

SMART SPEAKING GLOVE WITH ONE HAND FOR DEAF AND DUMB

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ABSTRACT

The sign language is an effective means of communication between the deaf and dumb communities and the general public, but it requires human translators. This paper describes the development of a smart speaking glove with one-hand deaf and Dumb individuals using Arabic sign language. The glove bridges the communication gap between those with hearing and speech problems and those who don't understand sign language. It accurately converts sign language motions into audio and text, enhancing dignity, independence, and social inclusion. The glove, made of flexible sensors and a six-dimensional motion tracking device, allows deaf individuals to communicate with regular people via a smartphone, reducing the gap between them. It has focused on six major scenarios based on sentences and words of foodstuff and welcome signs. In cooperation with the Zawia Center for the Deaf and Dumb, every scenario was evaluated. The glove performed well when tested for side bending, resistance, voltage, and angle.

Keywords: Arabic language, Microcontroller, Flex sensor, glove, Deaf and dumb individuals

القفاز الناطق الذكي بيد واحدة للصم والبكم

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ملخص البحث

تعتبر لغة الإشارة وسيلة فعالة للتواصل بين مجتمعات الصم والبكم وعامة الناس، ولكنها تحتاج إلى مترجمين. تصف هذه الورقة تطوير قفاز ذكي لأشخاص الصم والبكم الذين يستخدمون لغة الإشارة العربية. يعمل القفاز على سد فجوة التواصل بين الأشخاص الذين يعانون من مشاكل في السمع والنطق وأولئك الذين لا يفهمون لغة الإشارة. فهو يحول بدقة حركات لغة الإشارة إلى صوت ونص، مما يعزز الوجود والاستقلال والاندماج الاجتماعي. قد ركز على ستة سيناريوهات رئيسية

تعتمد على كلمات ترحيب وجمل لمنتجات غذائية. تم اختبار جميع الحالات بالتعاون مع مركز الصم والبكم بالزاوية. تم تقييم القفاز أيضًا من حيث الأداء (الانحناء، المقاومة، الجهد والزاوية) وأعطى نتائج جيدة.

الكلمات المفتاحية: اللغة العربية، المتحكم الدقيق، حساس Flex، القفاز، الصم والبكم.

1. Introduction

Assistive technologies provide rehabilitative and adaptive devices for people with disabilities, such as hearing aids, wheelchairs, deaf and blind gloves, spectacles, prostheses, pill organizers, and sign language [1,2]. Sign language as shown in Figure 1, is a communication skill that uses gestures instead of sound to convey meaning, combining hand shapes, orientations and movement of the hands to express fluidly a speaker's thoughts [3]. Deaf people use gestures instead of sound to communicate, requiring a translator to understand their language [4, 5].

Deaf people are increasingly relying on modern coping techniques to help them overcome everyday difficulties and integrate socially and professionally. Talking Gloves are an example of assistive technology that converts sign language into words [6].

Sign language is a language that uses hand gestures and body movement to convey meaning, as opposed to acoustically conveyed sound patterns. It has no language relation to talking languages, but varies depending on the country [7]. Deaf people are increasingly relying on modern coping techniques to communicate, such as Talking Gloves, which converts sign language into words [8]. The paper aims to lower the communication gap between deaf and dumb people and normal people, and help the people to learn, understand, and communicate with these disabled people.

