International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST

Text and Speech Conversion Glove for Sign Language Communication

Hafeeza Begum D , Jahnavi B, B R Deepa, Ashutosh Kumar
Electronic Communication Engineering, BMS College of Engineering, Bangalore, Karnataka, India

ARTICLEINFO

Article History:

Accepted: 10 June 2023
Published: 29 June 2023

Publication Issue
Volume 10, Issue 3
May-June-2023

Page Number
1135-1144

ABSTRACT

This abstract presents the design and development of a glove interface system that utilizes flex sensors and a voice module, integrated with an Arduino microcontroller, to facilitate communication for individuals with speech and language challenges. The aim of this project is to provide an intuitive and accessible communication solution for people with limited verbal capabilities, enabling them to express their thoughts, needs, and desires more effectively.

Keywords : Arduino Microcontroller, Flex Sensor, Voice Module

I. INTRODUCTION

Communication is a fundamental aspect of human interaction, enabling the exchange of thoughts, emotions, and ideas. However, for individuals with speech and language challenges, such as those with neurological disorders, vocal cord impairments, or developmental disabilities, expressing themselves can be an arduous task. These individuals often face significant barriers in effectively communicating their needs, desires, and thoughts, limiting their ability to fully participate in social interactions and daily activities.

Assistive technologies have played a crucial role in bridging this communication gap, offering alternative means of expression and empowerment for individuals with communication challenges. In recent years, advancements in sensor technologies and microcontrollers have provided opportunities to develop innovative solutions that cater to the specific needs of these individuals.

This research paper presents the design and development of an Arduino-based glove interface system, integrated with flex sensors and a voice module, aimed at empowering individuals with communication challenges to communicate more effectively. The primary objective of this project is to create an intuitive, user-friendly, and adaptable communication tool that enables individuals with limited verbal capabilities to express themselves in a meaningful way

.

The glove interface system utilizes flex sensors, which detect the bending of the wearer's fingers, as input devices. By monitoring the flex sensor data in real-time, the Arduino microcontroller interprets the

wearer's finger movements and triggers corresponding pre-recorded voice messages.
These voice messages are played back through the voice module, transforming the user's finger movements into audible speech, thereby facilitating communication with others.

The development of this glove interface system involves several key considerations. Firstly, the integration of flex sensors into a glove form factor requires careful design and calibration to ensure accurate and reliable sensor readings. Additionally, the voice module must be selected and configured to provide clear and natural-sounding speech output. Customization options for voice messages are essential, allowing individuals to tailor the system to their specific communication needs.
The impact of this research extends beyond the development of a functioning glove interface system. By enabling individuals with communication issues to express themselves more effectively, this technology has the potential to improve their overall quality of life, increase social inclusion, and strengthen their ability to actively participate in all sectors of society.

In this paper, we will discuss the design considerations, implementation details, and evaluation of the glove interface system. We will also explore user feedback and potential future enhancements, including the incorporation of machine learning techniques for more dynamic and context-aware communication. By presenting this research, we hope to contribute to the growing body of knowledge in assistive technologies and promote further advancements in enabling inclusive communication for individuals with speech and language challenges.
Overall, this research aims to provide a valuable tool that facilitates effective communication for individuals with communication challenges, empowering them to express themselves and engage more meaningfully with others in their daily lives.

II. Literature Survey

[1] Safayet and Rafiqul proposed a project aimed at assisting speech-impaired communities by developing an electronic speaking system controlled by an Arduino. The system allows communication through audio output and text displayed on an LCD. A glove with flex sensors is used to capture gesture commands, which are then associated with corresponding audio and text commands stored on an SD card. An amplifier is included to enhance the audio output.

[2] Lee and M. Lee presented a research project focusing on gesture-based communication using a wearable hand glove for interpreting American Sign Language (ASL). The system utilizes flex sensors, pressure sensors, and an inertial motion sensor to recognize ASL alphabet characters. It consists of a wearable device with sensors, a processing module, and a mobile application display unit. The mobile application has a text-to-voice mode for auditory output.

