেশন ট্র্যাকিং সিস্টেম), Figure 5(e) taking out the tracking device from the bag – *please take out the tracking device from my bag* (দয়া করে আমার ব্যাগ থেকে ট্র্যাকিং ডিভাইসটি চালু করুন), Figure 5(f) seeking help in case of getting lost – *I got lost, please help me* (আমি হারিয়ে গিয়েছি, দয়া করে আমাকে সাহায্য করুন), Figure 5(g) seeking help for any medical emergency – *I am feeling sick, please take me to the doctor* (আমি অসুস্থতা বোধ করছি, দয়া করে আমাকে ডক্টরের কাছে নিয়ে চলুন), and Figure 5(h) calling the emergency number – *please call emergency 999 for me* (দয়া করে আমার জন্য ইমারজেন্সি ৯৯৯ এ কল করুন).

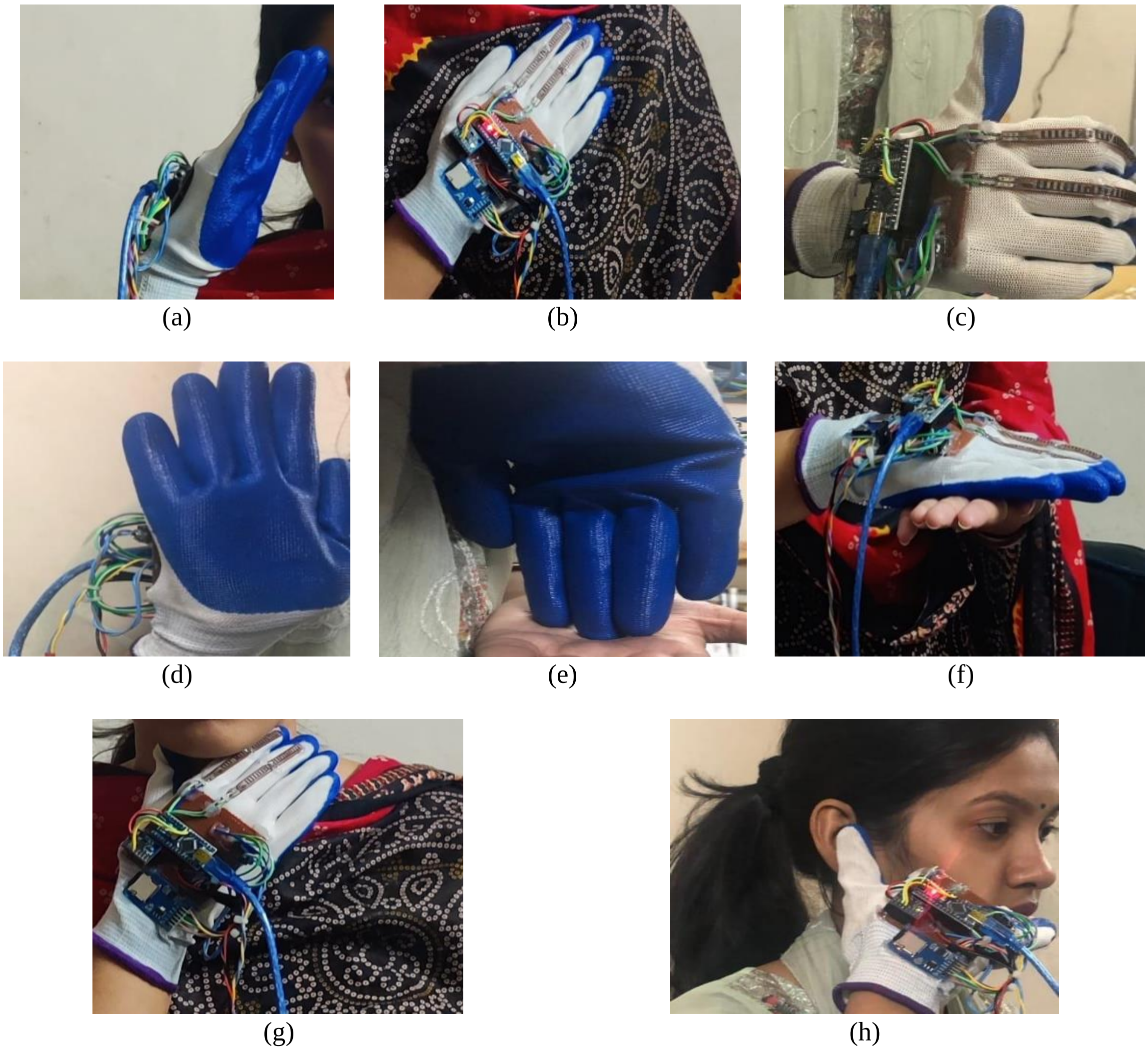


Figure 5. The training sign language gestures: (a) greeting, (b) introduction, (c) introducing team member, (d) introducing project name, (e) taking out the tracking device from the bag, (f) seeking help in case of getting lost, (g) seeking help for any medical emergency, and (h) calling the emergency number

4. RESULTS AND DATA ANALYSIS

A prototype sign language translator is produced after acquiring all the essential equipment and attaching it to one another. As the person moves their hand or finger while wearing the gloves, the flex sensor generates resistance, which is transformed into voltage via the resistors utilizing the voltage divider rule. Along with the flex sensor, the MPU6050 generates a value. These values are relayed to the Arduino, which already has the desired sentence for the readings stored in it. Arduino then connects to the SD card and compares the stored sentence in the Arduino to the stored sentence in the SD card. If a match is identified, the sound is played through the Bluetooth speaker. The device was tested using 8 trained sentences, and the results of the inputs were as predicted. The device has a short setup time to hook up with the Bluetooth speaker, and it takes just 1 second to understand the input motion. Figure 6 shows the setup of the sign language translator device.