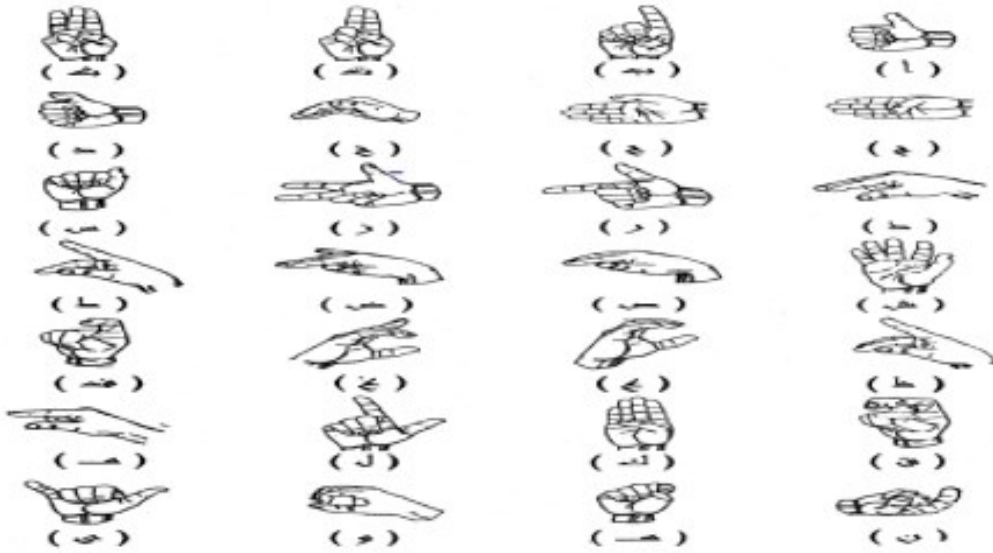


Figure 1 Arabic alphabet in sign language [23]

Deaf Arabs have been using sign language since ancient times, but it was not used as a means of communication until recent decades. Arab sign language was officially adopted during the sixth conference of bodies working in the care of the deaf in 1991 AD, but some schools still use old methods [9].

Arab countries spread the language by organizing training courses and preparing dictionaries, and news bulletins and TV programs translated into sign language. The Arabic sign language differs between the countries, with different dialects in the talking languages.

2. Methodology

The block diagram structure of the study is shown in Figure 2. It uses an Arduino Mega 2560 as a microcontroller board based on the ATmega2560 to control a flexible sensor that measures the amount of deflection or bending. It is connected to a three-pin device connector with an input voltage of 5 volts and an output voltage of 0-5 volts. It has a flat resistance 25 K Ohm and a bending resistance range of 45 K to 125 K Ohms as shown in Figure 3a and 3b [10, 11].

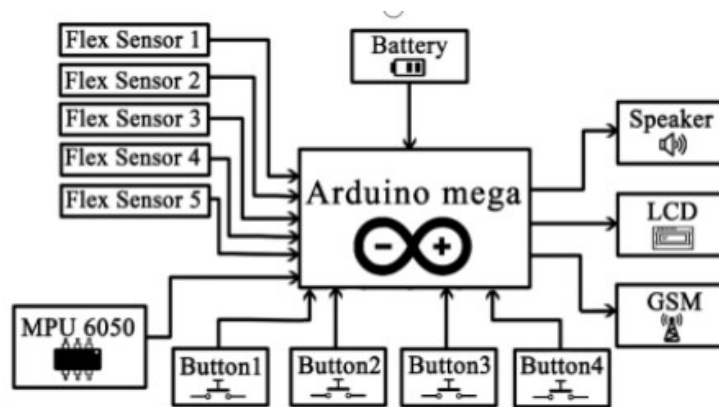


Figure 2 shows the block diagram structure

$$V_{OUT} = V_{IN} \left(\frac{R_1}{R_1 + R_2} \right) \tag{1}$$



Figure 3a. Flex sensor [10]

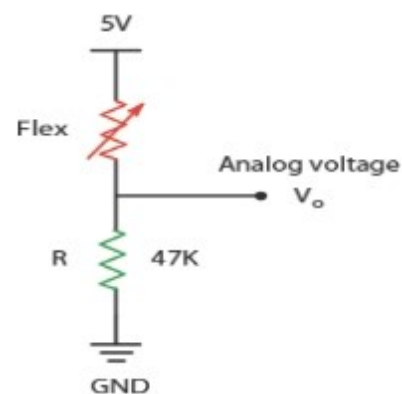


Figure 3b. Output voltage relating to V input, R1 and R2 (flex).

