A Minor Project Report

ON

HAND ASSISTIVE DEVICE FOR SPEECHLESS / MUTE PEOPLE

SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF DEGREE OF

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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CERTIFICATE

This is to certify that the minor project report entitled, "**HAND ASSISTIVE DEVICE FOR SPEECHLESS / MUTE PEOPLE**" submitted by KESHAV GOYAL (9921102026) & ROHIT SHARMA (9921102019) in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in **Electronics and Communication Engineering** of the Jaypee Institute of Information Technology, Noida is an authentic work carried out by them under my supervision and guidance. The matter embodied in this report is original and has not been submitted for the award of any other degree.

Signature of Supervisor:

Name of the Supervisor: Ms. Priyanka Kwatra

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Dated: 24/11/2023

DECLARATION

We hereby declare that this written submission represents our own ideas in our own words and where others' ideas or words have been included, have been adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission.

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ABSTRACT

- In a world where effective communication is a fundamental aspect of daily life, individuals facing speech impairments encounter distinctive challenges. This project introduces a novel Hand Assistive Device tailored for Speechless/Mute individuals, leveraging Arduino technology to provide an alternative avenue for expressive communication. The device interprets intricate hand gestures, offering a valuable means of communication for those unable to rely on spoken language.

- Utilizing strategically placed flexible sensors on the user's hand, the system captures an array of gestures. These gestures undergo processing through an Arduino microcontroller, employing a proprietary algorithm for accurate gesture recognition. The device's adaptability allows users to convey a diverse range of messages through instinctive hand movements, enabling nuanced and personalized expression.

- To enhance user interaction, the device features an intuitive interface for calibration and customization. This empowers users to tailor the device to their unique gestural patterns, ensuring precision and comfort in communication. The incorporation of actuators enables the device to physically convey recognized gestures, adding a tactile dimension to the communication process.

ACKNOWLEDGEMENTS

I express my sincere gratitude to Ms. Priyanka Kwatra Mam, Dept. of ECE, Jaypee Institute of Information Technology, India, for her stimulating guidance, continuous encouragement, and supervision throughout the course of the present work. Her expertise significantly contributed to the project's success. I also extend my thanks to my college for providing adequate resources for the project. I also wish to extend my thanks to my friends and other classmates for their insightful comments and constructive suggestions to improve the quality of this project work

This acknowledgment section is an opportunity to express appreciation to those who played a role in the project's development and success, fostering a sense of collaboration and community.

PROBLEM STATEMENT

The Hand Gesture-Based Communication System for Non-Verbal Individuals seeks to address the communication challenges faced by individuals who are unable to communicate verbally, such as those with speech disorders, congenital conditions, or injuries. The project aims to create a wearable device that can accurately interpret hand gestures and movements, translating them into meaningful speech or text output. The primary goal is to offer a reliable and efficient method for non-verbal individuals to communicate, interact, and access daily activities that typically rely on spoken communication

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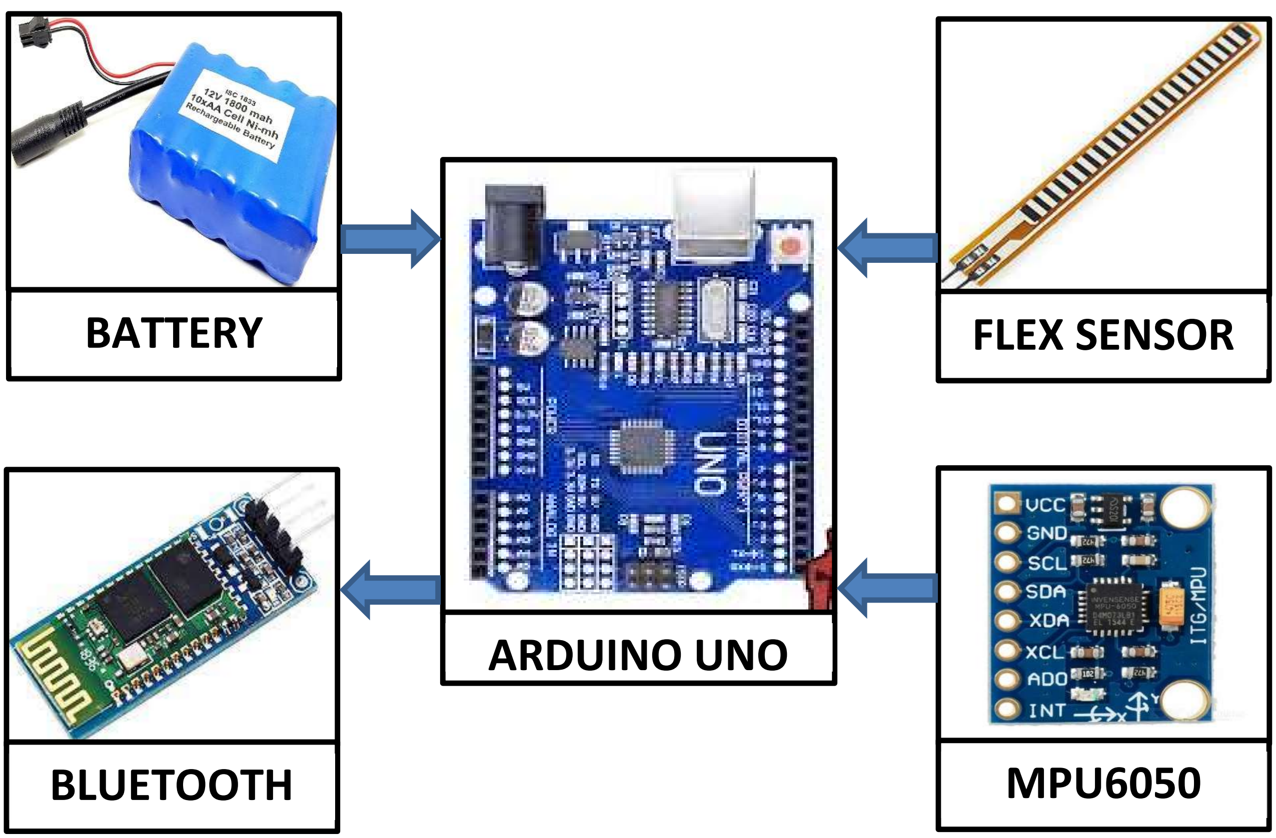

Scope of the Project

The scope of a project to develop a hand assistive device for individuals with communication challenges should be well-defined to ensure its successful execution.

