Birla Institute of Technology & Science

Pilani Campus

presents

Web 3.0 Online Hackathon

Sign Language to Speech Convergence

a project by

CodeCyber

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Executive Summary

Human beings use communication, especially sound communication to express feelings, thoughts, and ideas. Sound communication is widespread and the most popular way of communication. Wider community uses sound communication to interact with each other. Without proper communication, they can't express their feelings or needs in an appropriate manner. It is only possible to make one understand via communication and sound communication is widespread and used by most of the global people. There is another side of the coin, not everyone on earth understands/expresses themselves using sound language properly. The fact is deaf-mute people are deprived of sound communication. Since deafmute people are deprived of using sound language it is a huge barrier for them to communicate and express their feelings or needs. Therefore, sound language is not appropriate for everyone and there are many people who neither speak sound language does not understand the opposite who use sound language. There is a huge communication gap these two groups of people who use sound communication and who are unable to use sound communication (usually deal-mute people). Instead of sound language, deaf-mute people are used to communication through sign language. By means of sign language deaf-mute people can express themselves to each other. Deaf-mute people can break the barrier of sound communication by means of sign language communication. Sign languages are used worldwide, and many people depend on sign language. Use of sign language is getting popular day by day and it's been a blessing for mute-deaf people.

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INTRODUCTION

Indian Census in 2011 estimated that over 26 million people suffer from some kind of disability that is equivalent to 2.1% of the total population. The most common types of disabilities are disability in movement (that accounts to 20.9%), hearing impairment (19.5%), and speech impairment (7.68%) [1]. People with speech impairment use sign language to communicate with the society.

Deaf-mute people need to communicate with normal people for their daily routine. The deafmute people throughout the world use sign language to communicate with other people. However, it is possible only for those who have undergone special training to understand the language. Sign language uses hand gestures and other means of non-verbal behaviour's to convey their intended meaning [9]. It involves combining hand shapes, orientation and hand movements, arms or body movement, and facial expressions simultaneously, to fluidly express speaker's thoughts. The idea is to create a sign language to speech conversion system, using which the information gestured by a deaf-mute person can be effectively conveyed to a normal person.

To bridge this communication, gap the method used is by using flex sensors that is attached to the glove that the user will wear, here we wish to eliminate this glove and the messy hardware that are introduced due to the use of flex sensors. Flex sensors are employed to monitor finger bends, accelerometers track hand motion, and contact sensors register finger interaction. The Arduino Uno processes the sensor data. This information is wirelessly transmitted via a Bluetooth module to mobile phones or computers. The text is then converted into speech through text-to-speech conversion software.

In this introduction, we will delve deeper into the intricacies of sign language to speech conversion using Arduino, exploring the underlying technology, the advantages it brings to both deaf and mute individuals, and the potential it holds in shaping the future of assistive technology for people with disabilities.

LITERATURE REVIEW

1) Vijayalakshmi, P., & Aarthi, M. (2016). Sign language to speech conversion. 2016 International Conference on Recent Trends in Information Technology (ICRTIT).

Abstract:

Human beings interact with each other to convey their ideas, thoughts, and experiences to the people around them. But this is not the case for deaf-mute people. Sign language paves the way for deaf-mute people to communicate. Through sign language, communication is possible for a deaf-mute person without the means of acoustic sounds. The aim behind this work is to develop a system for recognizing the sign language, which provides communication between people with speech impairment and normal people, thereby reducing the communication gap between them. Compared to other gestures (arm, face, head and body), hand gesture plays an important role, as it expresses the user's views in less time. In the current work flex sensor-based gesture recognition module is developed to recognize English alphabets and few words and a Text-to-Speech synthesizer based on HMM is built to convert the corresponding text.

2) Vishal, D., Aishwarya, H. M., Nishkala, K., Royan, B. T., & Ramesh, T. K. (2017). Sign Language to Speech Conversion. 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC).

Abstract:

Improvement in Science and Technology aims to better the world. The need for a comfortable and simplified life paves way to opportunities that can enhance the existing technology. The empowerment of differently abled will always stand as a priority. In this paper we propose the idea of a wristband that could convert sign (Hand gestures) to speech signals and enable the mute to enjoy the world in a better way. The wearable device uses the electrical impulses generated by movement of every finger to produce signs; each sign depicts a particular word. The band is a combination of wearable computer aided with sign to speech conversion techniques and a sensor suite. Compared to the existing methods, the proposed design provides a user-friendly experience and does not consider any specific parameter from the end user, this makes it a generalized band which can be worn by anybody. This would result in cost minimization when produced in large scale. The compactness of the design aims to provide more ease of usage.