The output voltage measured is the voltage drop across the pull-down resistor, not the voltage drops across the flex sensor as shown in Figure 3b. The output voltage from equation (1) decreases with increasing bend radius, as seen with a 5V supply and a 47K Ohm pull-down resistor, especially when

the sensor is flat (0°), the output voltage is 3.26V. The sensor's resistance increases to almost 100k Ohm when bent to 90° , resulting in a lower output voltage to become 1.59V. Figure 4 illustrates the MPU6050 which is a 6-axis Motion Tracking Device that combines 3-axis Gyroscope, 3-axis Accelerometer and Digital Motion Processor. [6].

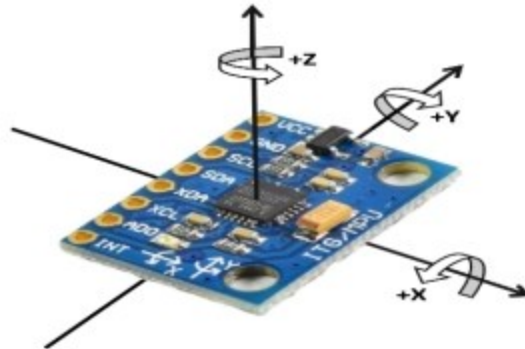


Figure 4 illustrates the MPU6050

DF Player Mini MP3 Player for Arduino is a low-cost MP3 module with a simplified output to the speaker. IIC/I2C Interface Adapter Module is used for 16×2 LCD Display that converts I2C serial data to parallel data for 16×2 LCD display. SIM800A GSM Modem is a complete Quad-band GSM/GPRS solution with RS232 Interface for low power consumption. The 18650 Li-ion battery is used in high drain applications due to its superior capacity and discharge rate.

Electrical Resistance is the resistance of a circuit to electric current. The Adjustable Mb-102 Breadboard Power Supply Module 3.3v/5v converts electrical signal into sound, but must be amplified with an amplifier before it is sent to the speaker. The most suitable glove for this work was the cloth glove due to its flexibility and ease of movement.

3. Deaf-dump glove circuit diagrams

Figure 5 shows the complete connection of circuit elements with the controller which have five flex sensors were installed on the glove and connect them to the Arduino and configured with the MPU6050. A mono speaker is connected as well.

4. Results and Discussion

This paper was conducted in cooperation with the center for the Deaf and Dumb in Zawia city to focus on the Arabic sentence speaking with one hand instead of using both. Once the hand movements are recognized, the glove converts them into spoken words using a built-in speech synthesis system as illustrated in Figure 6. This enables the wearer to communicate verbally with others. The glove was programmed with a wide range of Arabic sign language vocabulary, ensuring that it can understand and translate various signs accurately. The translation from sign language to spoken words happens in real-time, enabling smooth and efficient communication between the wearer and others. The conversation included foodstuffs such as ice cream, juice, tuna, and chocolate, and included pictures of the welcome signs, words and sentences used in the food market, and the position of the flex, voltage, angle, resistance R1 value, and MPU angles.