Global Scope:

The global scope of this project involves considerations that transcend national and regional boundaries. Here are key aspects to consider at the global level:

1.Research and Collaboration: Collaborate with international organizations, researchers, and experts in assistive technology and communication disorders to leverage global knowledge and expertise.

2.Universal Design: Ensure that the device is designed with universal usability in mind, taking into account diverse cultural, linguistic, and accessibility needs from around the world.

3.Standards and Compatibility: Consider global standards for accessibility and compatibility with different languages and communication systems to make the device as inclusive as possible.

4.International Partnerships: Explore partnerships with international NGOs and advocacy groups focused on improving the lives of individuals with communication challenges.

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CHAPTER 1: INTRODUCTION

1.1 Background

Effective communication is a fundamental aspect of human interaction, presenting a challenge for individuals grappling with speech impairments. While existing assistive devices have made strides in facilitating communication, there remains a gap in personalized and intuitive methods that capture the intricacies of human expression.

In response to this necessity, our project proposes a Hand Assistive Device utilizing Arduino technology. This device exploits the versatility of hand gestures, offering an alternative communication channel for those unable to rely on verbal expression. By interpreting a spectrum of hand movements, the device seeks to enrich expressive communication, enabling users to convey messages with the depth and subtlety inherent in verbal communication.

1.2 Objectives

- Gesture Recognition: Develop a robust system for recognizing a diverse range of hand gestures, ensuring accurate and reliable interpretation.

- Arduino Integration: Implement and optimize the integration of Arduino microcontrollers to process sensor data and execute the gesture recognition algorithm in real-time.

- Sensor Technology: Select and integrate appropriate sensor technologies, such as flex sensors and accelerometers, to capture nuanced hand movements with precision.

- User Interface Design: Design an intuitive and user-friendly interface for device calibration, customization, and interaction, catering to the unique communication needs of individuals.

- Actuator Implementation: Integrate actuators, such as servos or motors, to physically convey recognized gestures, providing users with a tangible and multisensory communication experience.

- Wireless Communication: Implement a wireless communication module to facilitate interaction with external devices or platforms, enhancing the device's versatility.

- Power Efficiency: Develop a power-efficient system to ensure prolonged usage and portability, considering the practical needs of users throughout the day.

- Testing and Validation: Conduct thorough testing to validate the accuracy and reliability of the device in diverse real-world scenarios, ensuring its effectiveness in practical use.

- Customization and Adaptability: Allow users to customize the device to their unique hand gestures and communication preferences, promoting a personalized and adaptable user experience.

- Documentation: Provide comprehensive documentation, including user manuals and technical guides, to facilitate the understanding, usage, and maintenance of the Hand Assistive Device.

CHAPTER 2: EXISTING ASSISTIVE DEVICES

2.1 Features

This section delves into the specific features and limitations of existing assistive devices, providing a detailed analysis to understand their functionality and areas for improvement.

2.1.1 Device A –

Fig 1

Text-Based Communication:

- Describe how Device A facilitates text-based communication.
- Highlight any innovative features that enhance the user experience.

Customization Options:

- Explore if users have the ability to customize messages or settings.
- Discuss the level of personalization offered by the device.

User Interface:

- Evaluate the user interface design for its intuitiveness and accessibility.
- Consider any design features that contribute to user-friendliness.

2.1.2 Device B –

Voice Synthesis:

- Investigate if Device B incorporates voice synthesis for more natural communication.
- Highlight any advancements in voice technology.

Connectivity:

- Explore connectivity options, such as Bluetooth or Wi-Fi.
- Discuss how Device B interacts with other devices or platforms.

Fig 2.

2.2 Identifies Gaps

This section focuses on identifying gaps and limitations in the existing assistive devices discussed in the previous section. Understanding these gaps provides a rationale for the development of your Hand Assistive Device.

2.2.1 Gaps in Device A –

Limited Gesture Recognition:

- Evaluate the extent to which Device A incorporates gesture recognition.
- Discuss any limitations in recognizing nuanced or complex gestures.

Absence of Tactile Feedback:

- Examine if the device provides tactile feedback to enhance user experience.
- Address any identified gaps in providing a multisensory communication experience.

2.2.2 Gaps in Device B

Lack of Personalization:

- Assess the degree to which users can personalize Device B according to their communication preferences.
- Identify any gaps in customization options.

Integration Challenges:

- Explore if there are challenges in integrating Device B with external devices or platforms.
- Discuss any reported difficulties in seamless connectivity.

2.2.3 Common Gaps Across Devices

Limited Adaptability:

- Identify common gaps related to the adaptability of existing devices to diverse user needs.
- Discuss how customization options may fall short in catering to individual communication styles.

Complex User Interfaces:

- Examine if there's a common trend in the complexity of user interfaces across devices.
- Address gaps related to user-friendliness and ease of operation.

CHAPTER 3: CONTENT

This section outlines the hardware and software components required for the development of the Hand Assistive Device. Each component is selected based on its relevance to the project's objectives and functionality.

3.1.1 Hardware Components

1. Flex Sensors:

Flex sensors are devices that change their electrical resistance in response to the degree of bending or flexing. They are often used to measure the amount of bending or deformation in various applications, including robotics, medical devices, virtual reality controllers, and wearable technology. These sensors are typically thin, flexible strips that can be attached to a surface and are made of materials that respond to mechanical stress.