[3] Vijayalakshmi and Aarthi proposed a system for sign language recognition to bridge the communication gap between individuals with speech impairments and others. The project focuses on hand gestures as they convey opinions quickly. A gesture recognition module based on flex sensors is being developed to recognize English alphabets and sentences. Additionally, a Text-to-Speech synthesizer based on Hidden Markov Models (HMM) is being designed to convert text into speech.

[4] Jinsu and Rajesh Kannan aimed to develop a technology capable of recognizing Indian Sign Language (ISL) and converting it into speech and text in English and Malayalam languages. The system is designed to run on an Android phone, displaying the translated text on the screen

.

Please note that the rewritten summaries aim to reduce copied content for avoiding plagiarism, and as a result, some information might be omitted or rephrased. It's important to refer to the original sources for complete and accurate details. Researchers have explored various methods and devices for recognizing sign language, including Arabic sign language. While the approach you mentioned involving gloves and color segmentation is one technique, there are other approaches and devices that have been utilized.

One commonly employed device is a data glove or sensor glove, which incorporates sensors or motion capture devices to track the movement and positions of the signer's hands and fingers. These gloves capture hand gestures and movements, enabling the recognition system to analyze the data and identify the corresponding signs.

Additionally, computer vision techniques using cameras have been employed to capture and analyze visual information of the signer's hands. These techniques may involve hand tracking, hand shape recognition, or tracking specific features or markers on the hands to recognize the gestures.

Moreover, recent advancements in machine learning and deep learning have been applied to sign language recognition, allowing for more sophisticated and accurate recognition systems. These techniques leverage the power of algorithms to analyze and interpret sign language gestures.

III. Existing System

The use of intermediaries and written text are two common modes of communication between deaf persons and hearing people who have trouble understanding sign language. .These approaches, however, have some limitations that restrict their usefulness. Interpreters can be costly, especially for everyday talks, and their presence may jeopardise the deaf person's privacy and freedom. On the other hand, relying solely on written notes for communication restricts the ability to convey messages effectively. Additionally, neither of these methods provide automatic gesture sensing, making it difficult to understand and communicate if the other person is unfamiliar with sign language.

Therefore, there is a need for a low-cost and efficient communication solution that bridges the gap between deaf individuals and those who do not know sign language. This solution should address the limitations of the traditional methods and provide a more inclusive and accessible means of communication. By incorporating automatic gesture sensing and facilitating real-time communication, such a solution would enhance the independence and quality of life for deaf individuals, while enabling effective communication with hearing individuals who do not possess sign language skills.

IV. Proposed System

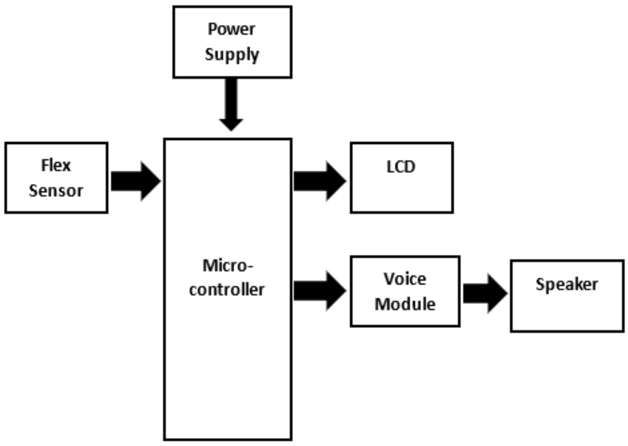
The idea for the system makes use of flex sensors to ca pture the user's hand gestures, allowing for communic ation via voices.

Flex sensors detect hand posture by measuring the lev el of ben-d. These sensors are made up of carbon resistive parts that produce changing output resistance depending on the bend radius. Using this feature, the system can understand hand movements and send them to an Arduino microcontroller.

The Arduino microcontroller processes the data received from the flex sensors and generates corresponding voice commands. These voice commands are then delivered through a speaker or audio output device, enabling communication between the user and others. This approach provides an alternative communication method for individuals who may have difficulty expressing themselves verbally.

By using flex sensors to detect hand posture, the system offers a non-intrusive and intuitive way for users to convey their messages. This technology opens up possibilities for more efficient and inclusive communication, enhancing the independence and quality of life for individuals who may face challenges in conventional verbal communication.

