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SIGN LANGUAGE TO SPEECH CONVERSION USING ARDUINO

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Abstract: This innovative initiative in India represents a significant leap forward in addressing communication barriers for the deaf population. The glove-based device, integrating flex sensors and an Arduino Nano control unit, facilitates the recognition of intricate sign language gestures. The system's ability to convert these gestures into text, displayed on an LCD, demonstrates a tangible bridge between sign language and written communication. The wireless transmission of information to a PC or cellular phone for subsequent text-to-speech conversion underscores the adaptability and potential widespread use of the technology. Moreover, the ongoing prototype development indicates a commitment to expanding the system's capabilities beyond basic alphabets and numeric characters. This forward-looking approach suggests a vision for a comprehensive communication tool that can accommodate a broader range of sign language expressions and linguistic nuances. Additionally, the initiative's impact extends beyond individual communication, potentially influencing societal perceptions and inclusivity. The incorporation of machine learning and continuous improvement in gesture recognition algorithms could further enhance the system's accuracy, promoting a more seamless and natural interaction between the deaf community and the larger population. Overall, this groundbreaking initiative not only addresses immediate communication challenges but also sets the stage for a more inclusive and technologically advanced future for individuals with hearing impairments in India.

Keywords – Sign language, Arduino, ASL, Sound Glove, Dumb, Gesture recognition, Deaf, Flex.

I. INTRODUCTION:

Sign language serves as a natural mode of communication for individuals facing challenges with hearing and speech. Nevertheless, comprehension can pose difficulties for those unfamiliar with sign language. The proposed glove system aims to ease communication for individuals who are deaf or mute by translating hand gestures into both text and speech.

This innovative solution seeks to improve the efficiency of communication between the deaf and the hearing population. Derived from American Sign Language (ASL), the gloves utilize flex sensors, accelerometers, and contact sensors to accurately capture intricate gestures.

Flex sensors are employed to monitor finger bends, accelerometers track hand motion, and contact sensors register finger interaction. The Arduino Nano processes the sensor data and displays recognized gestures as text on an LCD. 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. Despite ongoing research, there is currently no commercially available system that offers a portable, efficient, and highly accurate solution for converting sign language into speech.

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.

II. EXISTING SYSTEM:

The Myo armband, developed by Thalmic Labs (now owned by North Inc.), is a gesture control device that can capture hand and arm movements. While it is not specifically designed for sign language, developers have explored its use in creating applications for sign language recognition.

Leap Motion is a hand-tracking device that can capture hand and finger movements in 3D space. Developers have experimented with using Leap Motion for sign language recognition and gesture-based interfaces.

The Kinect sensor, initially developed for gaming, has been used for various applications, including sign language recognition. Its ability to capture depth and motion makes it suitable for tracking hand gestures.

Some researchers and developers have explored the use of wearable devices equipped with sensors, such as gloves or bracelets, to capture hand movements for sign language recognition.

Several mobile applications have been developed to translate sign language into text or speech. These apps often use smartphone cameras for gesture recognition.

Academic and research institutions have developed prototypes for sign language recognition using a combination of sensors and machine learning algorithms. These prototypes may not be commercially available but contribute to the ongoing research in the field.

III. PROPOSED SYSTEM:

The system's overall operation is elucidated through the block diagram depicted in the figure. This diagram outlines the sequential order and hierarchy of the various functional blocks within the project, aiming to provide a responsive and user-friendly interface.

To engage with the system, an individual wears a glove equipped with flex sensors, contact sensors, and an accelerometer. The person then performs gestures based on the American Sign Language (ASL). The Arduino Nano serves as the central processing unit, collecting signals from the flex sensors and accelerometer integrated into the glove.

Subsequently, the processed output is conveyed through two channels: firstly, it is displayed on an LCD to present the text output, and secondly, it is transmitted wirelessly via Bluetooth to either an Android Smartphone or a Personal Computer. The receiving end of this transmission comprises text-to-speech software or application, facilitating the conversion of the displayed text into audible speech output. This dual-channel communication setup enhances the accessibility and usability of the system.