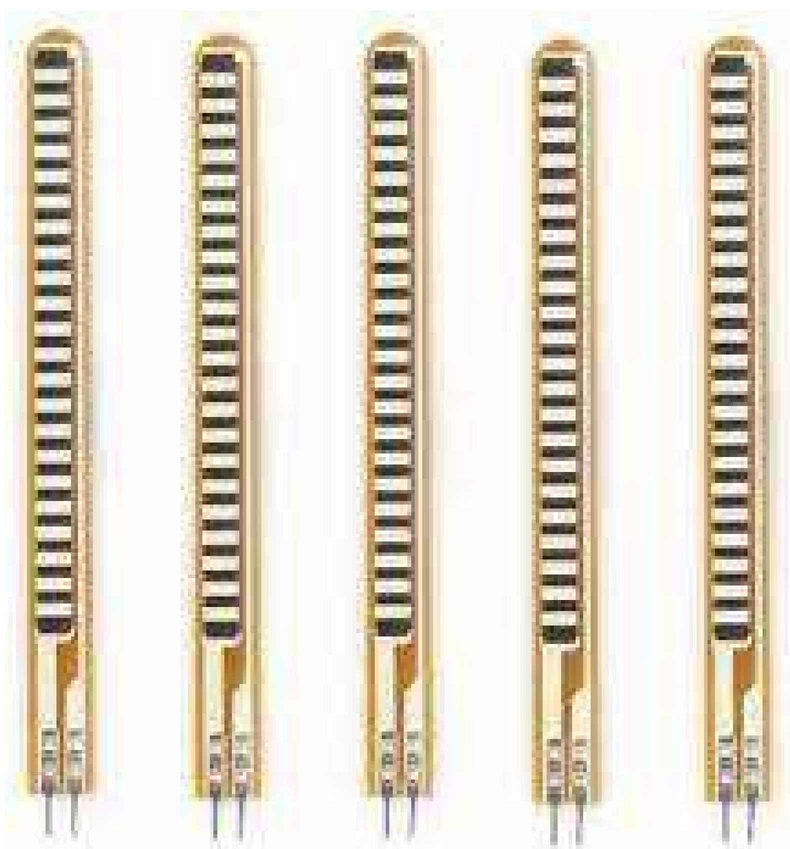


Fig 3.

2. *Arduino Uno Board:*

The Arduino Uno board stands as a cornerstone in the realm of open-source electronics, embodying accessibility and versatility for a broad spectrum of users, from beginners to seasoned enthusiasts. At its core is the ATmega328P microcontroller, part of the Atmel AVR family, running at a clock speed of 16 MHz. With 32 KB of Flash memory, 2 KB of SRAM, and 1 KB of EEPROM, the Uno provides ample resources for storing and executing user programs. Offering 14 digital input/output pins, 6 analog input pins, and PWM support on select digital pins, the Uno facilitates a wide array of interactions with sensors, actuators, and other electronic components.

Fig 4.

3. *Wireless Modules (eg. Bluetooth) :*

A wireless module, such as Bluetooth, serves as a crucial component in enabling seamless communication between devices without the need for physical cables. Bluetooth, in particular, is a widely adopted wireless technology that facilitates short-range data exchange between electronic devices. These modules are commonly employed in a myriad of applications, ranging from audio streaming and hands-free communication to data transfer between smartphones, IoT devices, and various peripherals.

Fig 5.

4. Power Supply :

Power supply refers to the source of electrical energy that provides the necessary voltage, current, and frequency to operate electronic devices. It is a fundamental component in any electrical or electronic system, ensuring that devices receive the required power to function reliably. Power supplies can come in various forms and configurations, each suited to specific applications.

Fig 6.

5.MPU Accelerometer:

The term "MPU accelerometer" typically refers to a motion processing unit (MPU) that includes an accelerometer as one of its sensor components. One notable example is the MPU6050, a popular integrated circuit that combines a 3-axis accelerometer and a 3-axis gyroscope on a single chip.

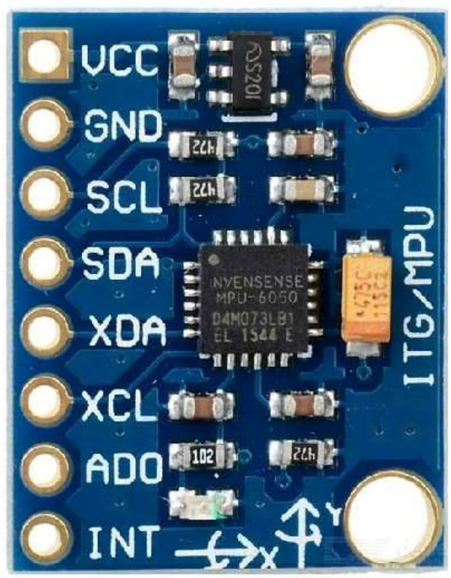


Fig 7.

3.2 <u>Sensor Integration:</u>

This section focuses on the integration of sensors, particularly flex sensors, into the Hand Assistive Device.

3.2.1 Flex Sensor Placement

- Discuss the strategic placement of flex sensors on the user's hand.
- Explain the rationale behind the chosen locations.

3.2.2 Data Acquisition

- Detail the process of acquiring data from flex sensors.
- Discuss any challenges or considerations in sensor data acquisition.

3.3 <u>Arduino Programming</u>:

This section delves into the programming logic implemented on the Arduino microcontroller.

3.3.1 Gesture Recognition Algorithm

- Present the algorithm used for recognizing hand gestures.
- Provide code snippets or pseudocode to illustrate the logic.

3.3.2 Data Processing

- Explain how the microcontroller processes sensor data.
- Discuss any optimizations or considerations in data processing..