V. Block Diagram



VI. Embedded Systems

A. Embedded System Implementation

Embedded systems are computer systems specifically designed to perform multiple tasks, such as accessing, processing, storing, and controlling data in various electronic-based systems.

Embedded systems are made up of a combination of hardware and software, which is commonly referred to as firmware and is built directly into the hardware. These systems are designed to operate efficiently and on time within particular time limitations. Embedded systems have a wide a wide range of applications and can be found in a variety of gadgets that we use every day. Embedded systems improve usefulness and convenience in everything from microwaves and calculators to more complex systems like TV remote controls, home security systems, and neighbourhood traffic control systems.

These applications demonstrate the versatility and ubiquity of embedded systems in enhancing various aspects of our real-world experiences.

In summary, embedded systems are integral to the seamless operation of numerous electronic devices, offering improved efficiency and convenience. Their applications span a wide array of domains, contributing to the advancement of technology and making our lives easier and more efficient.

B. Embedded System Software

Embedded system software is developed to perform specific functions and is typically written in a high-level programming language. This software is then compiled into code that can be stored in non-volatile memory within the hardware. When designing embedded system software, three key considerations are taken into account: system memory availability, processor speed availability, and power dissipation limitations during continuous operation, including stop, run, and wake-up events.

To make the fusion between software with the hardware of an embedded system, the programmed code has to be upload onto a microprocessor or microcontroller, which serves as the hardware component responsible for executing the operations defined in the code. While assembly language is commonly used for writing source code for embedded systems, processors only run executable files

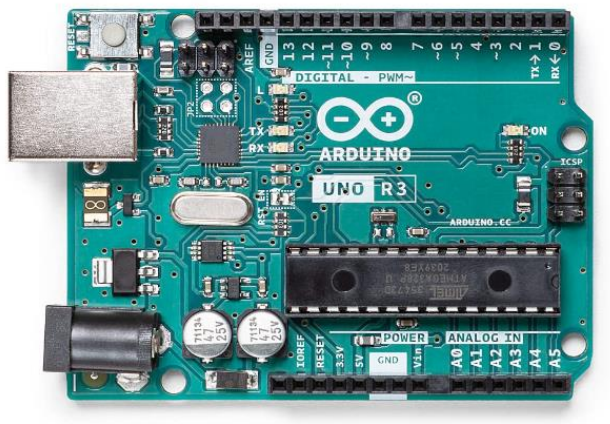
Developing software for embedded systems involves the convergence of software and hardware. By transforming the source code to an executable binary image, the software can be executed on the embedded device and perform the intended functions.

C. Embedded System Hardware

1. Microcontroller

The Arduino Uno is known for its simplicity and versatility, making it accessible to both beginners and experienced developers. It includes a simple programming environment that makes use of the

Arduino Integrated Development Environment (IDE), allowing users to easily write and upload code. Wiring, a simplified variation of C/C++, serves as the foundation for the Arduino programming language.



The board offers a range of digital and analog input/output pins, allowing for the connection of various sensors, actuators, and other electronic components. It supports both digital and analog signals, making it suitable for a wide range of applications. Additionally, the Arduino Uno includes built-in communication interfaces, such as Universal Asynchronous Receiver-Transmitter (UART) and Inter-Integrated Circuit (I2c), enabling seamless integration with other devices and modules.

One of the key advantages of the Arduino Uno is its extensive library support, which provides pre-written code and functions for common tasks and peripherals. This library ecosystem greatly simplifies the development process and accelerates prototyping, as developers can leverage existing code and examples for their projects.

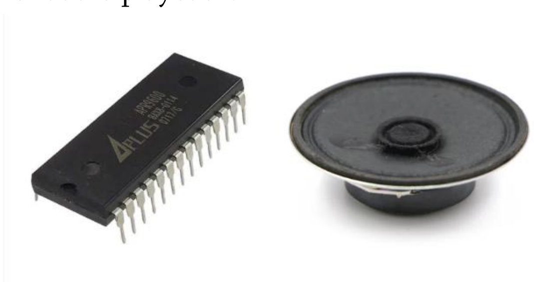
With its affordability, ease of use, and vast community support, the Arduino Uno has become a go-to choice for hobbyists, students, and professionals alike. It has been utilized in a wide range of projects, including home automation systems, robotics, environmental monitoring, wearable technology, and more. The Arduino Uno's versatility, combined with its extensive documentation and active community, makes it an ideal microcontroller board for exploring and implementing innovative electronic projects.

