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# A Linguistic Communication Interpretation Wearable Device for Deaf and Mute User

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**ABSTRACT:** There is a segment of society, which does not have access to today's sophisticated acoustics, but gesture-based sign language, such as using the hands or the shoulders of the eyes, can be a vital tool for making sure their audio is audible. The most widely used sign language in the world, known as ALC—American Linguistic Communication—varies slightly depending on the nation. Deaf and mute people can communicate effectively by using hand gestures to convey their message. The wearable good glove we developed for this study will translate ALC motions into the proper alphabets and words. It makes use of a glove with a number of flex sensors on the fingers' distal and proximal interphalangeal joints as well as the metacarpophalangeal joint to detect finger bending. The complete system is divided into three units: a wearable hand glove unit with a flexible device that records user-created ALC gestures, a processing unit in charge of taking sensor data, and a final unit that uses a machine classifier to identify the appropriate alphabet. In order to receive known alphabet data in text form through a wired channel via the mobile "Sign to Speech App," which presented that text data into this app, the smartphone unit is linked to the processing unit. Its user-friendly design, low cost, and availability on mobile platforms give it an edge over traditional gesture language techniques.

**KEYWORDS:** American Linguistic Communication, Arduino Uno, Distal & Proximal interphalangeal joints, Flex Sensors, Metacarpophalangeal joints, Sign to Speech App.

## 1. INTRODUCTION

### 1.1 Background

Life in a technological age of the digital realm, where everything is uncomplicated as well as straightforward, a portion of our population is missing out on the advantages of this epoch i.e. Deaf along with Mute individual. Due to disparities in speech styles, there seems to be little coordination between these special people and the conventional humans in our community. The ability to hear and express is a person's most potent platform for sharing data, feelings, and sentiments. It's something numerous individual take for granted. Hearing loss and muteness affect a large proportion of the world's population. These impairments, either partly or total, have a massive impact on the survival of the afflicted cluster [1]. As per the World Health Organization (WHO), 466-million individuals globally are deaf. Out of those 34-millions, people are children [2]. These sections of society encounter multiple barriers to communication that hinder their personal and work lives while performing in any appropriate activity. Consequently, they practice a peculiar form of sign language, which integrates the use of facial expressions (e.g., eyelid expression) along with hands, yet they need a universal sign language [3]. Across the globe, individuals from diverse regions follow different acceptable gestures. American Linguistic Communication (ALC) is perhaps the most regularly used sign language [4]. When we conducted a survey on worldwide sign languages, we observed that there is really no international sign language in the entire planet. Various countries each had their own sign language for disabled persons to convey and express their emotions. ALC, sometimes known as American linguistic communication [5], is a specialized language used among deaf along with muted users to interact with in U.S.A as well as English-speaking areas of Canada. It is not just the gesture expression, but its include the movement of the eyelids, thoughts and feelings. Sign language was innovated in the late 19th century at the American College of the Deaf, and it disperse extensively among the deaf population. This was the most complex sign relative to any others language but it also includes the movement of eyebrows and expressions. ASL was invented in 19th century in American school of deaf and it circulated quickly from within the deaf community. Figure 1 depicts the symbols used by ALC for alphabets of English languages.

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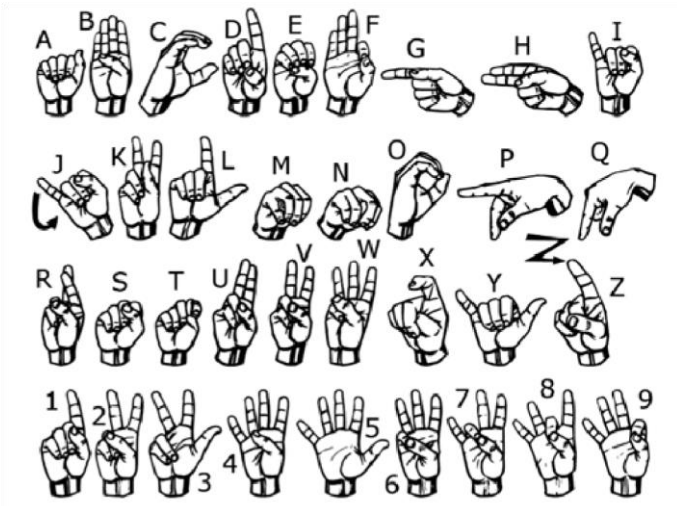


