JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

MULTI-PURPOSE SMART GLOVE FOR DIFFERENTLY ABLED COMMUNITY PEOPLE

[1]Aaryesh Mane, [2]Naveen Junjur, [3]Shlok Shetty, [4]Yuvraj Manchadi, [5]Prof. Viplav Soliv
[1,2,3,4]Student [5]Profressor
[1,2,3,4,5] Department of Electronics and Telecommunication Engineering
[1,2,3,4,5] Rajiv Gandhi Institute of Technology, Mumbai, India

Abstract— This research presents a transformative leap in assistive technology with the introduction of the "Multi-PurposeSmart Glove," a paradigm-shifting innovation designed to enhance the lives of differently-abled individuals. Focused on facilitating interaction between deaf and hard-of-hearing individuals and the general public, the Smart Glove converts sign language gestures into easily understandable text and speech synthesis. Beyond communication, this portable solution extendsits capabilities to managing home appliances and monitoring health. The Smart Glove's multi-functional approach aims to empower individuals with special needs, offering seamless transitions between modes to promote greater independenceand a more accessible lifestyle.

***IndexTerms* - Smart Gloves, Sign Language, Sensors, Home automation.**

I. Introduction

Sign languages serve as a vital means of communication for the deaf and hard-of-hearing community, extending their utility to individuals who, while capable of hearing, may face challenges in speech. This project endeavors to overcome communication barriers between individuals with special needs and the broader population through the introduction of an innovative system. The focal point of our approach is the expression of words facilitated by glove gestures and finger bending, a process captured by flex sensors. These analog signals are seamlessly converted into digital data using an Arduino Nano, then transmitted via Bluetooth to a smartphone for real-time word display. Additionally, the digital signals are forwarded to an RF module, enhancing the system's versatility by incorporating home automation functionalities.

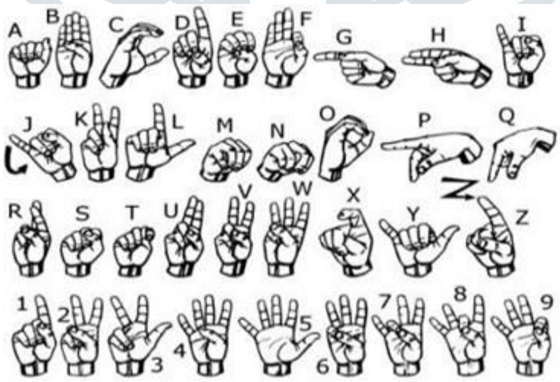

Fig. 1. American Sign Language

Noteworthy in our project is the integration of a health monitoring feature, leveraging a heart rate sensor that continuously captures user data. This health information is then conveniently displayed on the user's smartphone, contributing to a comprehensive and user-centric assistive technology solution. In contrast to prevalent vision-based gesture recognition systems that rely on cameras, our sensor- based approach prioritizes accuracy. This evolution in gesture recognition technology promises a significant advancement in augmenting the expressive capabilities of differently-abled individuals. As we delve into the details of our system's de- sign, functionality, and impact, we anticipate a transformative contribution to the field of assistive technology.