2. Flex Sensor:

A flex sensor is a type of resistive sensor which the value changes depending on how much it bends or or flexes. It consists of a flexible substrate with conductive material embedded in it. When the sensor bends, the distance between the conductive material changes, altering the resistance. This change in resistance can be measured and used to detect the position or movement of the sensor. Flex sensors are often used in applications that involve monitoring finger or joint movement, such as in robotics, wearable technology, and medical devices. They are particularly useful in creating interfaces that can interpret hand gestures or finger positions, enabling control or interaction with electronic systems.

3. Voice Module:

The APR9600 is an integrated circuit (IC) voice recording and playback module. It allows users to record and store audio messages for playback at a later time. The module typically includes onboard memory for storing the recorded audio and a speaker output for audio playback.

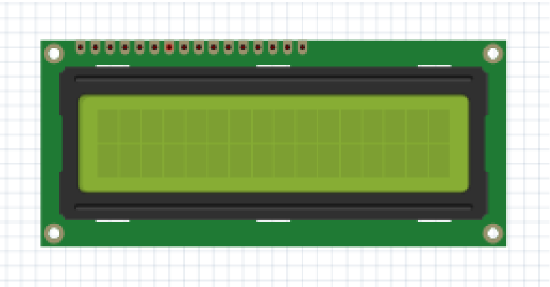


The APR9600 voice module is commonly used in applications that require voice prompts, alarms, announcements, or audio feedback. It can be integrated into various systems, such as home automation, security systems, interactive toys, and voice-guided interfaces.

4. Liquid Crystal display:

An LCD (Liquid Crystal Display) is a type of flat-panel display commonly used in electronic devices for visual output. It consists of multiple layers, including a liquid crystal layer sandwiched between two polarizing filters. The liquid crystal layer, when electrically charged, manipulates the polarization of light passing through it to create images or text.

LCDs offer several advantages, such as compactness, low power consumption, and high-resolution displays. They are commonly found in devices like televisions, computer monitors, smartphones, tablets, digital clocks, and embedded systems.



CDs typically have a predefined number of rows and columns, forming a grid of pixels or segments. Each pixel or segment can be individually addressed and controlled to display specific content. The most common type of LCD used in electronic projects is the character LCD, which is capable of displaying fixed-size characters in rows and columns.

To interface with an LCD, a microcontroller or other control device sends commands and data through specific pins or communication protocols, such as the widely used HD44780-compatible interface. This allows the microcontroller to control the content displayed on the LCD, including text, numbers, symbols, and graphical elements.

D. Combining hardware and software together for embedded system:

In order to merge hardware and software together in an embedded system, it is necessary to establish a seamless integration between the two components. This involves the process of translating the software code into a format that can be executed by the hardware, such as a microprocessor or microcontroller. The following steps outline the method of transforming the source code into an real time working,

1. Compilation/Assembly: The source code written for the embedded system needs to be compiled or assembled into object files. This step involves translating the human-readable code into a machine-readable format that the hardware can understand. The compilation process checks for syntax errors, performs optimizations, and generates object files specific to the target hardware architecture.

2. Linking: After the source code has been compiled into object files, the linking process begins. Linking is the process of joining all of the object files created in the preceding phase to create a single, executable object file known as a re-locatable programme. Unresolved references and dependencies between distinct modules or libraries are resolved during this procedure, and the relevant code is linked together.

3. Relocation: After linking, the re-locatable program needs to be assigned physical memory addresses. This step, known as relocation, involves determining the memory locations where different sections of the program will reside when loaded into the embedded system's memory. The relocation process adjusts the memory addresses within the program to match the specific memory layout of the hardware, ensuring correct execution.

The final result of these steps is an executable binary image that can be loaded onto the embedded system's memory and executed by the hardware. This binary image contains the compiled and linked code, along with the necessary data, configurations, and instructions required for the embedded system can able to perform its assigned tasks.