**Fig.1** Infographic of American Linguistic Interpretation [11]

Google Translate recognizes virtually all languages, easier to comprehend diverse cultures inside the contemporary era. Nevertheless, it seems there is no interpretation device available for hand signals. To tackle this challenge, a gauntlet with an alphabetic as well as words repository embedded with numerous sensors could be deployed. We built a prototype that a deaf/mute person takes, and it convert their communication into something comprehensible to regular folks, enabling their voice to be heard. Signal language, just like all the other languages, includes either formally and informally linguistic reference. We included only such people themselves, without obeying any norms, to make the formal element of the language seem informal. Inside the system, we included 26 alphabet letters so that. We put 26 alphabets within the database so that this tool has a large number of alphabets that may be seen and heard on the cell android program called "Sign to Speech App."

### 1.2 Statement of the Problems

Many individuals are deaf and mute, and then as a result, they seem unable to interact and listen. There are plenty of contributory factors to such impairments, namely-genetic disorders, contagious diseases, unforeseen mishaps, exposure to conflict, and drug consumption, amongst many others. These professional entities converse by sign language, consisting of hand body language and facial expressions. Special zones, on the other hand, have their own signal language [6]. The primary issue seems to be that the vast majority of the people have either a fistful of awareness of sign language or nothing at all. This reduces communication gap between the physically handicapped individual and the normal individual as they express their feedback [7].

### 1.3 Purpose of the Study

The purpose of this study are:

1. To convert sign language that user made through hand gesture into text form, which also visually displayed on mobile app connected through the smart glove.
2. Through text to speech feature, which is added into the app, sound of pronunciation of text is also available so that normal people can easily understand what the physically challenged user want to convey.
3. Through machine learning model we also want to remove the requirement of hardwire programming for each alphabet as well as word. Therefore through machine classifier the hand gesture data that mobile application get through sensor can be accurately recognised for each alphabet or words that user wants to share to other people.

### 1.4 Scope

This research work has mainly focuses on how to convert the American Sign Language that involves hand gesture made by the physically challenged user into words, which has visual and sounds by fabricating a smart device. The main benefits of this device is that it can act as a translator between physically challenged user and healthy person so that they can share their ideas, emotions and information independently as well as effectively without the need of external translator. The device also act as a kind of Solution Bridge between two different communication styles. It is portable, user friendly and easily connected to user smart phone.

## 2. LITERATURE REVIEW

Siddharth et al. used a digital camera to perform image analysis on the alphabets. Whenever an image/sign is presented to the camera, it identifies the sign that was generated before this. This discovers the sign via leveraging the outlines formed on the image employing imageprocessing technique. The said study illustrates a motion detection mechanism based on outlines. It negates necessity external devices and then a markers; a simple webcam is enough. This system will become even more durable when distortion as well as fuzz motion are minimized by utilizing some additional sophisticated algorithms, permitting for more precise translation of hand movements into commands [8].

Arslan et al. presented a sign-to-letter language translation system based on gloves. Its structure contained 5-flex transducer, a microchip to analyse sensed data, a letters and numbers screen to represent individual outcomes, and then a microphone to concentrate the result. This generated graphical representations that can only be seen on a Liquid crystal display as well as a sonic output that could have been recognized on speakers. A disadvantage of this approach is that it restricts the person's freedom to move [9].

There are 2-significant approaches include using computer vision dependent human activity recognition as well as a glove embedded with sensors. Computer vision dependent system could include a laptop including a webcam linked up to it. Symbols are generated next to webcams, which get processed using a multitude of computer vision techniques to achieve the intended impact. The second approach is by using a glove embedded with sensors along with interpreted the signal to the output platform [10].

Timothy et al. also designed a method on signing translation involving 9-flex transducer together with a mobile application. They crafted flex transducers from the base up, along with a piezo resistive merging of carbon particles implanted in a elastomer of fluorine. It transformed all twenty-six alphanumeric characters towards the mobile app. In addition, they utilized eight-flex transducer on the finger joints instead of nine. Additionally, they have such a comprehensive robot navigation app [11].

Liang et al. suggested a methodology of classifying alphabets according to movements they portray. The difficulty of dynamic gestures, especially involve time-dependent feedback, encompasses not just the complication of hamming window methods, as well as the transport issue. Quite a wider window is required, and the simple matching approach is inadequate. Moreover, informational Glove is employed, thus enhances the system cost [12].

