

A Study on Smart Glove Interface for Augmented Communication: Assisting Children Aged 5-8 with Language Impairments

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Abstract

This study seeks to focus on bridging the gaps in individuals who have impairments in communication and language. This is a small effort to develop an assistive smart glove device which will enhance speech and language and help assistant activities of daily living skills. This researcher has attempted to use an assisted method, a model of hand-gesture-to-text conversion system. It enables the children and adults with communication disabilities be part of the mainstream society and be included in social interaction. This will enhance the accuracy and precision of sign language, interpretation and communication. This is a prototype which demonstrates a concept which is functional. Further research need be undertaken to fine-tune and optimize its fullest potential, enabling addressing its present technical issues.

Keywords: Speech and Language Impairments, Assistive Glove Prototype, Social Inclusion.

Introduction

Augmentative and Alternative Communication devices enables people with communication disabilities overcome hindrances and barriers towards speech and communication. In India there are 7.5 percentage of people with speech impairments (Suryadev, Alam, Rahman, & Harika, 2022). This is achieved by giving functional accessibility to communication enhancing the person with disability to communicate and make meaningful interactions (ASHA, 2026). By using Augmentative and Alternative Communication devices (AAC) in daily functioning, a person with communication difficulty can improve better functioning in various areas of life including better academic output, employability and improves mainstreaming into the society. AAC assists in early intervention in children with disabilities enabling them to ask for their desired needs immediately. This directly supports their improvement in social interaction and communication. This in turn brings positive independent living skills (ASHA, 2026). As communication is our fundamental tool for building relationships, AAC helps people with difficulties in communication establish 'bond and intimacy between individuals' says (Crowe, Machaliecek, Wei, Drew, & Ganz, 2021).

By fostering positive interactions, developing a sense of mutual well-being, it creates situations and environment where people with communication difficulties can share their needs, feeling and experiences with others in the society (Crowe, Machaliecek, Wei, Drew, & Ganz, 2021).

Objectives

- To fill the gaps in communication for persons with disabilities using gesture-to-speech conversion.
- To develop and create a cost effective, ergonomic glove that helps for sustainable usage and easy adaptability.
- To Foster skills in literacy, education and employability prospects for people with communication difficulties.
- To achieve inclusion of persons with disabilities into the society through improvised AAC tools assisting communication and interpersonal conversations.

Methodology

By using an Arduino Nano to process data, the researcher has used a sensing system which is analogue and flex based to detect bending angles. This device uses the following units and sensors: Microcontroller unit, Flex sensors and a Monitoring system to achieve the above said objectives.

- The researchers have used a Microcontroller unit to convert analog signals into digital and to process these signals.
- To make data visualization possible and to check resistance values, the team used a laptop with Arduino IDE in order to use the serial monitor.
- Considerations: A voltage divider circuits were used in the system to map flex sensor resistance.

Definitions

AAC – Augmentative and Alternative Communication (AAC) is a type of assistive technology designed to help people who struggle with speaking, writing, or understanding language. It provides tools and strategies to bridge communication gaps, allowing individuals to express their thoughts, needs, and emotions more effectively (Howes, 1983).

AAC methods range from simple to high-tech, including: Manual signs, gestures, and finger spelling, tangible objects, drawings, and picture or letter boards and the devices that generate speech electronically (Howes, 1983).

ADL – Activities of daily living (ADLs) are the routine, self-care tasks—like eating, dressing, bathing, and moving around—that most people

do independently. Measuring a person’s ability to handle these basics is a key way to assess their overall functional health (Information, 2026).

Procedure

Configuration of Hardware and Calibration: A five flex sensors interfaced with Arduino microcontroller was used to set up this experiment. Using a common ground and a 5 V power supply an analogue pin was connected to sensors. Uniform resistance was achieved in the initial calibration, with 30 kΩ measured in sensors in a planar state and at 180 degree flexion, at 80 kΩ

Development of Software

To enable and process the inputs simultaneously an individual sensor validation was used and the control logic was fully optimised converting into an unified algorithm. To achieve and process the recognition of gestures, ranges in finger displacement were found analytically for different hand signs needed. To make sure there is constant and consistent detection of signs and to make it more stable the system had to go through an iterative testing across multiple subjects.

Block Diagram

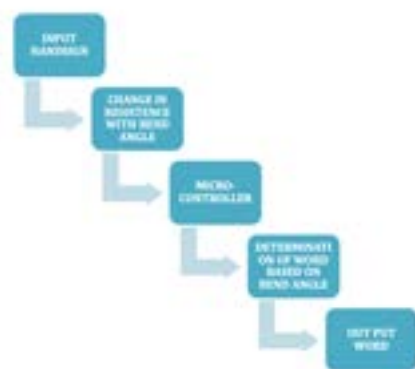


Diagram 1 Block Diagram

The above diagram demonstrates a wireless recognition system with gestures and it is called a “smart glove”. It is very important to know that this smart glove constantly tracks how a hand is moving and bending according to the data recorded sent to the computer to be used or displayed.