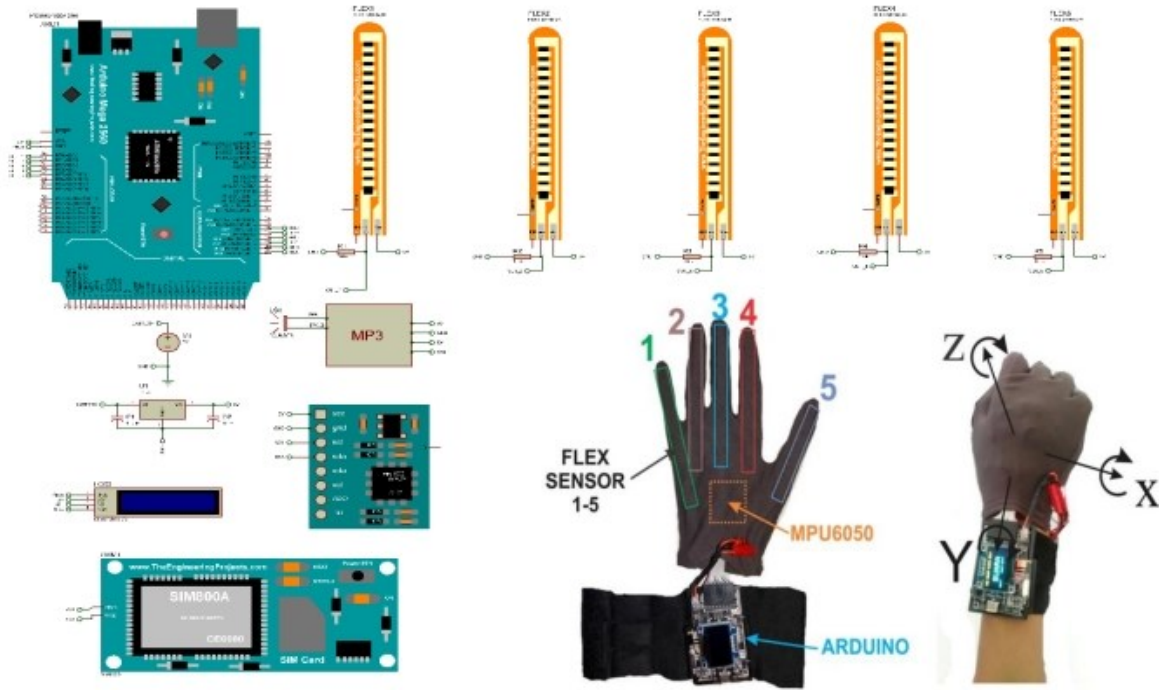


Figure 5 Deaf-mute glove circuit diagrams

A person which is wearing the glove waits 3 seconds for the MPU6050 sensor to initialize, then a gesture is detected based on the hand's direction and the angle degree of five-finger flexion. The sensor's value is fed to the Arduino Mega's ADC, with each sensor's value varying based on hand direction or bending. The gesture is defined as specific values for each sensor. When a selected gesture is chosen, it is translated into text on the LCD screen and speech on the speaker, which is sent to the phone via the SMS button.

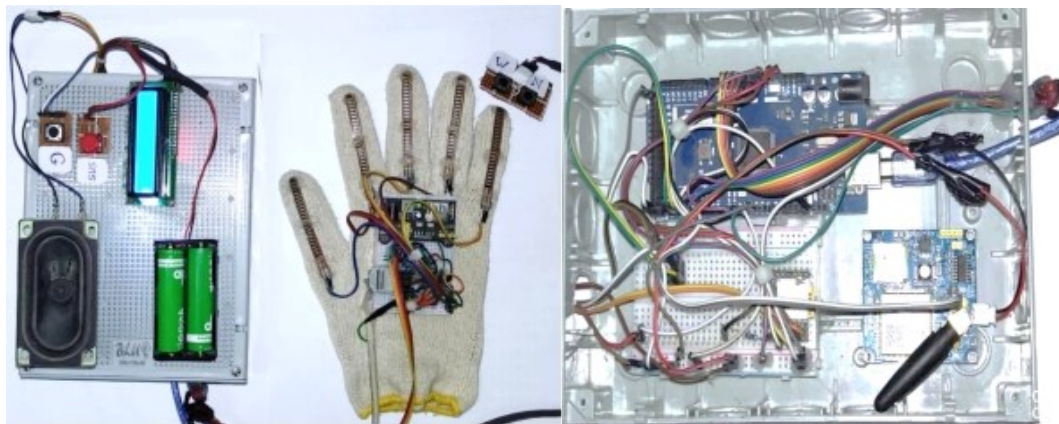


Figure 6 schematic of One hand smart glove.

The gesture, "Hello مرحبا," displays text and sound simultaneously, and can be used to send messages to a phone as shown in Figure 7. Table 1 illustrates the flex sensor and the measured values of V, R and angle.