Linguistic communication translation mechanism suggested by Nikhita et al. would be the use of lamp light emitting diode (LEDs) on fingers to recognize gestures. Inside the controller, the couple's data is converted from ADC. The computer code program of the alphabet gestured is remotely transmitted via ZigBee. Upon reception, a letter similar to the transmitted ASCII code is seen and detected on the laptop in Processing 2.0. The LED and LDR are situated in sightline that used a sleeve, making this approach impractical. This is often needed in order to avoid any outside light source without meddling with sensing activity [13].

Another technique was suggested by Boon at incorporates a framework that exploits 5-flex transducer as well as 2-pressure transducers, as well as one proximity sensor, to determine signals of ALC. Its efficiency was only 65.7 percentile when just flex transducers and proximity sensor utilized, however with the inclusion of a pressure transducer, accuracy rose to 98.2 percent [14].

Thad's et al. device is an imaginative and prescient-based entirely strategy. In his virtual image processing method, a digital digicam had interconnected with the user's hat as well as the table. The user seated in a hard - and - fast region such that device could properly comprehend the gesture. While identifying symptoms and symptoms associated to alignment or postural, the accuracy of an image processing techniques set of regulations may be decreased. Environment luminance fixtures also affect the accuracy of a simple image processing body of norms [15].

Contrary to most of the recent linguistic interpretation framework, we constructed a simple framework incorporates merely 5-flex transducers. This framework ensures mobility of users. This approach leverages a uncomplicated smartphone app to visualize as well as hear towards the audio. This methodology enables individuals could connect over a length about twenty meters through Smartphone application. The processing formulation is quick since it should not need to execute image analysis upon that sign as

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well before presenting that; we only have to build the phonetic symbols sign and it will be exhibited to same app. Nevertheless, this device costs around three hundred AED, key to competitive advantage viability. It instrument interprets twenty-six alphabet letters.

## 3. METHODS

This section is split into two parts:

a) How Device is fabricated?
b) How flex sensor data is processed?

### 3.1 Fabrication of Device

The design and fabrication of the smart wearable glove is completed by first identifying any gloves that can perfectly fit onto the user hand. Then, we paste the flex sensor on the finger location of gloves for all fingers namely-chico, anular, medio, indice and pulgar. After this, we connect two wires to each flex sensor and using zero printed circuit board (PCB) we soldered those wire to that PCB and make their ground common. Then, we use six long wires connect one of its end to zero PCB with their respective sensor and the other end is connected to bread broad where our Arduino Uno is pasted then we make voltage divider circuit using 10kohm resistor for each sensor and connect each sensor with the Analog pins of Arduino Uno. This completes our device fabrication. The device is shown in figure 2 below.