II. Literature Survey

The utilization of IoT-based smart assistance gloves for individuals with disabilities, proposed by [1], involves a data glove method with flex sensors to tackle communication obstacles encountered by those with vocal and hearing impairments. Through the utilization of wireless serial port modules and GSM modules, the system facilitates efficient data transmission and emergency notifications, underscoring the significance of innovative assistive technologies in promoting autonomy. Within India, a population exceeding three million individuals confront hearing challenges, while more than two million individuals cope with speech disorders, underscoring the extensive prevalence of these impairments [2]. With the objective of addressing communication hurdles for the deaf and mute population, [3] recommends the creation of a gesture recognition framework employing a specially designed data glove. This framework seeks to convert sign language gestures into coherent English letters and words promptly, thereby enhancing communication skills and overall quality of life for differently abled persons. Similarly, a groundbreaking sign-to-speech/text mechanism for those with hearing and speech impairments is introduced by [4], utilizing a transmitter-receiver configuration with flex sensors that capture Arabic sign language gestures. Pioneering solutions for gesture management of household gadgets using flexible sensors and an Arduino microcontroller are examined by [6], providing simplicity, efficacy, and wireless control for individuals with disabilities. Additionally, [8] accentuates various strategies for bridging communication divides between the deaf-mute community and others, with a focus on gesture recognition frameworks. Techniques under scrutiny encompass glove-based methods that utilize flex sensors, tactile sensors, and accelerometers for gesture interpretation, with potential uses in household automation and interactive gaming. Moreover, a study investigating the fusion of sensor gloves and computer technology to educate children in Australian Sign Language, as put forth by [9], leverages tactile and flexible sensors to detect markings and furnish details regarding hand configuration. By formulating hardware components like gloves with sensor compartments and software modules for data refinement and categorization, this study confronts the distinct challenges of instructing sign language, contributing to the progression of assistive technologies for education and communication. [7] scrutinizes a variety of technologies aimed at bridging the communication abyss for the deaf-mute community, encompassing smart gloves with bend sensors, accelerometers, and Bluetooth for gesture recognition, alongside image processing techniques and computer vision algorithms for gesture interpretation, with potential uses in household automation and interactive gaming. [5] delves into a novel sign language interpretation system that utilizes wearable sensors and machine learning algorithms to attain exceptional precision in recognizing American Sign Language gestures. This investigation underscores the promise of wearable sensor technology in facilitating instantaneous interpretation and communication for the deaf and mute community.

III. METHODOLOGY

This study concentrates on improving the translation of American Sign Language (ASL) by employing a three-phase strategy: sensor recognition, processing, and display/listening. The central element is the flex sensor, which is a variable resistor sensitive to bending. One flex sensor is designated for the thumb, while four are allocated for the remaining fingers, displaying increased resistance when bent. The Transmitter segment, which includes the Arduino Nano, acquires input from the flex sensors. Specific hand positions activate sensor values, which are then converted to voltage and processed by the microcontroller. Alphabets and words are recognized based on predetermined ranges, sent wirelessly, and exhibited with audio feedback on a mobile device. Expanding on this idea, the integration of gestures for appliance control through relay-connected microcontrollers is implemented in home automation. Addressing the lack of significant advancements for individuals with disabilities, this project introduces smart assistance gloves that utilize flex sensors. Instructions are inserted into an Arduino Uno, capturing finger gestures for presentation in an Android application and audio feedback. Sensor values are wirelessly transferred to a mobile device using an NRF transceiver, eliminating the need for an LCD. The microcontroller interprets the sensor data, converting changes in resistance to voltage. Alphabets and words are recognized within defined ranges, ensuring precise ASL translation. Moreover, this concept extends to home automation, allowing gesture-controlled operation of appliances via relay-connected microcontrollers. To further enhance accessibility and user experience, continuous refinement and optimization of the ASL translation system are prioritized, integrating feedback from users with disabilities. Additionally, ongoing research and collaboration with experts in assistive technology contribute to the evolution of this innovative solution, addressing emerging challenges and advancing inclusivity. Through iterative development and community engagement, the smart assistance gloves aim to empower individuals with disabilities by providing efficient communication tools.