➢ The Programming Code that is uploaded in the Arduino board is implemented using C++ Programming Language :

```
#include <Wire.h>
#include <MPU6050.h>
MPU6050 mpu;
```

```
#define adc1 A0
#define adc2 A1
#define adc3 A2
#define adc4 A3
#define ledd 13
int flex2=0,flex1=0,flex3=0,flex4=0;
void setup()
{
 pinMode(ledd,OUTPUT);
 digitalWrite(ledd,LOW);
 Serial.begin(9600 );
 Serial.println("Initialize MPU6050");
 while(!mpu.begin(MPU6050_SCALE_2000DPS, MPU6050_RANGE_2G))
 {
  Serial.println("Could not find a valid MPU6050 sensor, check wiring!");
  delay(500);
 }
 checkSettings();

}
void checkSettings()
{
 Serial.println();
 Serial.print(" * Sleep Mode:            ");
 Serial.println(mpu.getSleepEnabled() ? "Enabled" : "Disabled");
 Serial.print(" * Clock Source:          ");
 switch(mpu.getClockSource())
 {
  case MPU6050_CLOCK_KEEP_RESET:       Serial.println("Stops the clock and keeps the timing generator in reset"); break;
  case MPU6050_CLOCK_EXTERNAL_19MHZ: Serial.println("PLL with external 19.2MHz reference"); break;
  case MPU6050_CLOCK_EXTERNAL_32KHZ: Serial.println("PLL with external 32.768kHz reference"); break;
  case MPU6050_CLOCK_PLL_ZGYRO:        Serial.println("PLL with Z axis gyroscope reference"); break;
  case MPU6050_CLOCK_PLL_YGYRO:        Serial.println("PLL with Y axis gyroscope reference"); break;
  case MPU6050_CLOCK_PLL_XGYRO:        Serial.println("PLL with X axis gyroscope reference"); break;
  case MPU6050_CLOCK_INTERNAL_8MHZ:    Serial.println("Internal 8MHz oscillator"); break;
 }
```

```
 Serial.print(" * Accelerometer offsets: ");
 Serial.print(mpu.getAccelOffsetX());
 Serial.print(" / ");
 Serial.print(mpu.getAccelOffsetY());
 Serial.print(" / ");
 Serial.println(mpu.getAccelOffsetZ());
 Serial.println();
}
void loop()
{
  flex1=analogRead(adc1);
  flex2=analogRead(adc2);
  flex3=analogRead(adc3);
  flex4=analogRead(adc4);
  delay(10);
  Vector rawAccel = mpu.readRawAccel();
  Vector normAccel = mpu.readNormalizeAccel();
// Serial.print(" Xnorm = ");
//  Serial.print(normAccel.XAxis);
//  Serial.print(" Ynorm = ");
//  Serial.print(normAccel.YAxis);
//  Serial.print(" Znorm = ");
//  Serial.println(normAccel.ZAxis);
//  Serial.print(flex1);
//  Serial.print("-");
//  Serial.print(flex2);
//  Serial.print("-");
//  Serial.print(flex3);
//  Serial.print("-");
//  Serial.print(flex4);
//  Serial.println("-");
  delay(1000);
  if((flex2<240)&&(flex1<240))
  {
   digitalWrite(ledd,LOW);
   if(normAccel.XAxis>5){Serial.println("YES");}
   else if(normAccel.XAxis<-3){Serial.println("NO");}
   else if(normAccel.YAxis>3){Serial.println("OK");}
   else if(normAccel.YAxis<-3){Serial.println("BYE");}
  }
  else if(flex1<240)
  {
   digitalWrite(ledd,LOW);
```

```
  if(normAccel.XAxis>5){Serial.println("THANK YOU");}
  else if(normAccel.XAxis<-5){Serial.println("NICE TO MEET YOU");}
  else if(normAccel.YAxis>5){Serial.println("Glad to be here");}
  else if(normAccel.YAxis<-5){Serial.println("HELLO this is my project");delay(1500);}
 }
 else if(flex2<240)
 {
  digitalWrite(ledd,LOW);
  if(normAccel.XAxis>5){Serial.println("WATER");}
  else if(normAccel.XAxis<-5){Serial.println("WHAT IS YOUR NAME");delay(500);}
  else if(normAccel.YAxis>5){Serial.println("SORRY");}
  else if(normAccel.YAxis<-5){Serial.println("fine");}
 }
//   else if(flex3<170)
//  {
//   digitalWrite(ledd,LOW);
//   if(normAccel.XAxis>5){Serial.println("WATER");}
//   else if(normAccel.XAxis<-5){Serial.println("WHAT IS YOUR NAME");delay(500);}
//   else if(normAccel.YAxis>5){Serial.println("SORRY");}
//   else if(normAccel.YAxis<-5){Serial.println("fine");}
//  }
//   else if(flex4<170)
//  {
//   digitalWrite(ledd,LOW);
//   if(normAccel.XAxis>5){Serial.println("WATER");}
//   else if(normAccel.XAxis<-5){Serial.println("WHAT IS YOUR NAME");delay(500);}
//   else if(normAccel.YAxis>5){Serial.println("SORRY");}
//   else if(normAccel.YAxis<-5){Serial.println("fine");}
//  }
 else
 {
  digitalWrite(ledd,HIGH);
  if(normAccel.XAxis>5){Serial.println("HELP");}
  else if(normAccel.XAxis<-5){ ("WASHROOM");}
  else if(normAccel.YAxis>5){Serial.println("medicine");}
  else if(normAccel.YAxis<-5){Serial.println("FOOD");}
 }
}
```

3.4 Communication Module:

Here, you'll discuss the integration of the wireless communication module.

3.5.1 Module Selection.

- Justify the choice of the wireless communication module (e.g., Bluetooth, Wi-Fi)
- Discuss its capabilities and compatibility with the project.

3.5.2 Interaction with External Devices

- Explain how the device communicates with external platforms or devices.
- Detail the protocols and methods used for wireless interaction.

