Voice Control Robotic Hand Mechanism

A thesis report submitted to the department of mechanical engineering for the partial fulfillment of the degree of Bachelor of Science in Mechanical Engineering

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January- 2025

Approval

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Declaration

We, hereby, declare that the work presented in this project is the outcome of the investigation and research work performed by us under the supervision of Nahiyan Chowdhury, Lecturer, Department of Mechanical Engineering, Sonargaon University (SU). We also declare that no part of this project and thesis has been or is being submitted elsewhere for the award of any degree.

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Acknowledgement

First of all, we are grateful to Allah, the almighty for giving us the courage and enthusiasm to complete the thesis work. The authors express their gratitude to “Nahiyan Chowdhury” for his constant & meticulous supervision, valuable suggestion and encouragement to carry out this work. For all this, the authors acknowledge their sincere gratitude to him. We are also grateful to all our thesis & project working team of SU for their help in construction of the project work and give their valuable knowledge and time for completing the experiment. Finally, we would like to thank everybody who supported us in any respect for the completion of the thesis.

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Abstract

A Voice-Controlled Robotic Hand is an innovative system designed to perform tasks based on spoken commands. This project integrates robotics with voice recognition technology, creating a seamless interface between humans and machines. The robotic hand serves as a functional and interactive tool capable of mimicking human hand movements, making it suitable for a wide range of applications, from assisting people with disabilities to enhancing automation in industrial tasks.

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Chapter 1 Introduction

1.1 General

This project presents a system whereby the human voice may specify continuous control signals to operate a real 3D robotic arm. Our goal is to help the people with disabilities by assisting them in their daily activities with the help of a robotic arm. It is indeed possible for a user to learn to move the position of real-world objects with a robotic arm using only non-verbal voice as a control mechanism. Individuals with motor impairments such as those with paraplegia, spinal cord injuries, war-time injuries, or amputations rely on others to assist them in their daily activities. Advances in assistive technologies have begun to provide an increase in independence for these individuals, but there is great potential for further technological developments to significantly improve their abilities, independence, and overall quality of life.

1.2 Objective of the Project

The objective of a Voice Control Robotic Hand Mechanism project typically focuses on integrating voice recognition technology with robotics to achieve efficient, hands-free control. Here's a clear articulation of the objectives:

- Primary Objective: To design and implement a robotic hand mechanism that responds to voice commands, enabling natural and intuitive control for various applications.
- Voice Recognition Integration: Implement a robust voice recognition system capable of accurately interpreting and responding to user commands in real-time.
- Robotic Hand Mechanism Design: Develop a mechanical hand capable of mimicking human hand movements, including grasping, pinching, and pointing.
- Wireless Communication (if applicable): Use wireless communication protocols (e.g., Bluetooth, Wi-Fi) to transmit commands from the voice interface to the robotic hand.

1.3 Background of the Project

The Voice Control Robotic Hand Mechanism project emerges at the intersection of robotics, artificial intelligence, and assistive technology. Over the years, advancements in these fields have created opportunities to improve human-robot interaction, making robots more intuitive, accessible, and effective in various domains.

Historical Context: The development of robotic hands has been inspired by the human hand, one of the most complex and versatile tools in nature. Early robotic hands were mechanically operated, focusing on mimicking basic movements. With time, the integration of microcontrollers, sensors, and actuators allowed these mechanisms to perform more intricate and precise tasks.

Voice control, on the other hand, has its roots in speech recognition technology, which has seen tremendous growth with the advent of machine learning, natural language processing (NLP), and cloud-based services.

Advancements in Technology: Recent developments in robotics and voice recognition have made it possible to merge these technologies into practical systems:
Voice Recognition Systems: Modern systems like Google Assistant, Amazon Alexa, and Apple's Siri have set benchmarks in speech recognition. These advancements provide a foundation for integrating voice control into robotics.
Robotic Mechanisms: Robotic hands now employ advanced materials, servo motors, and precise control algorithms to replicate the dexterity of human hands.
Wireless and IoT Integration: The rise of the Internet of Things (IoT) allows for remote operation of devices, enabling seamless communication between the voice interface and the robotic hand.
Relevance in Today's World: The need for voice-controlled robotics is growing, particularly in the following areas:
Assistive Technology: Providing mobility and independence to people with physical disabilities by enabling them to control robotic prosthetics or assistive devices hands-free.
Industrial Automation: Reducing manual workload and enhancing safety in hazardous environments by allowing voice-controlled robotic systems to perform complex tasks.
Smart Home Applications: Expanding the capabilities of home automation systems with robotic mechanisms that respond to voice commands for household tasks.