Figure 7 word (Hello مرحبا)

Table 1 shows the flex sensor and the measured values of V, R and angle of the word of (Hello).

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Flat	1.39	47.37	38.50
Flex_2	Flat	1.31	22.01	35.50
Flex_3	Flat	1.21	12.49	31.92
Flex_4	Flat	1.04	13.44	26.26
Flex_5	Curvature	1.76	154.11	54.32

Figure 8 illustrates sentence of (How are you كيف حالك) is a sign language used to ask about the situation and send messages to the phone when pressing the SMS button. It expresses three fingers that are bent flat except for the fourth and fifth, which are bent by 147 degrees and 159 degrees, respectively, as shown in Table 2.



Figure 8 the sentence of (how are you كيف حالك)

Table 2 shows the flex sensor and the measured values of V, R and angle of the word of (H.R.U).

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Flat	1.29	26.40	34.77
Flex_2	Flat	1.24	8.42	32.97
Flex_3	Flat	1.04	0.00	26.26
Flex_4	Curvature	2.04	147.24	68.91
Flex_5	Curvature	1.78	159.74	55.27

Figure 9 displays a price "how much كم السعر " gesture, displaying text and sound simultaneously. The hand is bent flat, except for the first and second fingers, with the first bent by 152 degrees and the second by 126 degrees as illustrated in Table 3.

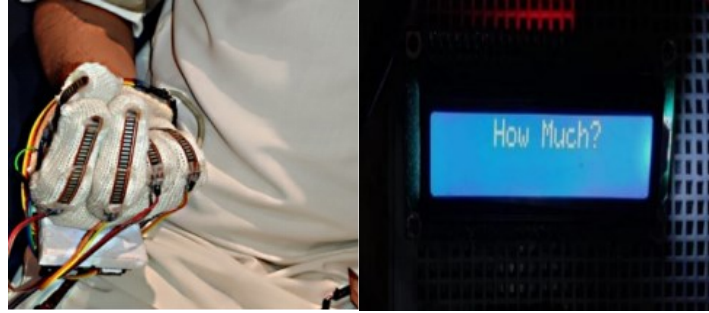


Figure 9 the sentence of (How Much كم السعر)

Table 3 shows the status of bending flex sensor and the measured values of sentence of (How much كم السعر)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Curvature	1.90	152.24	61.29
Flex_2	Curvature	1.87	126.21	59.74
Flex_3	Flat	1.45	47.22	40.84
Flex_4	Flat	1.01	9.50	25.31
Flex_5	Flat	1.08	0.00	27.55

The "OK حسننا " gesture involves bending the first finger by 149 degrees, followed by 136 degrees, 135 degrees, and 131 degrees.as shown in the Figure 10 and Table 4.

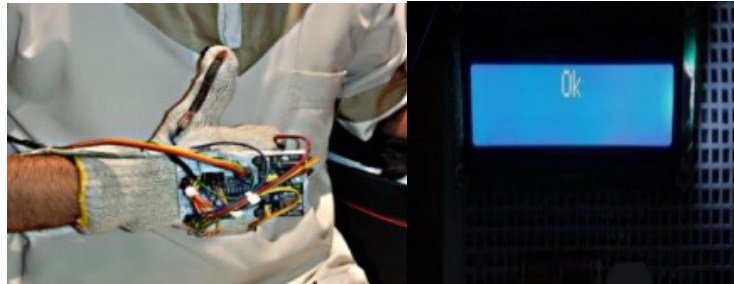


Figure 10 word (OK حسننا)

Table 4 shows the status of bending flex sensor and the measured values of sentence of (OK حسننا)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Curvature	1.89	149.25	60.77
Flex_2	Curvature	1.92	136.17	62.33
Flex_3	Curvature	2.06	135.82	70.06
Flex_4	Curvature	1.92	131.50	62.33
Flex_5	Flat	1.08	0.00	27.55

The 'No' gesture is a hand gesture where the first finger is bent by a specific angle. as shown in the Figure 11 and Table 5.