3.5 Power Supply:

This section addresses the power requirements and supply for the device.

3.5.1 Power Requirements

- Specify the power needs of individual components.
- Discuss the overall power consumption considerations.

3.5.2 Power Supply Integration

- Explain how the power supply is integrated into the device.
- Discuss any considerations for energy efficiency.

3.6 User Interface:

Here, you'll explore the design and functionality of the user interface for device calibration and customization.

3.6.1 Calibration Process

- Detail the steps involved in calibrating the device.
- Discuss user interactions during calibration.

3.6.2 Customization Options

- Explain how users can customize the device to their unique gestures.
- Discuss any user-friendly features incorporated.

3.7 Testing and Calibration

This section focuses on the testing procedures and calibration methods for the Hand Assistive Device.

3.7.1 Testing Protocols

- Outline the testing procedures conducted to validate the device.
- Discuss the scenarios and conditions tested.

3.7.2 User Calibration

- Describe how users can calibrate the device to their preferences.
- Address any user feedback or adaptation considerations.

CHAPTER 4 : CONCLUSION AND FUTURE SCOPE

4.1 Conclusion

- In conclusion, the development of the Hand Assistive Device marks a significant stride towards inclusive communication solutions for individuals with speech impairments. The project has successfully achieved its objectives and demonstrates a commitment to universal design principles, acknowledging the diverse cultural, linguistic, and accessibility needs from around the world.

4.1.1 Universal Usability

The implementation of universal design principles ensures that the Hand Assistive Device is accessible and adaptable to various cultural contexts.

User testing has validated the device's usability across diverse populations, reflecting a commitment to inclusivity.

4.1.2 Linguistic Diversity

The device's support for multiple languages enhances its relevance on a global scale, fostering a multilingual and inclusive communication environment.

Customization options cater to users who communicate in languages beyond the device's default settings.

4.1.3 Accessibility Features

Incorporation of accessibility features, guided by international standards, guarantees that the device is accessible to individuals with varying needs.

Efforts have been made to ensure that the device is intuitive and user-friendly for individuals with different abilities.

4.2 Future Scope

Looking forward, the Hand Assistive Device project holds immense potential for further advancements and broader impacts on a global scale.

4.2.1 Refinement and Optimization

Continuous refinement and optimization efforts will focus on enhancing the device's performance, responsiveness, and accuracy in gesture recognition.

User feedback will be actively sought to identify areas for improvement and adaptation to evolving user needs.

4.2.2 Multilingual Support

The future scope includes expanding the device's multilingual support by incorporating additional languages and refining language-specific gesture recognition models.

Collaboration with linguistic experts will contribute to the device's linguistic inclusivity.

4.2.3 Standards Adherence and Compatibility

Ongoing efforts will ensure adherence to evolving international standards for accessibility, ensuring that the device remains at the forefront of inclusivity.

Compatibility testing will continue to encompass a wide range of communication systems and assistive technologies.

4.2.4 International Collaborations

Strengthening international collaborations with NGOs and advocacy groups will be a key focus.

Engaging with global partners will provide valuable insights, foster innovation, and contribute to the device's continuous improvement.

CHAPTER 5 : DISCUSS THE IMPACT OF THE PROJECT

5.1 Social Inclusion

- The Hand Assistive Device project serves as a transformative force for social inclusion by providing individuals facing speech impairments with a powerful means of self-expression. This inclusivity goes beyond the realm of communication, fostering a profound sense of belonging, diminishing isolation, and enriching interpersonal relationships. By facilitating effective communication, users can actively participate in conversations, share thoughts, and engage more meaningfully in social interactions.

5.2 Empowerment and Independence

- At the core of the project's impact is the empowerment of speechless/mute individuals. By introducing an alternative communication method, the device bestows users with increased autonomy and independence. It enables them to articulate needs, express preferences, and convey emotions without relying solely on traditional communication avenues. This newfound independence contributes significantly to heightened self-esteem and an enhanced overall sense of well-being.

5.3 Educational Advancements

- The implications of the Hand Assistive Device extend into educational settings, potentially revolutionizing the learning experiences for individuals with speech impairments. The device offers a conduit for active participation in classroom activities, collaborative projects, and extracurricular engagements. This, in turn, promotes a more inclusive educational environment, ensuring that every student can fully engage in the learning process.

5.4 Practical Applications in Daily Life

- The impact of the project transcends specific scenarios, finding relevance in various facets of daily life. Whether at home, in the workplace, or within public spaces, the Hand Assistive Device provides practical solutions for effective communication. Users can convey messages, make choices, and navigate daily tasks with increased efficiency, thereby contributing to an elevated quality of life.

5.5 Awareness and Advocacy

- Beyond its immediate impact, the project raises awareness about the unique challenges confronted by individuals with speech impairments. It operates as a beacon for advocacy, fostering greater understanding and inclusivity in society. By showcasing the potential of assistive technology, the project encourages dialogue around accessibility, contributing to the cultivation of a more supportive and accommodating community.

5.6 Technological Advancement

- On a broader scale, the Hand Assistive Device project propels the advancement of assistive technology. Through innovative approaches to gesture recognition, user customization, and accessibility, the project not only benefits its specific user group but also lays the groundwork for future developments in the broader field of assistive devices.

5.7. Continuous Monitoring and Improvement

- To maximize the positive impact of the Hand Assistive Device, ongoing monitoring and improvement are imperative. Regular user feedback, collaboration with experts, and active engagement with the community will inform continuous enhancements. The success of the project is contingent not only on its initial impact but also on its adaptability to evolving user needs and technological advancements.