3) Bhaskaran, K. A., Nair, A. G., Ram, K. D., Ananthanarayanan, K., & Vardhan, H. R. N. (2016). Smart gloves for hand gesture recognition: Sign language to speech conversion system. 2016 International Conference on Robotics and Automation for Humanitarian Applications (RAHA)

Abstract:

People with speech impairment find it difficult to communicate in a society where most of the people do not understand sign language. The idea proposed in this paper is a smart glove which can convert sign language to speech output. The glove is embedded with flex sensors and an Inertial Measurement Unit (IMU) to recognize the gesture. A novel method of State Estimation has been developed to track the motion of hand in three dimensional spaces. The prototype was tested for its feasibility in converting Indian Sign Language to voice output. Though the glove is intended for sign language to speech conversion, it is a multipurpose glove and finds its applications in gaming, robotics and medical field.

PROBLEM FORMULATION

The problem formulation for a sign language to speech converter involves defining the specific challenges and objectives of the project. Firstly, the system must accurately interpret and recognize sign language gestures, which often requires advanced techniques in image processing and computer vision. Once gestures are understood, the system must then translate them into understandable language. Subsequently, the translated language needs to be converted into spoken words through methods such as text-to-speech (TTS) technology. Integration with hardware devices, like cameras or microphones, is essential for capturing input and delivering output effectively. Additionally, attention must be given to user experience and interface design to ensure the system is intuitive for individuals communicating through sign language. Defining performance metrics, such as recognition accuracy and processing time, helps evaluate the system's effectiveness. Ultimately, the goal is to create a solution that is accessible and inclusive, meeting the diverse communication needs of users effectively. make point of it.

METHODOLOGY

The development of a Sign Language to Speech Conversion system, aimed at improving communication accessibility for the Deaf community. By utilizing sophisticated technology to interpret gestures and facial expressions, the system bridges the gap between sign language users and speakers of spoken languages.

Idle Mode: The system starts in idle mode, waiting for hand gestures or finger movements.

Gesture Detection: When a hand gesture is made, sensors detect the position and bending of each finger.

Sign Recognition: The microcontroller processes the sensor data and recognizes the sign based on pre-programmed logic.

Speech Output: If a sign is recognized, the system plays a corresponding sound through a speaker.

A) Block Diagram

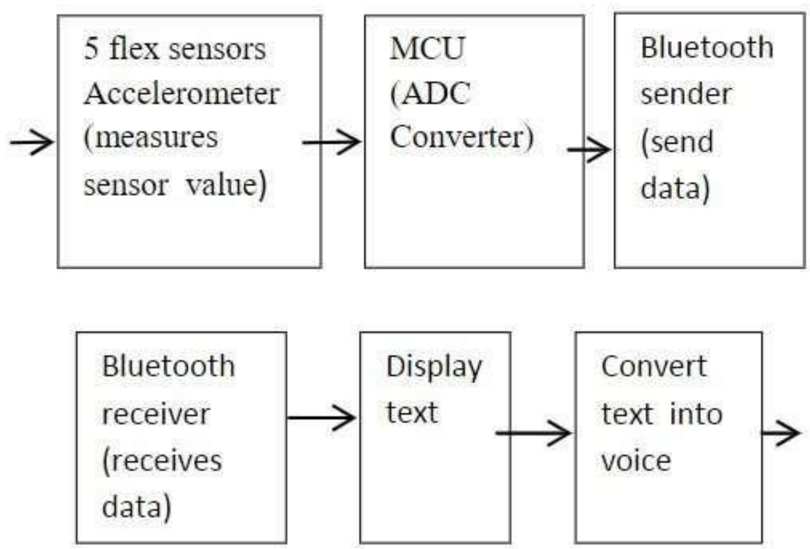

Fig. 2.1.1. Block Diagram

The overall functioning of the System is explained through the block diagram shown in figure. It represents the general order and hierarchy of various working blocks of the project. The person wears the glove which has flex sensors, contact sensors and accelerometer stitched to it and makes the gesture according to the American Sign Language (ASL). Arduino Uno is used to gather signals from the flex sensors and accelerometer placed on the glove. Then the processed output is Send via a Bluetooth link to an Android Smartphone or a Personal Computer consisting of test to speech software (application) and speech output is