1.4 Earlier Research

The Voice Control Robotic Hand Mechanism has its roots in multiple fields, including robotics, artificial intelligence, and assistive technologies. Over the years, researchers and engineers have contributed significant advancements to this area, laying the foundation for current and future developments. Here's an overview of earlier research efforts:
Mechanical Design and Dexterity: Early robotic hands, like the Stanford Hand (1985) and Utah/MIT Hand (1987), focused on mimicking the dexterity of human hands using mechanical linkages and multiple degrees of freedom.
Research centered on creating lightweight and flexible materials for robotic hands, such as soft robotics, which enable natural, human-like movements.
Sensor Integration: The use of force sensors, tactile sensors, and position encoders allowed robotic hands to perform precise tasks requiring feedback, such as grasping delicate objects.
Early Speech Recognition: Early systems, such as IBM's Shoebox (1962) and Bell Labs' speech recognition experiments in the 1970s, could recognize limited vocabulary and basic commands.
With advancements in machine learning and natural language processing (NLP) in the 1990s and 2000s, systems became more accurate and capable of understanding complex commands.
Integration with Robotics: By the early 2000s, researchers began integrating speech recognition into robotic systems. Projects like MIT's Cog explored voice-guided robotics for performing simple interactive tasks.
Prosthetics: Voice-controlled prosthetic hands, such as the i-Limb Hand (2007), were developed to help individuals with physical disabilities. These systems allowed users to perform basic actions, such as opening or closing the hand, through voice commands.

Assistive Robotics: Robotic arms and hands controlled via voice commands were employed to assist individuals with mobility impairments, enabling them to interact with their environment more effectively.
Notable Studies: Research published in journals like the International Journal of Robotics Research has explored the integration of speech recognition with robotic systems for industrial and healthcare applications.
IEEE Robotics and Automation Society has frequently published papers on intelligent robotics and the role of voice commands in control mechanisms.
Industry Contributions: ompanies like Boston Dynamics, Honda (Asimo), and SoftBank Robotics (Pepper Robot) have contributed significantly to advancing voice-interactive robotic systems.
Challenges in Earlier Research: Early voice recognition systems struggled with recognizing diverse or complex commands.
Lack of Real-Time Processing: High latency and limited computational power delayed real-time execution of commands.
Inaccurate Responses: Noise interference and lack of adaptive learning in early systems led to errors in recognition and execution.
High Costs: Early robotic hands and voice-controlled systems were expensive and not widely accessible.
Improved Voice Recognition: Modern systems leverage cloud computing and AI to achieve near-human accuracy in speech understanding.
Enhanced Mechanisms: Robotics has advanced with better materials, actuators, and control systems, enabling more lifelike hand movements.
Accessibility: Voice-controlled systems are now more cost-effective, user-friendly, and accessible to a broader audience.
By building upon these advancements, the Voice Control Robotic Hand Mechanism project can address the challenges and limitations of earlier research while exploring new applications in assistive technologies, industrial automation, and beyond.

1.5 Brief Overview of the Project

The Voice Control Robotic Hand Mechanism Project focuses on designing and implementing a robotic hand that responds to voice commands, combining robotics, artificial intelligence, and speech recognition technologies. This project aims to create an intuitive and efficient system for controlling robotic hand movements, enhancing accessibility and functionality in various applications.

1.6 Motivation for Project

The Voice Control Robotic Hand Mechanism project is motivated by the desire to create an intuitive and accessible interface for controlling robotic systems, addressing practical challenges in assistive technology, automation, and human-robot interaction. The following key factors drive this project:

- Empowering Individuals with Disabilities: Many individuals with physical disabilities, such as amputees or those with limited mobility, face challenges in performing

everyday tasks. A voice-controlled robotic hand can act as an assistive device, enabling them to regain independence and improve their quality of life.