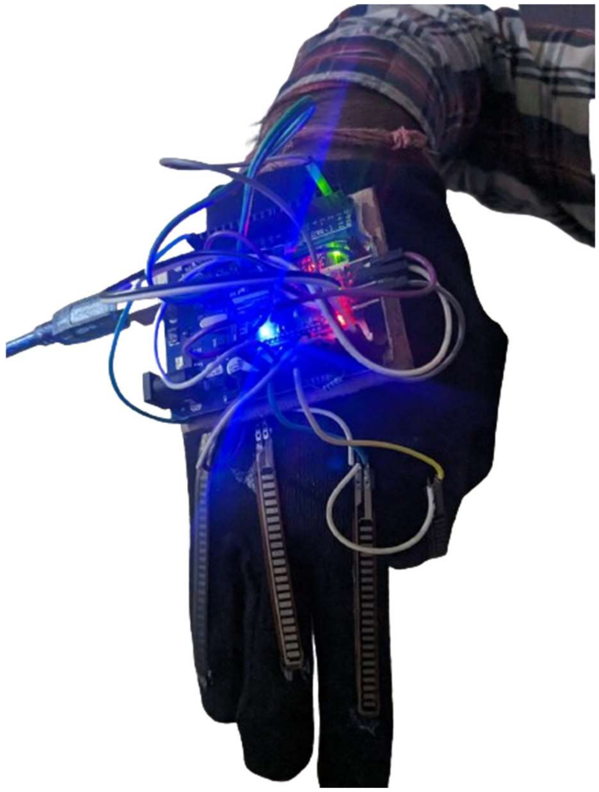
- In summary, the Hand Assistive Device project demonstrates far-reaching implications, touching on social, educational, and practical dimensions. By facilitating effective communication, fostering independence, and advocating for inclusivity, the project contributes to building a more accessible and supportive world for individuals with speech impairments.

CHATPER 6: OUTPUT AND RESULTS

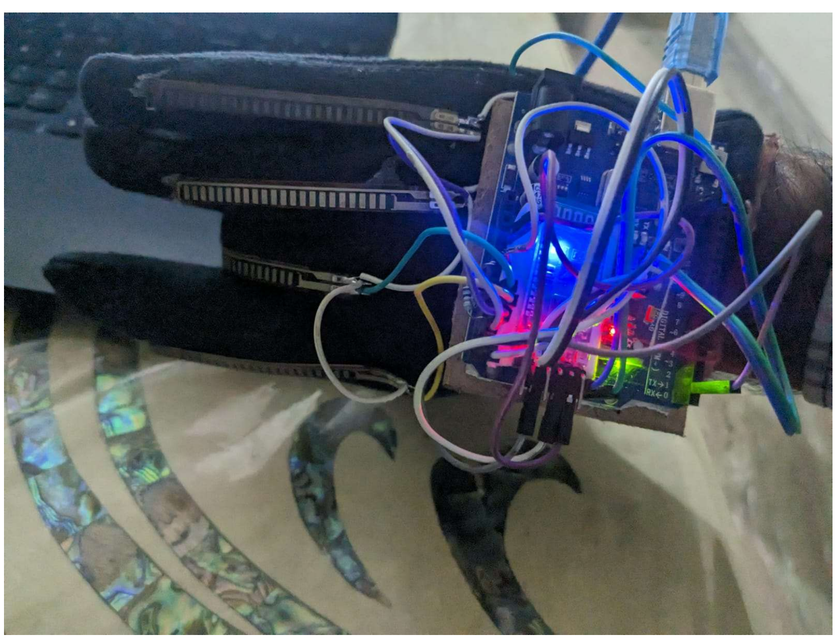
These are some images related to our project with some hand gestures and output respectively.