A. BLOCK DIAGRAM

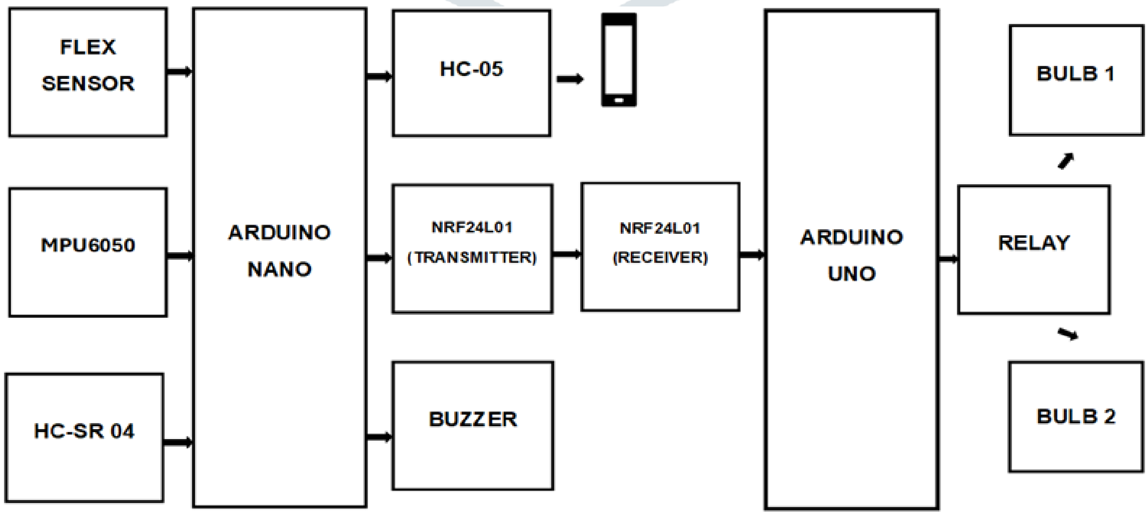

Fig. 2. Block Diagram

The main goal of this study is to enable individuals with hearing and speech impairments to effectively convey their basic needs. The system employs smart gloves equipped with flex sensors to capture finger movements, translating them into commands. Each finger is equipped with a total of five flex sensors, which are piezoresistive and exhibit resistance changes as the joints bend. The flex sensors, serving as variable resistors, play a crucial role in the system. As these sensors detect bending and deflection, the resistance increases proportionally. A voltage divider design is utilized to convert the resistance values of the flex sensors into voltage. The Arduino Nano, positioned on the transmitter side, receives these values through its analog pins. To enhance the accuracy of the flex sensor readings, a customized filter is employed to suppress fluctuating values and ensure consistency. Acting as the central processing unit, the Arduino Nano stores and processes this information. Additionally, the system integrates a Bluetooth module for wireless communication between the Arduino Nano and the Android application. The Android application, developed specifically for this study, functions as a user interface where the interpreted commands are visually and audibly displayed. The Arduino Nano wirelessly transmits the detected signs to the Android device, enabling real-time communication. The mobile application not only showcases the interpreted signs but also allows for speech output, enhancing accessibility. Furthermore, the system expands its capabilities to include home automation and health monitoring. Through gesture recognition, users can manage appliances linked to relays, activating or deactivating them based on specific gestures. Moreover, health monitoring entails tracking the user's pulse using a pulse sensor, with the data sent to the Android application via an HC-05 module. To ensure robustness and reliability, extensive testing and calibration procedures are conducted to fine-tune the flex sensors' sensitivity and responsiveness. This meticulous approach guarantees accurate translation of finger movements into actionable commands, enhancing the user experience. Additionally, continuous updates and refinements to the Android application are implemented based on user feedback, ensuring seamless integration and optimal functionality. The system's versatility is further enhanced through periodic software updates, introducing new features and improving overall performance. Collaborative efforts with experts in the field of assistive technology contribute to ongoing advancements, fostering inclusivity and empowerment for individuals with hearing and speech impairments.

IV. Results And Discussion

The project effectively illustrated the proficiency of the smart glove system in translating sign language gestures into corresponding letters and exhibiting them on a mobile device. This successful demonstration highlighted the system's ability to accurately identify the sign for the letter "B" by utilizing flex sensors integrated within the glove. Following this, the system wirelessly transmitted the recognized gesture data via Bluetooth to a mobile device, which then received the data and presented the letter "B" on its screen. This process confirmed the efficient communication between the smart glove and the mobile interface, showcasing the practical application of the developed technology in aiding communication for individuals with hearing and speech impairments. The integration of a relay module and accelerometer (MPU6050) into the smart glove system has facilitated seamless home automation through hand gestures.