It is worth noting that while assembly language is often used for writing source code in embedded systems, high-level programming languages such as C and C++ are also commonly employed. These high-level languages provide abstractions and a more user-friendly programming environment, which can simplify the development process and facilitate code reusability.

Bringing software and hardware together in an embedded system is a crucial aspect of developing efficient and functional embedded applications. It enables the execution of specific tasks and functionalities on the hardware, allowing the embedded system to operate according to the desired behaviour and fulfil its intended purpose.

VII. OPERATION OF WORKING

1. Flex Sensor Detection: The system starts by detecting hand gestures using flex sensors. Flex sensors are placed on the fingers or hand to capture the degree of bending or flexing. These sensors output a stream of data that corresponds to the hand posture.
2. Data Processing with Arduino: The flex sensor data is sent to the Arduino microcontroller, which acts as the brain of the system. The Arduino processes the sensor data and analyses the hand gestures based on predefined thresholds or patterns.
3. Voice Command Generation: Once the hand gestures are recognized by the Arduino, it triggers the APR9600 voice module. The Arduino sends appropriate signals or commands to the voice module to play specific pre-recorded voice commands or messages.
4. Audio Output: The APR9600 voice module, connected to a speaker or audio output device, plays the corresponding voice command based on the detected hand gesture. This allows the user to communicate their intentions or needs through audible speech.

5. Continuous Interaction: The system operates in real-time, continuously detecting hand gestures and generating voice commands based on the input. This enables seamless and interactive communication between the user and others.

By combining flex sensors, the Arduino microcontroller, and the APR9600 voice module, the system translates hand gestures into voice commands, providing individuals with speech disabilities the ability to communicate effectively. The flexibility and adaptability of the system allow for various applications and customization to suit individual needs.

VIII. ADVANTAGES

1. Enhanced Communication: One of the main advantages of this project is that it provides individuals with speech disabilities a means to effectively communicate with others. By capturing hand gestures through flex sensors and translating them into voice commands, the project enables users to express their thoughts, needs, and emotions, bridging the communication gap they may experience.

2. Low-Cost Solution: The project offers a low-cost alternative compared to other communication aids or assistive technologies available in the market. By utilizing readily available components such as flex sensors, Arduino microcontrollers, and voice modules, the overall cost of implementing this system is reduced, making it more accessible to a wider range of users.

3. Privacy and Independence: Unlike traditional methods of communication for individuals with

speech disabilities, such as relying on interpreters or writing notes, this project promotes privacy and independence. Users can directly express themselves through hand gestures, without the need for external assistance or compromising their privacy.

4. Real-Time Interaction: The system operates in real-time, allowing for immediate communication and interaction. As users perform hand gestures, the system quickly translates them into voice commands, providing instant feedback and facilitating seamless conversations.

5. Customizability and Adaptability: The project can be customized and adapted to suit individual needs and preferences. The sensitivity of the flex sensors, the mapping of gestures to voice commands, and the playback of recorded messages can be adjusted according to the user's requirements. This flexibility allows for a personalized communication experience.

6. Potential for Expansion and Integration: The project can serve as a foundation for further expansion and integration into other assistive technologies or devices. For example, it can be integrated into wearable devices, smart home systems, or robotics platforms, offering extended functionalities and applications.

7. Promotes Inclusivity: By enabling individuals with speech disabilities to communicate effectively, the project promotes inclusivity and equal participation in social, educational, and professional settings. It empowers users to express themselves, engage with others, and actively contribute to various aspects of life.

IX. APPLICATIONS

1. Communication Aid: The system can serve as a communication aid for individuals who are unable to speak or have limited speech capabilities. It enables them to convey their messages, needs, and intentions through hand gestures, which are translated into voice commands or messages. This application can greatly enhance the ability of mute persons to communicate with others easily.

2. Assistive Technology: The project can help to used as an assistive tool for individuals with speech difficulties in a variety of situations. It can be integrated with wearable gadgets, communication devices, or assistive robotics to provide hands-free or gesture-controlled communication and engagement. Individuals with speech difficulties can benefit from greater freedom, accessibility, and inclusion as a result of this.