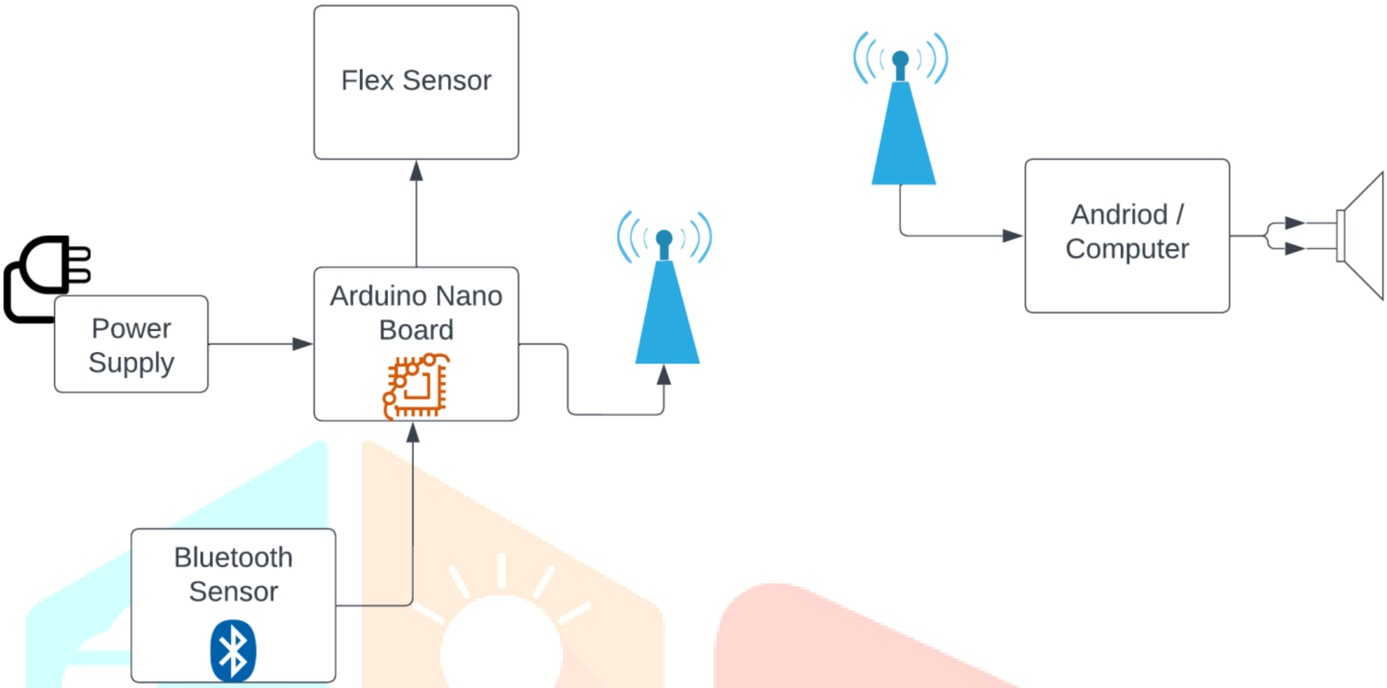

Fig 3.1 Architecture of our system

3.1 COMPONENTS REQUIRED:

- ARDUINO NANO
- FLEX SENSOR
- BLETOOTH SENSOR
- Accelerometer (ADXL338)
- POWER SUPPLY
- ANTENNA
- DEVICE
- SPEAKER

IV. HARDWARE DESCRIPTION:

1. ARDUINO:

Arduino / Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input / output pins (of which 6 can be used as PWM labors), 6 analog inputs, a 16 MHz quartz demitasse, a USB connection, a power jack, an ICSP title and a reset button. It contains everything demanded to support the microcontroller; simply connect it to a computer with a USB string or power it with an AC-to-DC appendage or battery to get started. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an expansive list of current, once or outdated boards see the Arduino indicator of boards. The Figure4.1 shown is the Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an expansive list of current, once or outdated boards see the Arduino indicator of boards.

1. PINS General Pin functions:

General-purpose input/output (GPIO) pins are pins on a microcontroller that can be configured as either inputs or outputs. This allows the microcontroller to interact with a wide variety of external devices.

Fig 4.1 PINS General Pin functions

1.2 TECHNICAL SPECIFICATIONS:

- IC Microchip ATmega328P (8- bit AVR core)
- Clock Speed 16 MHz on Uno board, though IC is able of 20 MHz max at 5 Volts
- Flash Memory 32 KB, of which0.5 KB used by the bootloader
- SRAM 2 KB
- EEPROM 1 KB
- USART peripherals 1 (Arduino software dereliction configures USART as an 8N1 UART)
- SPI peripherals 1
- I ² C peripherals 1
- Operating Voltage 5 Volts
- Digital I/ O Pins 14
- PWM Pins 6 (Pin# 3, 5, 6, 9, 10 and 11)
- Analog Input Pins 6
- DC Current per I/ O Pin 20 mama
- DC Current for3.3 V Pin 50 mama
- Size68.6 mm x53.4 mm
- Weight 25 g
- ICSP header: Yes

2. BLUETOOTH SENSOR:

Bluetooth is a short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances and building personal area networks (PANs). In the most widely used mode, transmission power is limited to 2.5 milliwatts, giving it a very short range of up to 10 metres (33 ft). It employs UHF radio waves in the ISM bands, from 2.402 GHz to 2.48 GHz. It is mainly used as an alternative to wired connections to exchange files between nearby portable devices and connect cell phones and music players with wireless headphones.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as IEEE 802.15.1 but no longer maintains the standard. The Bluetooth SIG oversees the development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device.[5] A network of patents applies to the technology, which is licensed to individual qualifying devices. As of 2021, 4.7 billion Bluetooth integrated circuit chips are shipped annually.