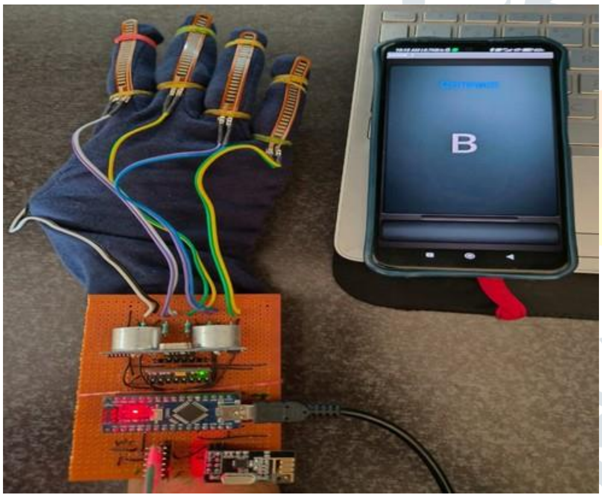

Fig. 3. ASL according to Letter “B”

Fig. 4. Home automation using glove

Through the integration of these various components, the system effectively transforms the intricate movements of the hand into corresponding actions, exemplified by its ability to regulate the functioning of light bulbs based on the orientation of the glove. The successful exhibition of the home automation feature serves to authenticate the pragmatic adaptability of the suggested system, extending its usefulness far beyond just translating sign language, thus enriching the flexibility and practicality of the intelligent glove. This pioneering characteristic not only broadens the array of functions that the system offers but also underscores its capacity to seamlessly amalgamate into the everyday routines of users, thereby delivering convenience and autonomy. It is imperative to undertake additional research and development endeavors aimed at refining and enhancing the home automation feature, with a primary focus on ensuring its dependability and user-friendliness in real-world scenarios. Moreover, the collection of user input and the implementation of iterative trials will be crucial in augmenting the user experience and guaranteeing harmonious interaction with a diverse range of home automation setups. Furthermore, delving into potential integrations with voice command systems or smartphone applications holds promise for enriching the comprehensive functionality of the system

V. Conclusion

The culmination of this endeavor signifies a notable progression in assistive technology for individuals with hearing and speech impediments. The successful creation of a holistic sign-to-speech/text system embedded in a wearable smart glove was achieved through the amalgamation of flex sensors, microcontrollers, and wireless communication modules. The system's capability to precisely interpret and convert American Sign Language gestures into verbal or written form underscores its effectiveness in facilitating communication for non-verbal individuals. Furthermore, the incorporation of supplementary functionalities such as home automation, facilitated by the relay module and accelerometer, highlights the adaptability and promise of the smart glove beyond communication support. By utilizing hand gestures to operate household devices, the scope of the device has been broadened, thereby augmenting the autonomy and quality of life for its users. Throughout the developmental phase, we encountered various obstacles such as sensor precision, signal processing, and system amalgamation, which were addressed through iterative testing and enhancement procedures. The collaborative endeavors of our interdisciplinary team, comprising engineers, researchers, and healthcare professionals, significantly contributed to surmounting these challenges and achieving our project objectives. Moving forward, there is room for further improvements and refinements to bolster the reliability, precision, and user-friendliness of the system. Prospective enhancements may entail integrating machine learning algorithms for gesture recognition, incorporating more advanced sensors for enhanced feedback, and designing a more intuitive user interface. In summary, this initiative marks a momentous advancement in crafting assistive technologies tailored to the requirements of individuals with impairments. By harnessing the capabilities of wearable technology, wireless communication, and sensor fusion, we have devised a versatile and efficient solution that empowers users to communicate and engage with their surroundings more seamlessly.

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