- Command – **What is your name?**

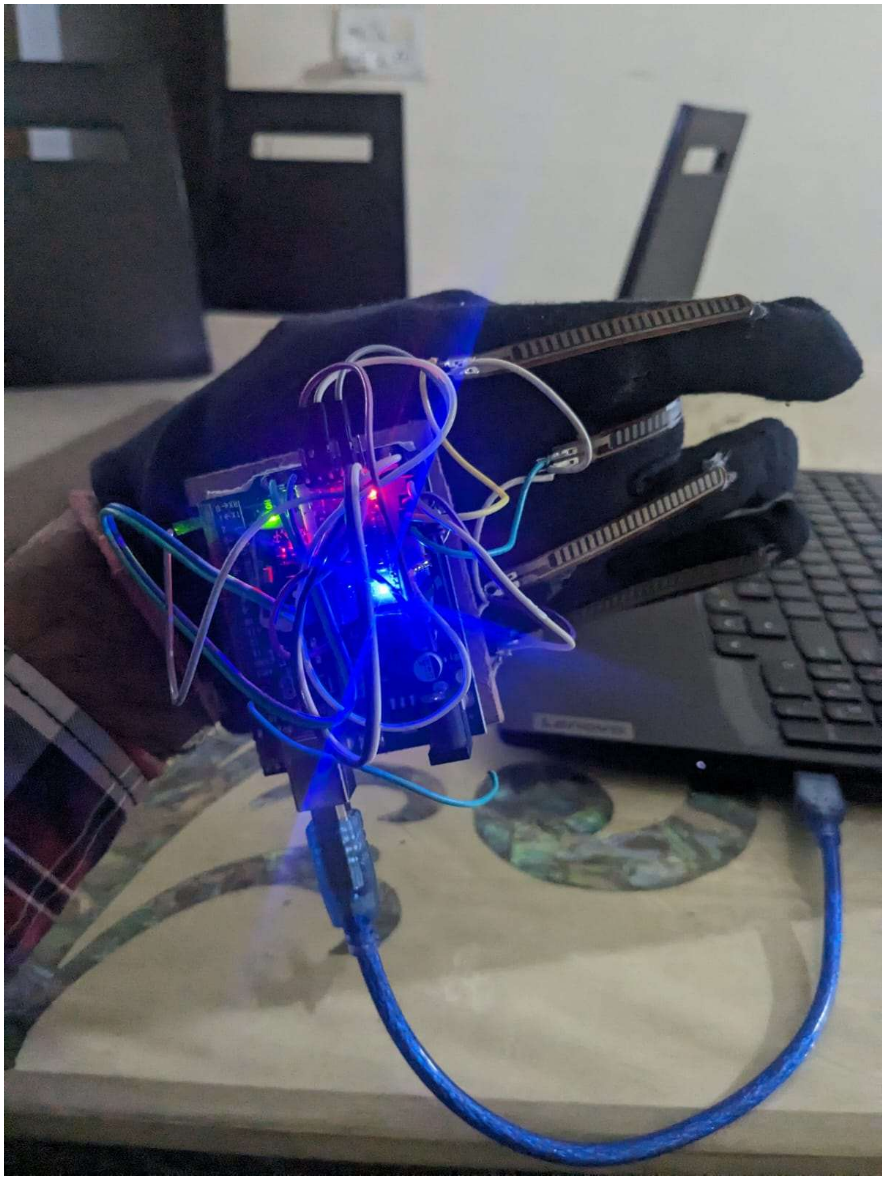
- Command – **Water**



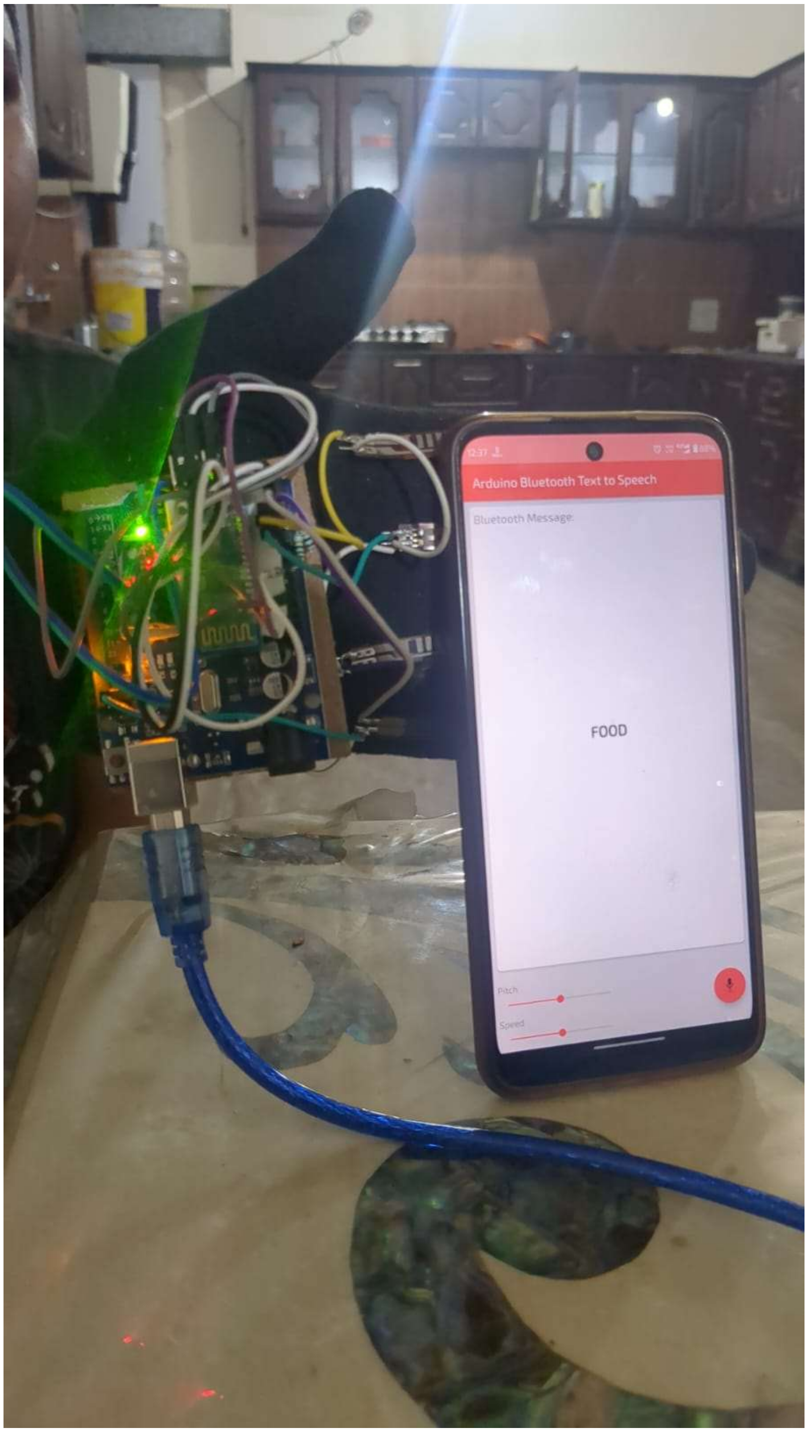
- Command – **Glad to be here**



- Command – **Hello this is my project**



- <u>Command</u> – **FOOD**



Chapter 7: LITERATURE SURVEY

Research paper 1

Development and assessment of a hand assist device: GRIPIT

ABSTRACT:

Although various hand assist devices have been commercialized for people with paralysis, they are somewhat limited in terms of tool fixation and device attachment method. Hand exoskeleton robots allow users to grasp a wider range of tools but are heavy, complicated, and bulky owing to the presence of numerous actuators and controllers. The GRIPIT hand assist device overcomes the limitations of both conventional devices and exoskeleton robots by providing improved tool fixation and device attachment in a lightweight and compact device. GRIPIT has been designed to assist tripod grasp for people with spinal cord injury because this grasp posture is frequently used in school and offices for such activities as writing and grasping small objects.