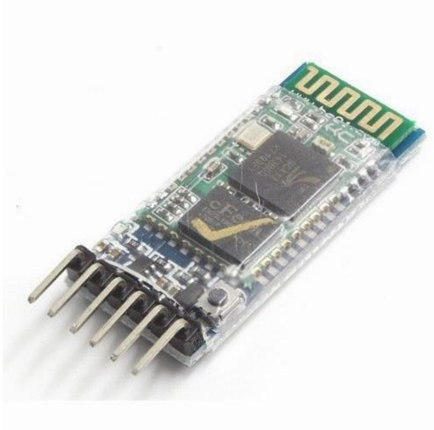

Fig 4.2 Bluetooth Sensor

3. 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 work 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. 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 Nano.

4. LCD unit:

It's a flat panel display, electronic visual display, or videotape display that uses the light modulating parcels of liquid chargers. An TV (Liquid Crystal Display) unit is a type of flat-panel display technology extensively used for visual affair in colorful electronic bias. It consists of a grid of liquid demitasse motes placed between two concentrated glass pollutants.

Fig 4.4 LCD unit

5. ESP8266:

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

Fig 4.5 Esp8266-based Node MCU Development Modules

5.1 FUNCTIONS:

ESP8266 has numerous operations when it comes to the IoT. Then are just some of the functions the chip is used for:

6.1.1 Networking:

The module's Wi- Fi antenna enables bedded bias to connect to routers and transmit data.

6.1.2 Data Processing:

Includes processing introductory inputs from analog and digital detectors for far more complex computations with an RTOS or Non-OS SDK.

6.1.3 P2P Connectivity:

Produce direct communication between ESPs and other bias using IoT P2P connectivity.

6.1.4 Web Server:

Access runners written in HTML or development languages.

6. Accelerometer Sensor (ADXL338):

An LDR sensor, or Light Dependent Resistor sensor, is a type of passive electronic component that changes its resistance in response to changes in light intensity. An LDR (Light Dependent Resistor) sensor, also known as a photoresistor, is an electronic component that changes its resistance based on the intensity of light incident upon it. This sensor comprises a semiconductor material whose conductivity varies with light levels. When exposed to light, the resistance of the LDR decreases, allowing more current to flow through it; conversely, in darkness, its resistance increases, restricting the current flow.

Fig 4.6 Accelerometer Sensor

V. SOFTWARE REQUIREMENTS:

5.1 MIT App Inventor:

It is an application which is used to prepare android applications. In the inventor application all the components that an android phone consists are available like buttons, text boxes, etc, Sensors like accelerometer, barcode detector, location sensor, etc, social things like email, texting, twitter, etc, connectivity like Bluetooth, activity starter, web, etc. The app is used develop the application for text to speech conversion. In that application the device like android phone or computer is connected to the Bluetooth module of the device through Bluetooth connectivity of the device. After connecting to the system serial data is received and we get text to speech output.