B) Flow Chart

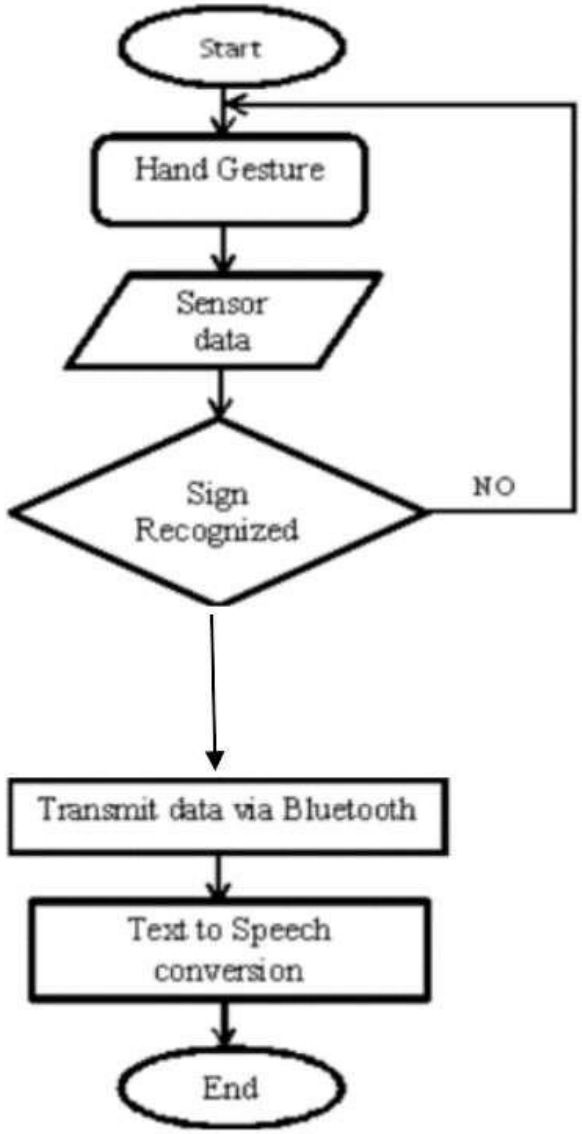

Fig. 2.1.4 Flow Chart

COMPONENTS DESCRIPTION

A) FLEX SENSOR

Flex sensor means flexible sensors, flexible sensor are sensors which change their resistance depending upon the bend on the sensor. The more the bend the resistance is also more. Flex sensor also works as variable analog voltage divider. Flex sensor consists of carbon resistive element within a thin flexible substrate. When the substrate is bent the resistive element produces a resistive output relative to the bend radius.

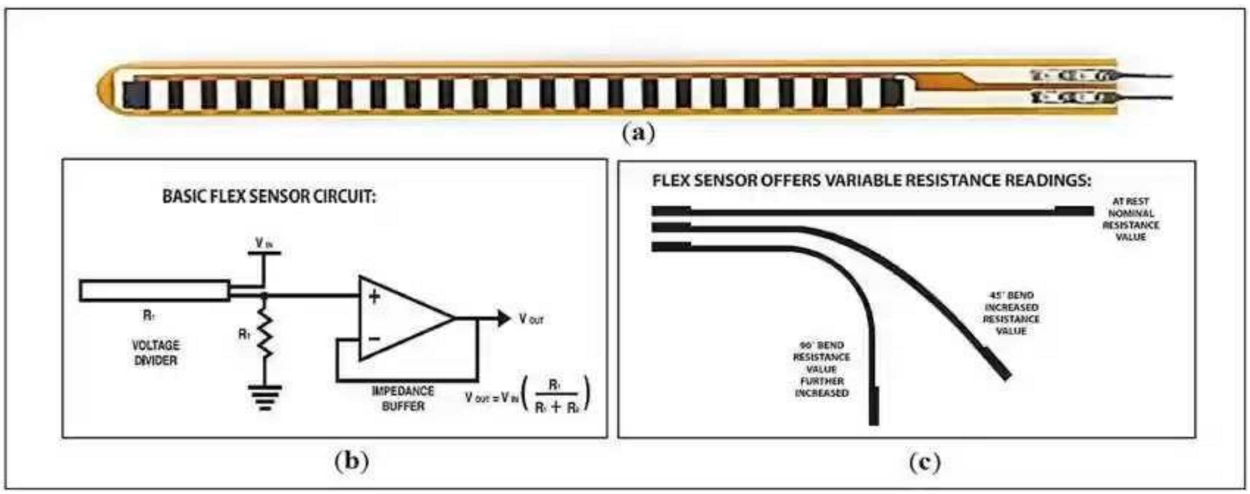

Fig. 3.1.2(2) Flex Sensor

The system consists of 5 flex sensors which are stitched on the fingers of the gloves because the main part of the gestures are fingers so for each finger a separate sensor is required. The hand gesture is inputted to the system via flex sensors the bent of each finger describes as shown in American Sign Language. As the fingers bends the sensors also starts bending and as the sensors bends the resistances also changes accordingly and that resistance value is inputted to the Arduino Uno.