- Reducing Barriers: Traditional robotic systems often require complex controls that are not user-friendly. Voice commands provide a natural and effortless way for users to interact with robotic devices.
- Human-Robot Interaction Advancement: Voice commands are one of the most intuitive ways humans communicate. Integrating this with robotics bridges the gap between humans and machines, making robotic systems easier to operate and more widely usable.
- Seamless Integration into Daily Life:
- A voice-controlled robotic hand can seamlessly integrate into environments like homes, workplaces, and healthcare facilities, providing practical solutions for routine and specialized tasks.
- Leveraging Advanced Technologies: The rapid advancement of speech recognition systems and robotics technologies provides an opportunity to merge these fields and create innovative solutions.

1.7 Project Management

Effective project management ensures the successful completion of the Voice Control Robotic Hand Mechanism Project by dividing it into manageable phases, assigning responsibilities, and monitoring progress. Below is a structured approach to managing the project:

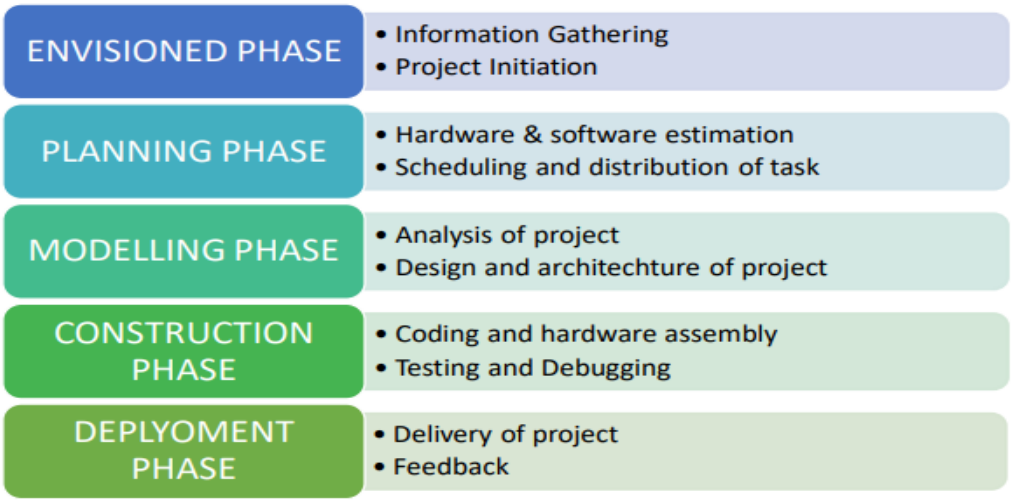


Fig-1.1: Project Management

- Project Scope and Goals
- Key Phases and Timeline
- Resource Management
- Risk Management
- Budget and Cost Estimation
- Success Metrics
- Communication and Reporting

Chapter 2 Theoretical Review

2.1 Introduction

The Voice Control Robotic Hand Mechanism is an innovative project that integrates advanced robotics with voice recognition technology to create a system capable of performing precise and dexterous hand movements through spoken commands. This project is inspired by the need for intuitive and user-friendly human-robot interaction systems, especially in assistive technologies, automation, and smart environments.

Robotic hands are among the most versatile and widely studied components in robotics due to their potential to replicate human dexterity. However, traditional control methods often involve complex interfaces, limiting accessibility for users with physical disabilities or those unfamiliar with technical systems. Voice control addresses this limitation by providing a natural and efficient means of communication between humans and machines.

This project combines the mechanical design of a robotic hand with advanced voice recognition algorithms to interpret and execute commands in real-time. It aims to enhance accessibility, productivity, and efficiency by allowing users to operate the robotic hand seamlessly, without requiring physical interaction.