VI. SIMULATION OUTPUT:

Fig 6.1 System Prototype

Fig 6.2 Final Prototype

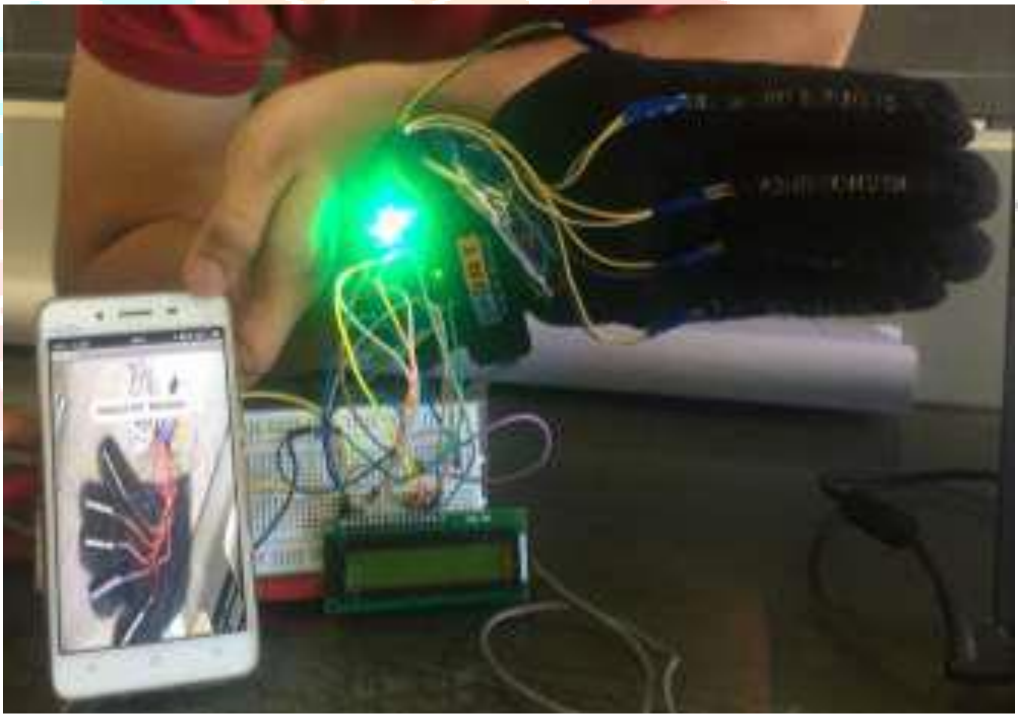

Fig 6.3 System with android application

VII.CONCLUSION:

The system serves as a vital link between individuals with hearing and speech impairments and those without, acting as a bridge to fill communication gaps. The gloves, designed to be independent and portable, boast minimal weight and low power consumption, ensuring practicality and ease of use for users. The primary function of the system is to convert hand gestures, particularly those derived from sign language, into text and subsequently into speech. This multi-step conversion process facilitates seamless communication between individuals who are deaf or mute and those who are not.

Notably, the system goes beyond oral communication by incorporating a text provision for situations where auditory perception may be limited. This feature ensures that even in conditions where the person may be unable to hear the generated speech, they can still comprehend and respond to the communicated message through visual text representation. By providing this comprehensive approach to communication, the system aims to break down barriers and enhance understanding between individuals with diverse communication abilities. The emphasis on portability, lightweight design, and alternative communication modes underscores the system's commitment to fostering inclusivity and accessibility in interpersonal interactions.

VIII. RESULT AND DISCUSSION:

8.1 RESULT:

The above system provides with conversion of Sign gestures to a limited scope; recognition of alphabets from A-Z and numeric's from 0-9. It displays the output on a LCD screen and sound output is obtained on the android Smartphone which is still in process. Hardware setup is show in the figure which shows the general components used in the system i.e. Arduino Nano, flex sensors, LCD, Bluetooth device HC-05, Accelerometer shows the initial prototype of the system. Initially the glove was made of net fabric and the sensors were stitched on it. The glove was not giving the accurate value as it should be.

And as we have stitched the sensor on the net the fabric started tearing so due to which the output was not accurate. The net gloves were also having a problem of fitting. To overcome to the problem, we have replaced the net gloves with cotton gloves and stitched the sensors and Arduino nano board with LCD display and Bluetooth module is stitched on the cotton glove. The whole PCB of Aurdino nano and Bluetooth module is fitted on the glove with the help of belt stitched on the glove as shown in figure 12(a). The belt on the glove provides perfect fitting to the user and also fits the whole circuit on the glove.

The whole system (gloves, LCD, android application on android phone). As shown in the figure the gloves are connected and software is installed on the android phone which looks as shown in figure. On the application the block "Select BT module" is selected and then the list of available Bluetooth device is displayed select the Bluetooth device having name "HC-05" and connect the android phone to the circuit. The output is then received on the screen in red color and also in the audio format. The figure 14 shows the output of alphabet "B" as shown in figure 1 the following gesture indicates the letter B.

The sensor (flex) value for fingers index, middle, ring, pinky is 255 whereas the sensor(flex) valve for thumb is below 100. When these conditions are satisfied then only the alphabet B will be displayed on LCD and via Bluetooth on android phone and then speech output is obtained. Accordingly, the output of letters "A, C, D, E, F, H, I, M, W" if successfully achieved.

7.2 DISCUSSION:

The Sign Language to Speech Conversion System utilizes a glove with flex sensors, contact sensors, and an accelerometer, integrated with Arduino Nano for real-time interpretation of American Sign Language (ASL) gestures. Bluetooth connectivity enables communication with Android smartphones or PCs, displaying text on an LCD and converting it to speech through a text-to-speech application.

The system aims to enhance communication for individuals with hearing and speech impairments, providing a responsive and user-friendly interface. While impactful, ongoing research can further refine gesture recognition accuracy and address challenges, ensuring the system's positive impact on inclusivity and accessibility in communication technology.

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