B) ACCELEROMETER(ADXL338)

Fig. 3.2.1.(4) ADXL338

The accelerometer is a thin, small, low power. The accelerometer consists of 3-axis X, Y, Z the change in position of the accelerometer changes the output of the X, Y, and Z axis according to that output of the axis the gesture is recognized. The sensor measures the static acceleration of gravity in tilt-sensing applications and dynamic acceleration resulting from motion, vibration. The accelerometer contains a Polysilicon surface semicromachined structure built on top of silicon wafer. The sensor measures the deflection of the surface and gives the deflection corresponding to particular axis. The accelerometer is placed on the wrist to sense the bending motion. Connection of accelerometer to the Arduino

Output pin connected to one of the analog pin on Arduino

Vin pin is connected to 3.3V pin on Arduino

GND pin is connected to ground pin on Arduino

C) BLUETOOTH MODULE (HC 05)

Fig. 3.2.1.(3) Bluetooth Module

The Bluetooth module is used to transfer text data from Arduino to mobile phone/computer. The Bluetooth module sends serial data to the target device and the target device displays that data on the screen. The data send to the Bluetooth module is the alphabets, numerical values, etc these data is then serially transferred to the target device and displays the output and further software of speech conversion.

D) ARDUINO UNO

Fig. 3.2.1. (1) Arduino Uno

Arduino is electronics prototyping platform based on user-friendly software and easy-to-use hardware and it is available as an open source. Arduino runs on Mac, Windows, and Linux. Atmega328 is a microcontroller unit present in the Arduino board. Atmega328 has 14 digital I/O pins out of which 6 can be used for Pulse width modulation outputs, 6 for analog inputs. It also consists of 16 MHz crystal oscillator, a port for USB connection, a port for power jack, an ICSP header, and a reset button. It can be connected to a computer using an USB cable or by using an AC-to-DC adapter or by using a 9V battery. ATmega328 has 32 KB of flash memory module for storing the programming, out of which 2 KB is used by the bootloader. It has 2 KB of SRAM and 1 KB of EEPROM which can be read and write with the EPROM memory. Atmega328 microcontroller can be programmed using the Arduino programming language.

E) SIMULATION

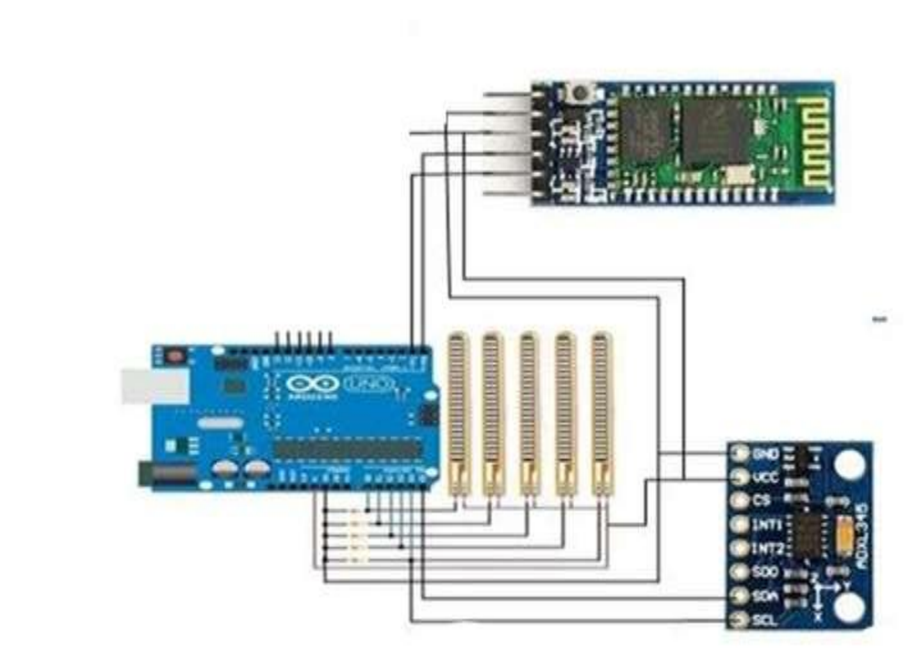

Fig. 2.1.2. Simulation

RESULTS

In this prototype system, the user forms a gesture and holds it approximately for 1 or 1.5 seconds to ensure proper recognition. Each gesture comprises of bending of all fingers in certain angles accordingly. Every bend of the sensor (finger) produces unique ADC value so that when different hand gesture is made, different ADC values are produced. A table of average ADC values for each sensor is maintained where F1, F2, F3, F4 and F5 represents the little finger, the ring finger, the middle finger, the index finger and thumb respectively.