2.2 System Design

The System Design of the Voice Control Robotic Hand Mechanism involves a combination of hardware and software components working together to interpret voice commands and translate them into mechanical actions. Below is a detailed breakdown of the system design:

1. System Architecture

The project consists of four main subsystems:

- Voice Recognition Module
- Microcontroller Unit
- Robotic Hand Mechanism
- Power Supply and Connectivity

2. Subsystem Components

- Voice Recognition Module
- Captures and processes voice commands, converting them into digital signals for the microcontroller.
- Microphone: Captures voice input.
- Speech-to-Text Software/API: Converts voice input into text or commands (e.g., Google Speech API, CMU Sphinx, or TensorFlow-based models).
- Noise Filtering Algorithm: Enhances accuracy by filtering background noise.
- Design Considerations:
- High accuracy in recognizing diverse accents and pronunciations.

- Real-time processing with minimal latency.
- Microcontroller Unit (MCU)
- Acts as the brain of the system, processing commands and controlling the robotic hand.
- Microcontroller Board: Examples include Arduino, Raspberry Pi, or ESP32.
- Command Processing Algorithm: Maps recognized voice commands to specific hand movements.
- Communication Interface: Includes Bluetooth, Wi-Fi, or USB for connectivity.
- Sufficient computational power to handle real-time processing.
- Compatibility with the voice recognition module and robotic hand actuators.
- Robotic Hand Mechanism
- Executes the physical movements corresponding to the received commands.
- Frame Structure: Designed to replicate the human hand with materials like ABS plastic, metal, or 3D-printed parts.
- Actuators: Servo motors or linear actuators for each joint and finger movement.
- Position sensors for joint feedback.
- Tactile sensors for grip detection.
- Control Circuit: Interfaces between the microcontroller and actuators.
- Lightweight and durable construction.
- Smooth and precise movements with multiple degrees of freedom (DOF).
- Power Supply and Connectivity
- Provides energy to the system and supports communication between components.
- Power Supply Unit: Batteries or external power adapter.
- Voltage Regulator: Ensures stable power delivery to components.
- Wireless: Bluetooth or Wi-Fi for remote operation.
- Wired: USB or serial communication for development and testing.
- Ensure power efficiency to extend operational time.
- Reliable connectivity for uninterrupted command execution.

3. Data Flow

- Voice Input: The user speaks a command (e.g., "Close hand").
- Signal Processing: The voice recognition module captures and processes the speech into a digital command.
- Command Mapping: The microcontroller interprets the command and determines the corresponding action for the robotic hand.
- Motor Control Signals: The microcontroller sends control signals to the actuators, driving the hand's movements.
- Feedback Loop: Sensors in the robotic hand provide feedback to the microcontroller, ensuring precise execution of the command.

4. Functional Workflow

- System powers on, and the microcontroller initializes the voice recognition module and robotic hand.
- The microphone captures the user’s voice, and the speech recognition algorithm processes it into a command.
- Command Execution: The processed command is sent to the microcontroller, which interprets it and activates the appropriate actuators to move the robotic hand.
- Feedback and Adjustment: Sensors monitor the hand's position and provide feedback to refine the movement in real-time.

6. Challenges and Solutions

- Challenge 1: Voice Recognition Accuracy
- Solution: Use advanced noise reduction algorithms and train the system on diverse speech datasets.
- Challenge 2: Precision in Hand Movements
- Solution: Employ high-quality servo motors and implement feedback loops using position sensors.
- Challenge 3: Latency Issues
- Solution: Optimize the microcontroller's processing algorithm to minimize delay.
- Challenge 4: Power Efficiency
- Solution: Use energy-efficient components and design a low-power standby mode.

7. Benefits of the Design

- Intuitive Control: Voice commands provide a user-friendly interface for operating the robotic hand.
- Versatility: The system can adapt to various applications, including assistive technologies and industrial automation.
- Scalability: The design allows for future enhancements, such as gesture control or AI-driven predictive actions.