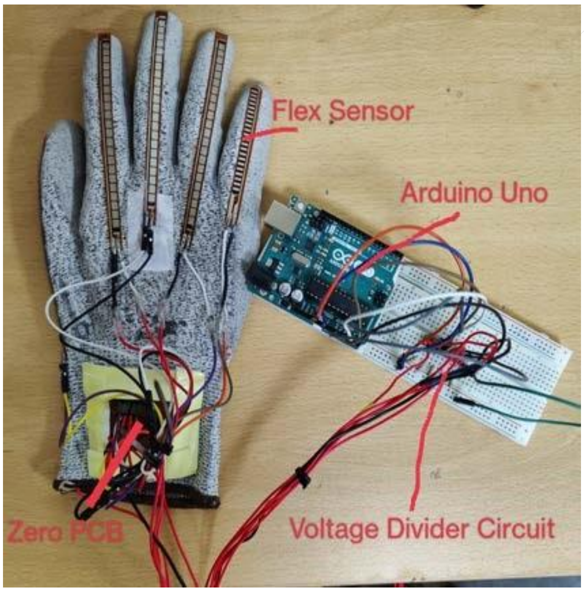


**Fig.2** Whole framework of our prototype

### 3.2 Flex Sensor Data Processing

The conversion of ALC split into 3-main levels: recognizing the quantities of sensing elements, analyzing, as well as presenting towards the sign. This flex transducer, that is essentially a potentiometer, seems to be the primary piece of this design. Flex transducers is composed with carbon layer upon polymer strands, and when this strip twists or diverts, electrical impedance of a flex transducer shows variation. We deployed one flex transducer to pulgar, anular, as well as subsequent fingers upon that hand. Flex transducer variant employed in this work is 2.2 inches as well as 4.5 inches in length for precision and accuracy in outcomes. Even as body of such component twists, electrical impedance of a flex sensing element incremented. As per the sequence in Figure 3, the very first feed to the Arduino Microcontroller is the flex transducer information. These outcomes from flex transducer acquired when hand is in an appropriate configuration as per gesture. Following executing analog to digital conversion, the impedance variation is matched to 0 to 1023 of 10-bit ADC, which is then processed by the Arduino. These actual values for a specific gesture correspond within the associated with a wide variety with that letter, thus assists in alphabetic recognition. When one similarity is discovered, its letter is transmitted via hardwired route, and is also presented as well as realized just on smartphone app.

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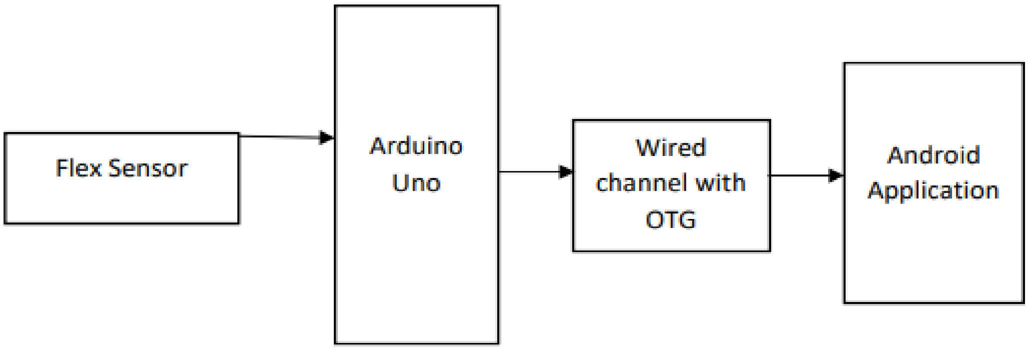


**Fig. 3** Control Flow representation

### 3.3 Flow of algorithm

For a better understanding of how smart glove work, we described an algorithm below:

1) Initially when we turn on the device, it initialize all sensor data as zero.
2) We take values from sensor pasted on the glove.
3) Then we use Analog to Digital Converter (ADC) and map the sensor value with 0-1023 value of a 10-bit ADC. After this, sensor values send to microcontroller.
4) In this step, comparison of sensor value should take place with range of values that we already found for each gesture corresponding to any 26 alphabet.
5) If sensor value which represent hand gesture made by user matches with any range of values from the range that we defined. Then it sends the corresponding alphabet to Sign to Speech app through wired channel. If sensor value does not match with any range of values then it go to step-2.
6) After receiving alphabet from microcontroller, Sign to Speech app displayed that alphabet and user can hear using text to speech feature interlinked with the app.

## 4. RESULTS

### 4.1 Validation with Serial Monitor

We first validate the working of the whole system w.r.t Arduino Serial Monitor where we can verify our algorithm works correctly. Therefore, whenever user do any ASL hand gesture corresponding to any alphabet then our algorithm takes that ASL gesture from flex sensor value then algorithm in microcontroller processed it and identify with every range of sensor values from database if it matches with any range corresponding alphabet will be printed on the serial monitor of Arduino along with sensor value. It is depicted in figure 4.

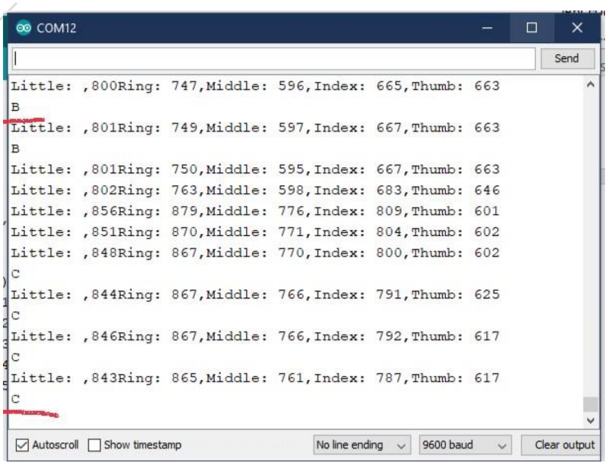


**Fig. 4** Arduino Serial Monitor with output

### 4.2 Actual implementation on User

When we got the validated the proper working of the device. We implemented it on one of the user shown in figure 5. In that figure as we can see user do different ASL gesture where gesture movement is capture by the flex sensor which is used as an input to the Arduino Uno. After getting input from the sensor program stored in Arduino Uno processed that data then matches it with all ranges of sensor value in database. In figure-7 when user did ASL gesture for alphabet "D" and "B" our microcontroller recognized it and send that alphabet through wired channel to Sign to Speech App where alphabet displays on the smart phone and hearing of alphabet is possible through text to speech feature.