Table 5.1: ADC values of each sensor (finger) for different gestures

Word	Flex1	Flex2	Flex3	Flex4	Flex5
OK	>745	>682	>722	>725	>335
Good	>740	>680	>700	<721	<335
Victory	<745	<682	>700	>721	<335
Smile	<745	<682	<722	>720	>335

Table no. 1

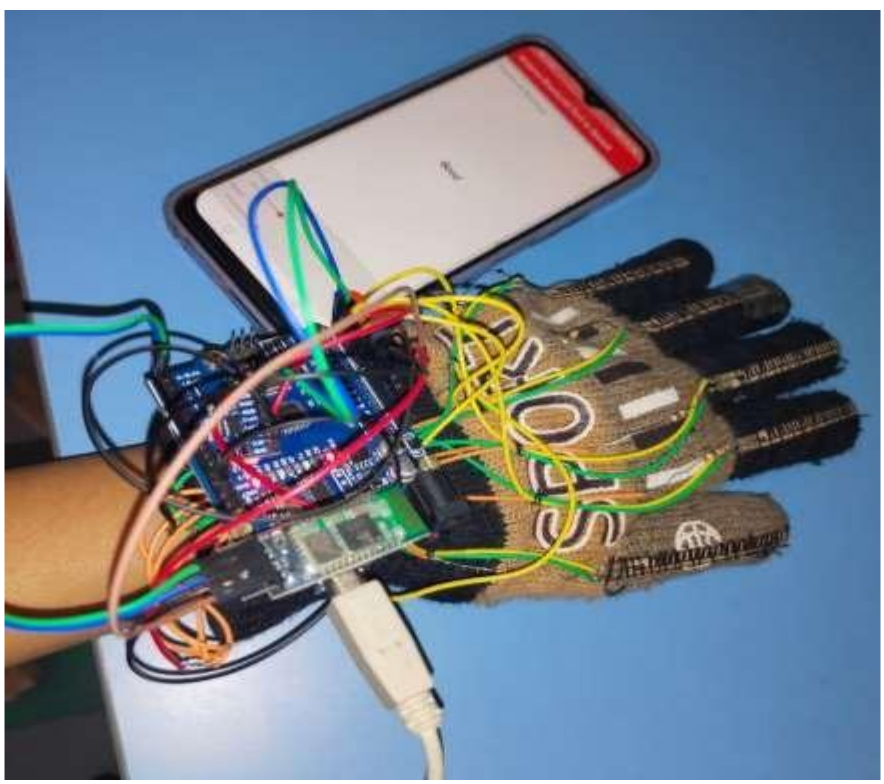

Fig. 2.1.3 Result Figure

CONCLUSION AND FUTURE SCOPE

CONCLUSION

This project is not only aimed at converting the sign language into voice, but also well known that inability to speak and hear is one major challenge for human race. To overcome these disabilities there are a lot of research and development going in different fields. This project aimed to minimize the major complexions in the system for further extensions, the sensor comes with the feature of gesture recognition and therefore the next phase of the project would be adding face recognition for capturing the expressions which in turn increases the productivity of the application by adding a little more accuracy. Also, for people with partial voice disabilities the speech recognition system will do the further enhancement in speech systems for the disabled people.

FUTURE SCOPE

Moving forward, the next phase of the project will focus on the incorporation of face recognition technology to capture expressions, thereby enhancing the accuracy and effectiveness of the application. This expansion will enable more nuanced and expressive communication, improving user engagement and satisfaction. Additionally, efforts will be directed towards further enhancing speech recognition systems to accommodate individuals with partial voice disabilities. By refining these features and functionalities, the system will continue to evolve as a comprehensive solution for enhancing communication accessibility. Furthermore, ongoing research and development will explore innovative approaches to address additional challenges and complexities, ensuring that the system remains adaptable and responsive to the diverse needs of its users. Through continued collaboration and innovation, we aim to advance the field of assistive communication technology and empower individuals with disabilities to communicate more effectively and participate fully in society.

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