Figure 11 the word (NO لا)

Table 5 shows the status of bending flex sensor and the measured values of V, R and angle of word of (NO لا)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Curvature	1.90	151.24	61.29
Flex_2	Curvature	1.73	100.84	52.90
Flex_3	Curvature	2.01	128.73	67.22
Flex_4	Flat	1.06	16.72	26.90
Flex_5	Curvature	1.61	120.31	47.49

The "chocolate شكولاته" gesture is a gesture involving two flat fingers bent at 180 degrees, 151 degrees, and 131 degrees as demonstrated in Table 6, used to express the desire for two pieces of chocolate as shown in the Figure 12.



Figure 12 shows the word (الشكولاتة chocolate) and sentence SMS (I want two pieces of chocolate أريد قطعتان من الشكولاتة chocolate)

Table 6 shows the status of bending flex sensor and the measured values of word of (Chocolate شكولاتة)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Curvature	2.08	180.00	71.23
Flex_2	Curvature	2.01	151.58	67.22
Flex_3	Flat	1.92	116.68	62.33
Flex_4	Flat	1.06	16.72	26.90
Flex_5	Curvature	1.66	131.57	49.70

The "tuna" gesture is used to send SMS messages, displaying text and sound simultaneously, and translates to "I want five cans of tuna" in Arabic as shown in the Figure 13 and Table 7.



Figure13 shows the word (Tuna التونة) and sentence (أريد خمس علب من التونة *I want five cans of tuna*)

Table 7 shows the status of bending flex sensor and the measured values of word of (Tuna التونة)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Flat	1.31	30.39	35.50
Flex_2	Flat	1.26	12.95	33.68
Flex_3	Flat	1.13	1.15	29.19
Flex_4	Flat	0.86	0.00	20.77
Flex_5	Flat	1.45	83.12	40.84

The "drink" gesture involves two flat, bent fingers, with the first bent by 172 degrees, the second by 166 degrees, and the third by 145 degrees as shown in Table 8, used to express a desire for three cans of drink, as illustrated in Figure 14.



Figure 14 shows the word (Drink المشروب) and sentence (أريد ثلاث علب من المشروب *I want three cans of drink*)

Table 8 shows the status of bending flex sensor and the measured values of word of (Drink مشروب)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Curvature	2.00	172.22	66.66
Flex_2	Curvature	2.09	166.98	71.82
Flex_3	Curvature	2.12	145.04	73.61
Flex_4	Flat	1.55	82.31	44.92
Flex_5	Flat	1.50	94.39	42.85

The "ice cream المتلجات" gesture represents fingers as edges, with the first finger bent by 178 degrees. The number gesture represents four, and the sign (ice cream) appears as the word ice cream in Arabic as illustrated in Figure 15 and Table 9.

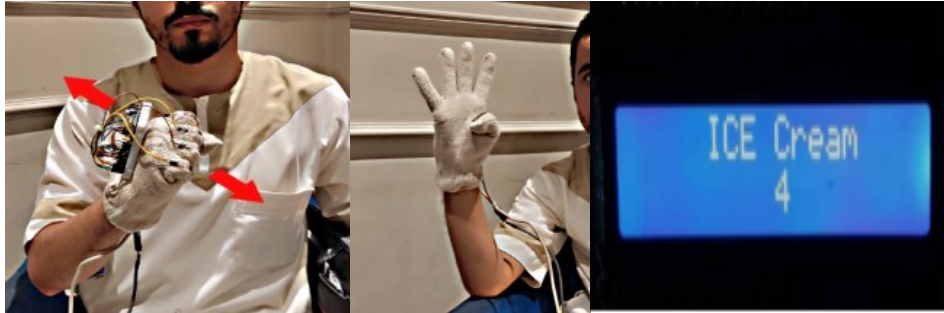


Figure 15 shows the word (Ice Cream المتلجات and the sentence (I want four pieces cans of ice cream أريد خمس قطع من المتلجات)

Table 9 shows the status of bending flex sensor and the measured values of V, R and angle of word of (Ice Cream المتلجات)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Curvature	2.03	178.21	68.35
Flex_2	Curvature	2.15	177.85	75.43
Flex_3	Curvature	2.14	147.87	74.82
Flex_4	Curvature	2.10	156.42	72.41
Flex_5	Curvature	1.68	137.21	50.60

Cheese الجبن is a sign language gesture involving three flat fingers, used to send messages to a phone when pressing the SMS button, expressing the sentence "I want three cans of cheese as shown in the Figure 16 and Table 10.