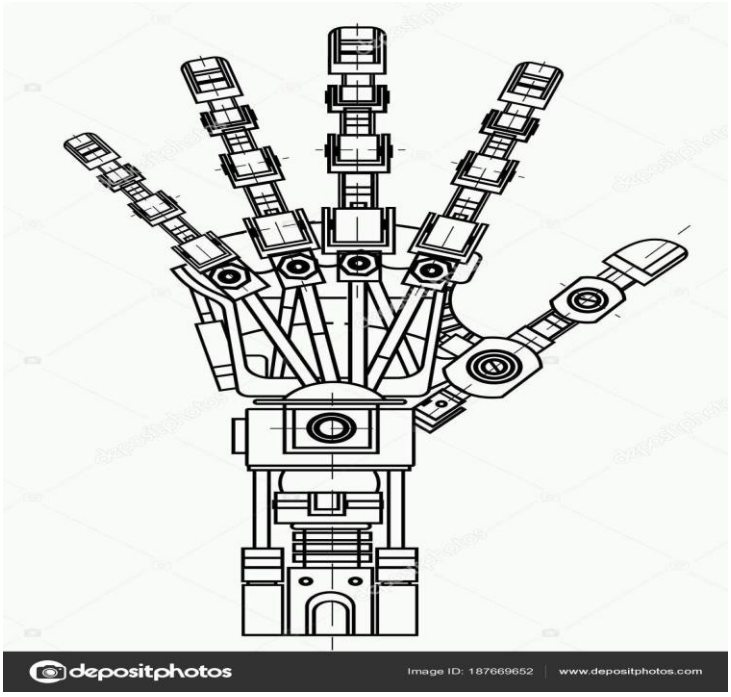


Fig-2.1: Design of Mechanical Robot Hand

2.3 Literature Survey

The Voice Control Robotic Hand Mechanism project builds upon a foundation of existing research in robotics, speech recognition, and human-machine interaction. A literature survey provides insight into the state-of-the-art technologies, methodologies, and challenges addressed by prior studies. Below is an overview of significant research and developments relevant to this project:

1. Speech Recognition Technology

Key Studies:
Rabiner, L., & Juang, B. H. (1993)
"Fundamentals of Speech Recognition" Focused on Hidden Markov Models (HMMs) as a basis for speech recognition systems. Discussed early methodologies for converting audio input into text commands. Graves, A., et al. (2013) "Speech Recognition with Deep Recurrent Neural Networks" Proposed Recurrent Neural Networks (RNNs) for continuous speech recognition, improving accuracy for real-time applications. Google Speech-to-Text API (2018) Introduced robust cloud-based speech recognition systems using deep learning. Showcased capabilities to handle diverse accents and noisy environments.
Insights: Advancements in speech recognition, particularly deep learning techniques like RNNs, Long Short-Term Memory (LSTM), and Transformer models, enable real-time and highly accurate voice command processing for robotics applications.

2. Robotic Hand Design and Control, Key Studies: Tao, Y., et al. (2002) "Development of a Five-Fingered Robotic Hand" Presented a robotic hand with multiple degrees of freedom (DOF) for precise motion. Emphasized the importance of integrating tactile and position sensors for feedback. Ma, Z., et al. (2016) "Soft Robotic Hands with Integrated Actuation and Sensing" Introduced soft robotics for human-like flexibility and adaptability. Conti, F., & Van der Smagt, P. (2016) "Hand Exoskeleton Devices for Rehabilitation and Assistance" Focused on the use of robotic hands for assistive and rehabilitative applications.
Insights: Designing robotic hands requires a balance between mechanical complexity and functionality. Incorporating soft materials and sensors enhances dexterity and adaptability, making these systems suitable for various environments.

3. Voice-Controlled Robotic Systems, Key Studies: Pandey, A., & Singhal, A. (2015) "Voice Recognition and Command Execution in Robotic Systems". Explored the integration of voice commands into robotic systems using Arduino and Google APIs. Highlighted challenges like noise interference and limited vocabulary recognition. Yadav, A., et al. (2018) "Design of Voice-Controlled Robotic Arm for Disabled People" Developed a robotic arm controlled by simple voice commands. Focused on improving accessibility and reducing dependency on physical interfaces. Amarasinghe, Y. W., et al. (2020) "IoT-Based Voice Control for Robotic Applications" Combined IoT with voice control, enabling remote operation via internet-connected devices. Insights: Voice-controlled robotics has shown significant potential in improving accessibility, particularly for individuals with disabilities. The integration of IoT and advanced APIs enhances remote functionality and system flexibility.
Key Challenges Identified in Literature: Voice Recognition Accuracy: Variations in accent, pronunciation, and noisy environments reduce reliability. Requires advanced filtering and adaptable machine learning models.
Latency in Real-Time Systems: Many systems exhibit delays due to processing limitations, especially in embedded systems.
Mechanical Complexity: High degrees of freedom in robotic hands often result in increased cost, weight, and complexity.
Limited Scalability: Most systems are designed for specific applications, limiting adaptability to broader use cases.