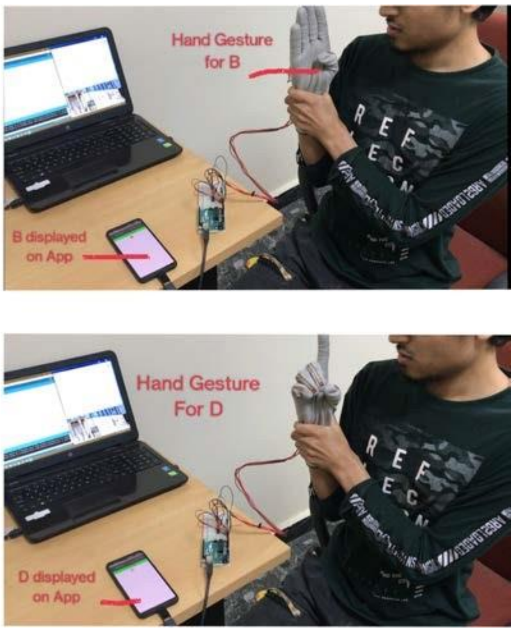


**Fig.5** Implementation in Real Time with user

### 4.3 Analysis of Flex Sensor Reading on Serial Plotter

After the actual implementation of smart wearable glove, we also analyse the flex sensor reading using Arduino serial plotter. The main aim of this analysis to figure out the sensor reading behaviour with time i.e. for any ASL gesture corresponding to particular alphabet what is average sensor values that each flex sensor shows. It is shown in figure 6 for every alphabet. In this figure top right corner, represent legend in which blue squared box is for little finger, red squared box for ring finger, green squared box for middle finger, yellow squared box for index finger, and purple squared box for thumb. Here x-axis represents time and y-axis represents flex sensor value.

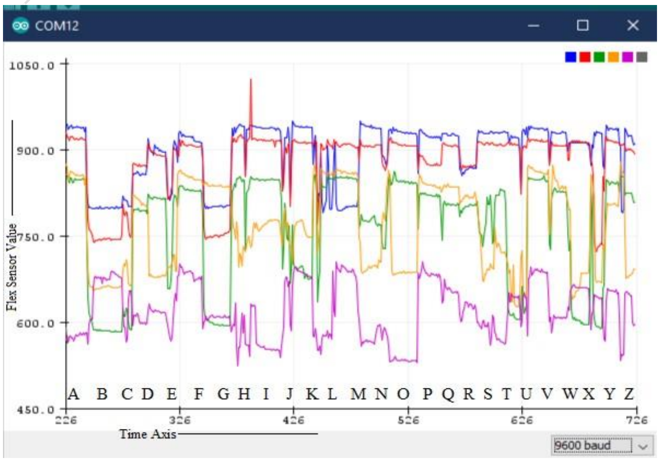


**Fig.6** Serial Plotter with different flex sensor reading

## 6. CONCLUSIONS

In brief, we accomplished our aim i.e. to create low cost prototype that can help deaf and mute community by translating their Sign language into alphabet, which can visually displayed on smart phone app and hearing of alphabet is also possible through text to speech feature. Throughout this research, flex transducer placed on the glove, including several electronic components in a really portable as well as modular design focused on the human, have been used to decipher ALC. Every person delivers a gesture in compliance to ALC, that Arduino Uno analyses. Following processing, all valuable data would be sent to a mobile application known as "Sign to Speech App" enabling visual and auditory exposition. Fundamental goal of this device is to identify hand gestures & transform these into relevant details in order to overcome the communication barrier between deaf & mute persons. The systematic architecture is adjustable, secure for using, readily presented, as well as modestly priced for enable anybody who cannot speak or listen. Another several strategies can be implemented, including namely adding towards the repository, communicating among devices throughout residences thru a unified IoT platform, and releasing an Emergency message to local security offices or doctors inside the event of a crisis.

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