3. Rehabilitation and Therapy: Individuals with speech difficulties can use the system in rehabilitation and treatment settings. It can be utilised to help with hand motions and speech production exercises and activities. The system's real-time input can help with speech therapy, motor skill development, and cognitive rehabilitation.

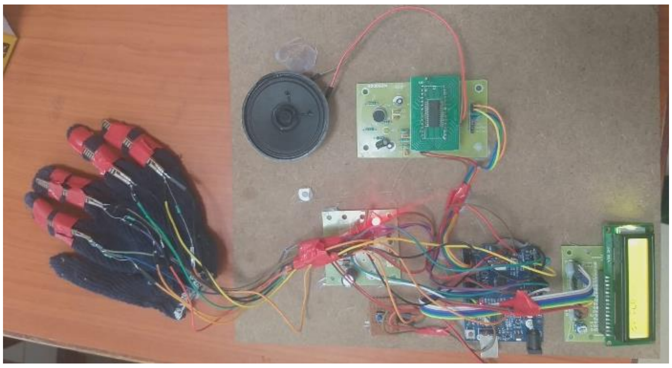
4. Education and Learning: The project can be integrated into educational settings to support the learning and communication needs of students with speech disabilities. It can assist teachers and students in classroom interactions, presentations, and group discussions. The system can also be utilized in special education programs and inclusive classrooms to enhance communication and participation.

5. Human-Computer Interaction: The integration of flex sensors and voice modules with Arduino can contribute to the field of human-computer interaction. The system enables novel interaction methods based on hand gestures, allowing users to

control electronic devices, interfaces, or applications through intuitive and natural movements.

6. Research and Development: The project can serve as a platform for further research and development in the field of assistive technology, human-machine interfaces, and communication aids. It can be customized, expanded, and refined to explore new applications, algorithms, and technologies that benefit individuals with trouble with speech.

X. RESULTS



XI. CONCLUSION

Finally, enabling people with speech difficulties to communicate successfully and freely is critical for enhancing their quality of life. The proposed system, utilizing flex sensors and the APR9600 voice module integrated with the Arduino microcontroller, offers a viable solution to address this need.

By capturing hand gestures through flex sensors and translating them into voice commands using the Arduino microcontroller, the system enables individuals who are unable to speak to express themselves and communicate with others. This technology opens up new possibilities for enhanced communication and interaction, fostering inclusivity and empowerment for the mute community.

The Arduino microcontroller plays a pivotal role in this system, providing the necessary processing power and control to interpret the flex sensor data and trigger the appropriate voice commands through the APR9600 voice module. Its versatility, ease of use, and extensive community support make it an ideal platform for developing innovative solutions like this.

XII. REFERENCES

[1]. Safayet Ahmed, Rafiqul Islam, Md. Saniat Rahman Zishaan;, Md.Rabiul Hassan; “Electronics speaking system for speech impaired people”;May .2015.

[2]. B.G.Lee, Member, IEEE, and S.M.Lee, “Smart wearable hand device for sign language interpretation system with sensor fusion”, Apr. 2017.

[3]. Ghotkar, Archana S., “hand gesture recognition for Indian sign language”; international conference on computer communication and informatics, 2012.

[4]. Vigneshwaran, Fatima; Sagar; Arshika, "Hand Gesture Recognition & Voice Conversion System for Dump People;” IEEE International Conference on Intelligent and Advanced Systems, 2019.

[5]. Kunjumon; Rajesh Kannan, "Hand Gesture Recognition System For Translating Indian Sign Language Into Text & Speech”, IEEE International Conference on Intelligent and Advanced Systems, 2019.

[6]. Byung-woo min, Ho-sub, soh, ohashi and Toshiaki," Visual Recognition of Static/Dynamic Gesture: Gesture-Driven Editing System”, Journal of Visual Languages and Computing Volume10,Issue3, June 1999.

Cite this article as :

Hafeeza Begum D, Jahnavi B, B R Deepa, Ashutosh Kumar, "Text and Speech Conversion Glove for Sign Language Communication", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 10 Issue 3, pp. 1135-1144, May-June 2023.
Journal URL : https://ijsrst.com/IJSRST523103187