Proposed Solutions in Literature: Implementing deep learning models for better speech recognition. Using lightweight materials and modular designs for robotic hands. Optimizing microcontroller programming to reduce processing delays.

2.4 Time Plan

The following tables define the main tasks in the project introduction and project itself.

T1	Project Definition	1 Week
T2	Collecting data	11 Weeks
T3	Analysis	7 Weeks
T4	Theoretical calculation	4 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

Table- 01: Time Scheduled Table for Project Introduction

The time of the project introduction is scheduled over 16 weeks, table 2 shows how the work was scheduled over this time:

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1																
T2																
T3																
T4																
T5																
T6																

Table-02: Time Plan Table for Project Introduction

The following table defines the main tasks in the project:

T1	Collecting data	3 Week
T2	Implementation	10 Weeks
T3	Analysis	5 Weeks
T4	Building and testing the system	8 Weeks
T5	Documentation	10 Weeks
T6	Prepare for presentation	2 Weeks

Table-03: Time Scheduled Table for Project

The time of the project is scheduled over 16 weeks, table 4 shows how the work was scheduled over this time:

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T1	■	■	■													
T2			■	■	■	■	■	■	■	■	■	■				
T3				■	■	■	■	■								
T4							■	■	■	■	■	■	■	■		
T5					■	■	■	■	■	■	■	■	■	■		
T6															■	■

Table-04: Time Plan Table for Project

Chapter 3 Methodology

3.1 Process of Project

The development process for the Voice Control Robotic Hand Mechanism involves systematic steps to ensure successful integration of hardware and software components. Below is a step-by-step outline:

1. Planning Phase
2. System Design Phase
3. Prototyping Phase
4. Testing Phase
5. Refinement Phase
6. Final Integration and Testing Phase
7. Deployment Phase
8. Future Scope and Scalability