The Process

The above diagram indicates the process involved in this AAC device. The gloves act as the flex sensors becomes the eye of the system. This enables the changes of resistance with the help of bend angle. The microcontroller collects all the raw data and the output is calculated based on the code provided. Next the visual basic interface provides the final output and this is shown in the Arduino serial monitor.



Diagram 2 Showing the Process

Circuit Diagram

The diagram 3 clearly shows the circuit used for the smart hand glove gesture. This has used Arduino Nano as the main brain to gather data from the sensors that moves and it is sent to another device wirelessly.

The Input (Sensors): The flex sensors which are five in number one for each finger and is connected to register which is 10 K in voltage with the divide are so cute. As and when the fingers bend there are changes in the resistance observed. And these are in turn connected to analog pins (A0 – A4) as shown in the Arduino. This enables us to read the moments and the curve of the fingers.

The Brain (Microcontroller): Arduino Nano: The digital data is achieved when the signals in the analog pins from the sensors are converted using a small micro controller. Using VCC and GND power and pins the entire circuit is powered.

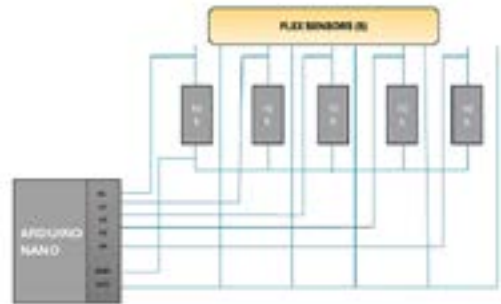


Diagram 3 Circuit Diagram

Resistance-Bend Tables for Specific Coded Words

Bend angle and resistance have a directly proportional relationship. The greater the angle, the greater the bend angle, and the lesser the actual bend. Based on the bend of each finger for a sign, the range of resistance values is observed from the serial monitor. Using this range, that is entered in the code to give that particular hand sign output. Thus each table is for a certain words. For each words, each fingers bend range is observed and then in the code, the word is given as output only when all fingers are in the bend range specified.

Table 1 Showing Resistance-Bend Table for Coded Word: Water



Resistance (k Ω)	Angle (degree)
320-500	100-170
130-190	30-80
320-490	100-165
193-380	85-125
180-195	60-90

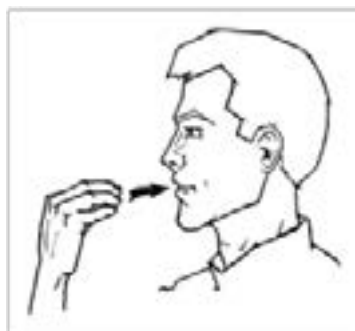
Table 2 Showing Resistance-Bend for Coded Word: Toilet



Resistance (k Ω)	Angle (degree)
170-375	65-120
500-640	170-250
600-680	200-300
375-510	120-180
130-180	45-90

Resistance Range (KΩ)	Angle Range (Degrees)	Observation
320–510	100–180	Mid-range movement.
330–490	110–160	Narrower subset of Range 1.
510–640	180–250	The highest resistance and widest angle (likely fully open or extended).
320–400	100–140	Lower-mid range.
130–180	30–70	The lowest resistance and smallest angle (likely the starting or "closed" position).

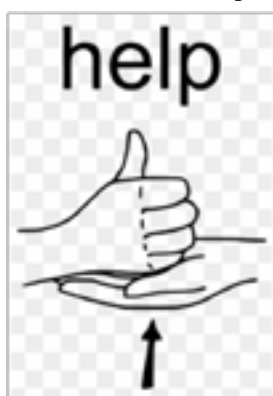
Table 4 The Coded Word: Food



Resistance (k Ω)	Angle (degree)
170-375	65-120
165-390	60-130
390-650	130-190
190-375	80-120
120-160	20-50

Table 1.4 showing Resistance-Bend table for coded word: Food)

Table 3 Showing Resistance-Bend Table for Coded Word: Help



Conclusion

This research study has successfully made a glove with the most basic configuration. It can be used as immediate help for persons who cannot afford higher end devices. It is coded for the basic words that any individual needs for everyday functioning, which strengthens daily living skills. The limitations here are the flex sensors, as they lose reliability over time, thus the bend–resistance values will start varying and output is not standard. This can be fixed by fabricating our own sensors using PVDF (Polyvinylidene Flouride). This will increase the reliability and life time of use, but the cost may increase significantly. Thus for future improvements, the sensor fabrication must be done without increasing the cost, then we can code for more words improving the functionality of the device.

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