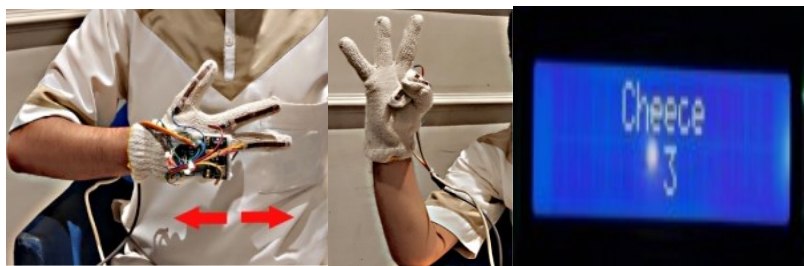


Figure 16 shows the word of (Cheese جبنة and I want three piece of cheese)

Table 10 shows the status of bending flex sensor and the measured values of word of (Cheese جبنة)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Curvature	1.85	141.26	58.73
Flex_2	Curvature	1.88	128.02	60.25
Flex_3	Flat	1.06	0.00	26.90
Flex_4	Flat	0.91	0.00	22.24
Flex_5	Flat	1.30	84.19	35.13

The "Bye مع السلامة" gesture is used to send messages to a phone by displaying the text and playing the sound simultaneously as shown in the Figure 17 and Table 11.

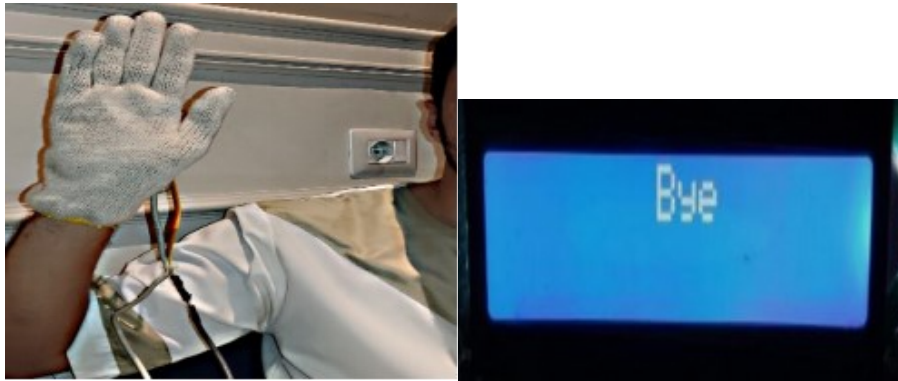


Figure 17 shows the word (Bye مع السلامة)

Table 11 shows the status of bending flex sensor and the measured values of word of (Bye مع السلامة)

Flex	Status	Volt (V)	Angle (Deg)	Resistance(Ω)
Flex_1	Flat	1.35	38.38	36.98
Flex_2	Flat	1.33	25.36	26.23
Flex_3	Flat	1.19	9.66	31.23
Flex_4	Flat	0.90	0.00	21.95
Flex_5	Flat	1.39	68.47	38.50

5. Conclusion

The Smart One-Hand Speaking Glove is a smart hand-held device that converts Arabic sign language into spoken words, improving communication skills for deaf and dumb individuals who primarily use Arabic sign language. This lightweight, reliable, and efficient tool enhances the lives of deaf individuals by converting sign language into audio, text, and SMS messages, making it a more accessible and effective means of communication in Arab-speaking societies.

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