3.2 Block Diagram of This Project

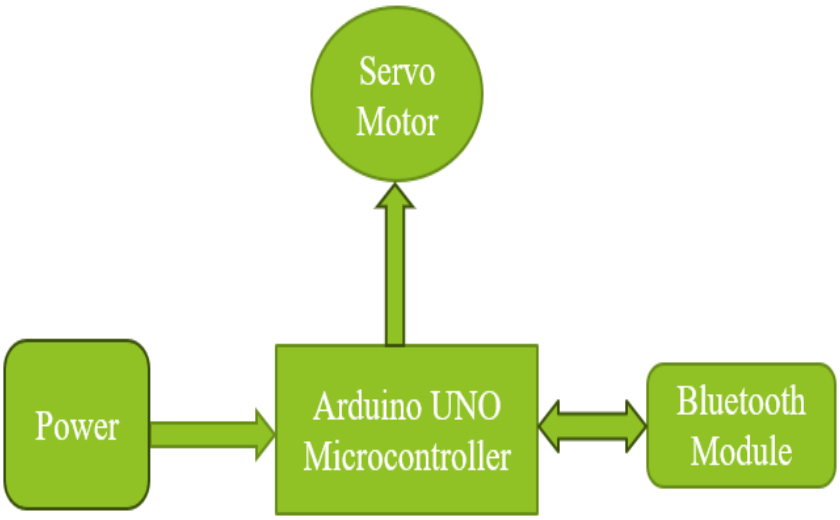


Fig-3.1: Block Diagram

3.3 Circuit Diagram of This Project

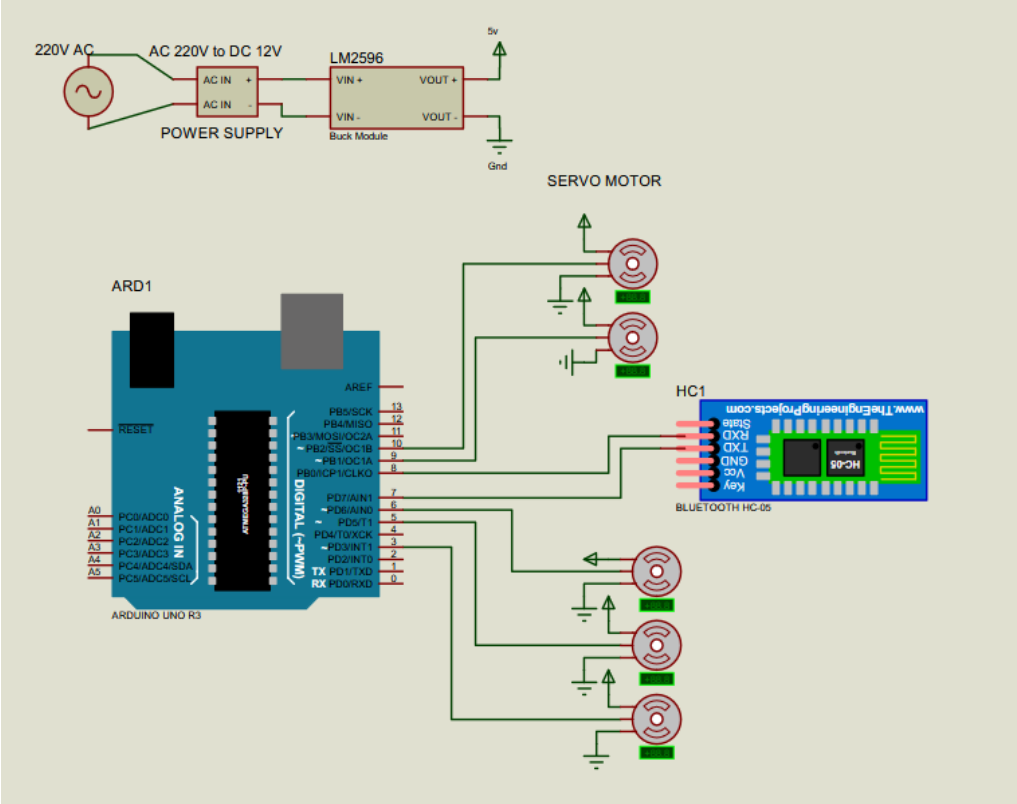


Fig-3.2: Circuit Diagram

3.4 Working Principal

The working principle of a Voice Control Robotic Hand project typically involves several key components and steps. Here's an overview of how it functions:

1. Voice Command Recognition:
Voice Input: The first step is to capture voice commands. This is achieved using a microphone or a voice recognition module (e.g., Google Assistant, Amazon Alexa, or a custom speech-to-text system).
Voice Recognition Module: The system processes the voice input using software or algorithms (such as Google Speech API, Python SpeechRecognition library, or other pre-trained models) to convert the audio signal into text. The system then interprets the text commands (e.g., "Open hand", "Close fist", "Rotate wrist").
2. Signal Processing:
The recognized voice command is sent to a microcontroller or a processor (like Arduino, Raspberry Pi, or similar). This microcontroller processes the command and translates it into actions.
3. Control System:
The microcontroller determines which motor or actuator to drive based on the command. The robotic hand typically includes servos or motors at the joints of the fingers, wrist, and possibly other parts.
For instance, a command like "Close fist" might trigger servos connected to each finger joint to move and close the hand.