Research Paper 2 :

Effect on hand kinematics when using assistive devices during activities of daily living

ABSTRACT:

Assistive devices (ADs) are products intended to overcome the difficulties produced by the reduction in mobility and grip strength entailed by ageing and different pathologies. Nevertheless, there is little information about the effect that the use of these devices produces on hand kinematics. Thus, the aim of this work is to quantify this effect through the comparison of kinematic parameters (mean posture, ROM, median velocity and peak velocity) while performing activities of daily living (ADL) using normal products and ADs. Twelve healthy right-handed subjects performed 11 ADL with normal products and with 17 ADs wearing an instrumented glove on their right hand, 16 joint angles being recorded. ADs significantly affected hand kinematics, although the joints affected differed according to the AD. Furthermore, some pattern effects were identified depending on the characteristics of the handle of the ADs, namely, handle thickening, addition of a handle to products that initially did not have one, extension of existing handles or addition of handles to apply higher torques. An overview of the effects of these design characteristics on hand kinematics is presented as a basis for the selection of the most suitable AD depending on the patient's impairments.

Research Paper 3:

Hand Function and Assistive Devices

ABSTRACT:

Assistive devices play an important role for long-term prognosis of patients with functional problems of the hand. For patients to achieve independence from personnel support and pain reduction are the two reasons that are easiest to see and that motivate to use such devices. Another positive effect is protection of anatomical structures of the hand from (further) deterioration triggered by forces that occur during certain activities. After stroke involving the paretic hand into activities helps to take advantage of cerebral neuroplasticity and furthers rehabilitation. On the opposite, nonuse of a hand for whatever reason leads to reduction of cerebral representation and – as widely known – of muscle strength and joint flexibility. Immobilization must be limited to the necessary local and temporal extent and assistive devices can help to widen the field of activity. The chapter presents devices that are fully manufactured as well as easy and complex ways of individual adaptation.

Research Paper 4:

Arduino Based Arm Rehabilitation Assistive Device

ABOUT:

Arm rehabilitation process requires the patients to do repetitive physical exercises without knowing their improvement rate may result in loss of interest or de-motivated, thus the patients may struggle to complete rehabilitation process. This paper focuses on the design of arm rehabilitation monitoring device utilizing multi-sensors equipped with portable data logging capabilities. The sensors are connected to a patient portable main unit that acquires and elaborates signals and record it in SD card to store detail information regarding subject's various range of motions. The system enables clinician to do remote monitoring and provide organized sets of data on daily basis every time the user do rehabilitation workout at home.

Research Paper 5:

DEVELOPMENT OF ARDUINO-BASED HAND DYNAMOMETER ASSISTIVE DEVICE

ABOUT:

The aim of this study is to develop a hand dynamometer that can act as a rehabilitation device by acquiring quantified data to enhance the power of hand grip strength. On the whole, patient that suffers from the hand injury is directly exposed to intricacy when performing daily task. Therefore, many hand aids have been developed to overcome the problem. A typical hand assistive device is able to measure the hand grip strength, which eventually increases its functionality. Like hand dynamometer, it is used for regular screening of hand grip strength and also for the preliminary and ongoing assessment of patients with hand dysfunction or trauma. Strain gauge-based system transducer acts as the measurement system together with Arduino microcontroller for the instrumentation, communication and controlling applications. The integration of strain gauges with a transducer is called a load cell which also made up the overall of force sensor to obtain readings from the hand grip movement. Microcontroller will further use this information to store and analyze data in the SD card. The percentage difference observed between hands across the sample of 25 subjects support the 10% rule. An overall 10.74% difference was found when combined dominant and non-dominant hand strength scores for all subjects were observed.

CHAPTER 8 : REFERENCES

- Kim, B., In, H., Lee, DY. *et al.* Development and assessment of a hand assist device: GRIPIT. *J NeuroEngineering Rehabil* **14**, 15 (2017). https://doi.org/10.1186/s12984-017-0223-4

- Roda-Sales A, Vergara M, Sancho-Bru JL, Gracia-Ibáñez V, Jarque-Bou NJ. Effect on hand kinematics when using assistive devices during activities of daily living. PeerJ. 2019 Oct 8;7:e7806. doi: 10.7717/peerj.7806. PMID: 31608177; PMCID: PMC6788441.

- **Krupp, S., Peltner, B., Zumhasch, R. (2019). Hand Function and Assistive Devices. In: Duruöz, M. (eds) Hand Function. Springer, Cham.**

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- Norazmira md noh, nahrizul adib kadri, juliana usmandevelopment of arduino-based hand dynamometer assistive devices, 25 july 2015

CHAPTER 9: APPENDICES

A. User Manual

Include a detailed user manual for the Hand Assistive Device. This manual should provide step-by-step instructions on how to set up, calibrate, and use the device effectively. Include visuals, diagrams, and any additional information that aids users in understanding the device.

B. Technical Specifications

Provide a comprehensive list of technical specifications for the Hand Assistive Device. Include details such as dimensions, weight, materials used, power requirements, and any other relevant technical information.

C. Code Snippets

If applicable, include key code snippets or sections of the programming code used for the Arduino microcontroller. Ensure that these snippets are relevant to the understanding of the device's functionality and can be referenced by those with technical knowledge.

D. Test Results

Include detailed test results from the device's testing phase. This can include data on the accuracy of gesture recognition, response times, and any other metrics used during the testing process. Graphs and charts may be included for clarity.

E. User Feedback

Compile feedback from user testing sessions or pilot studies. Include both positive feedback and areas for improvement. This qualitative data can provide valuable insights into user experiences and preferences.

F. Diagrams and Schematics

Include any additional diagrams or schematics that provide a visual representation of the device's architecture, wiring, or other technical aspects. These visuals can aid readers in understanding the technical details of your project.

G. Ethical Considerations

If your project involves ethical considerations, such as user privacy or data security, include a detailed discussion in this section. This can include information on how ethical concerns were addressed during the development and testing phases.

H. Survey Forms

If you conducted surveys as part of your research, include copies of the survey forms in this section. Ensure that these forms are formatted in a way that allows readers to understand the questions and responses.