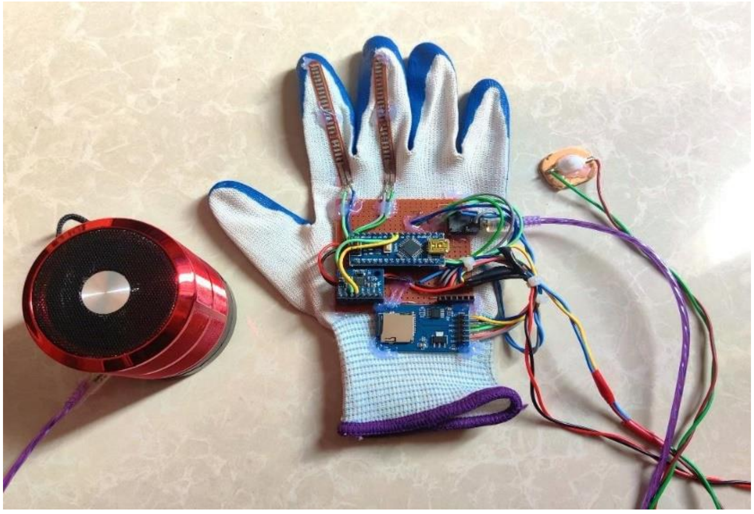
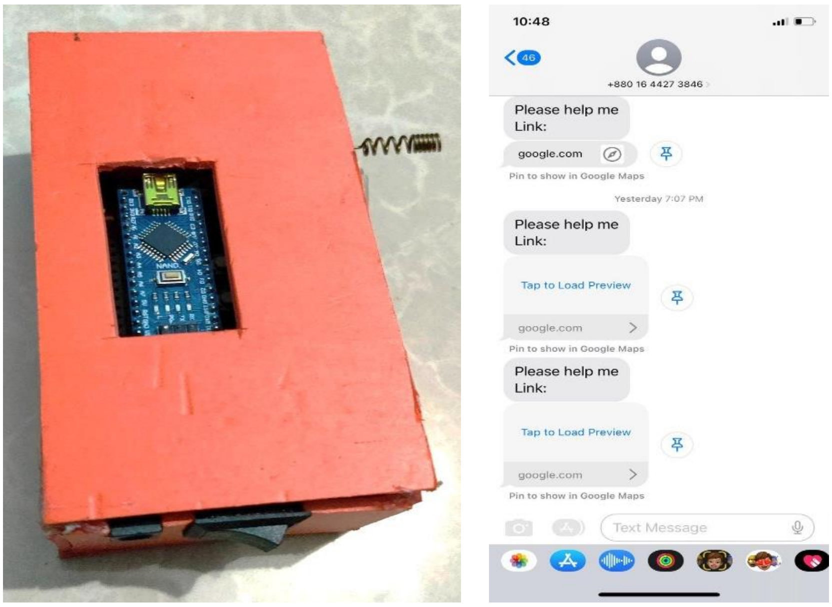


Figure 6. Setup of the sign language translator device

The location tracker device is made up of a battery that powers the Arduino Nano and the GSM/GPS module. The person's emergency contact information is maintained inside the Arduino. The device helps find locations using the GSM/GPS module. When you press the button, the entire system goes into action. The GSM/GPS module's light-emitting diodes (LEDs) begin to blink. When the module connects to the cellular network, the light begins to blink slowly. The Arduino contacts the GSM/GPS module when the emergency button is pressed. The location received from the module is sent to the emergency contacts saved in the Arduino Nano. Figure 7 shows the location tracking device where Figure 7(a) shows the setup of the location tracking device and Figure 7(b) shows the result of the tracking device.



(a) (b)

Figure 7. Location tracking device (a) setup and (b) result

5. CONCLUSION

Deaf and mute people experience several difficulties in communicating with others on a daily basis. The proposed approach for this project will meet their requirements. When the person who is using the device moves their hand to indicate the gesture, the requested sound is played via the Bluetooth speaker. This will help the individual express whatever is going through their mind. It can also help the individual escape potentially dangerous situations, such as if the individual is lost or sick, believes he or she may be in danger, and so on. Based on the training data, we achieved 99% accuracy. In addition, the exact location is relayed to the specified contact numbers, which are recorded as emergency numbers. The training sign languages employed here, however, are limited to only eight sign gestures. It would be interesting to be able to access the proposed method in more sign language. In the future, we will aim to design an entire wireless device to make it more convenient. Furthermore, we will attempt to design the device for two hands so that the user can express themselves with greater flexibility.

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