Wireless Communication: If the voice control system is not directly wired to the robotic hand, wireless communication (like Bluetooth or Wi-Fi) can be used to send the control signals to the robotic hand.
4. Actuators & Mechanism:
The actuators (usually servo motors or stepper motors) are responsible for the actual movement of the robotic hand.
Each motor or servo is responsible for a specific part of the hand (fingers, wrist). For example, the servo motors rotate the joints to create finger movements like opening, closing, or gripping.
The movement is guided based on the commands processed from the speech input.
5. Feedback Loop (Optional):
Some advanced systems incorporate feedback mechanisms to give the robotic hand sensory data, such as touch or pressure sensors to detect the force being applied by the hand. This feedback can help refine the control of the hand and make it more adaptive to varying commands.
6. Integration & Power Supply:
The entire system (voice recognition, control system, actuators, sensors) is powered by an appropriate power supply, which could include batteries or a connection to an external power source.
The microcontroller, voice recognition unit, and actuators are all integrated into the robotic hand setup.
Key Technologies Involved:
Speech Recognition Algorithms: For converting voice to text.
Microcontroller: For processing commands.
Actuators/Servos: For moving the robotic fingers.
Wireless Communication (optional): For remote control.
Sensors (optional): For feedback on the hand's movement.
The combination of voice recognition and mechanical actuators allows users to control the robotic hand with voice commands, making it a highly interactive and efficient project for applications in assistive robotics or human-computer interaction.

3.5 The list of Devices used in the Project is Given Below

- Arduino UNO.
- Power Supply.
- Buck Module.
- Servo Motor.

3.6 Arduino UNO

The Arduino UNO is a microcontroller board based on the ATmega328p . It has 14 digital input/output pins (of which 5 can be used as PWM outputs), 6 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

3.6.1 Technical Specifications

- Microcontroller: ATmega328

- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limit): 6-20V
- Digital I/O Pins: 14 (of which 5 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 56 KB of which 8 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 101.52 mm
- Width: 53.3 mm
- Weight: 37 g



Fig- 3.3: Arduino UNO

3.7 Power Supply

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power, see AC adapter) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-

mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. The switched-mode power supply's higher electrical efficiency is an important advantage.

Switched-mode power supplies can also be substantially smaller and lighter than a linear supply because the transformer can be much smaller. This is because it operates at a high switching frequency which ranges from several hundred kHz to several MHz in contrast to the 50 or 60 Hz mains frequency. Despite the reduced transformer size, the power supply topology and the requirement for electromagnetic interference (EMI) suppression in commercial designs result in a usually much greater component count and corresponding circuit complexity.



Fig- 3.4: Switched Mode Power

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight is required. They are, however, more complicated; switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

3.7.1 Technical Specifications

- Input Voltage: AC 85-265V
- Output Voltage: DC 12V
- Current: 10A
- Size:128mm*98mm*40mm
- Shell Material: Metal case / Aluminum base

- Protection: Shortage Protection, Overload Protection, Over Voltage Protection
- Widely used in Industrial automation, LED display, communications, etc.
- Safety Compliance: CCC/ FCC / CE
- Working Temperature: 0~40℃
- Storage Temperature: -20~60℃
- Ambient Humidity: 0~95% Non-Condensation

3.8 Buck Module

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with



Fig- 3.5: LM2596 Voltage Converter

excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed frequency oscillator. The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators. Available in a standard 7-pin TO-220 package with several different lead bend options, and a 7-pin TO-263 surface mount package.

3.9 Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Mechanism: A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.



Fig- 3.6: Servo Motor

3.9.1 Technical Specifications

- Power Supply: Through External Adapter.
- Weight: 55g
- Operating Speed: 0.17sec / 60 degrees (4.8V no load)
- Operating Speed: 0.13sec / 60 degrees (6.0V no load)
- Stall Torque: 13 kg-cm (180.5 oz-in) at 4.8V
- Stall Torque: 15 kg-cm (208.3 oz-in) at 6V
- Operation Voltage: 4.8 - 7.2Volts
- Connector Wire: Heavy Duty, 11.81" (300mm)

3.10 Bluetooth Module

A Bluetooth module is a compact device that facilitates wireless communication between two devices using Bluetooth technology. It is commonly used in projects like the Voice-Controlled Robotic Hand for transmitting commands wirelessly from a voice recognition unit (like a smartphone or microcontroller) to the robotic hand.

3.10.1 Specifications

- Bluetooth protocal: Bluetooth Specification v2.0+EDR
- Frequency: 2.4GHz ISM band
- Modulation: GFSK(Gaussian Frequency Shift Keying)
- Emission power: ≤4dBm, Class 2

- Sensitivity: ≤-84dBm at 0.1% BER
- Speed: Asynchronous: 2.1Mbps(Max) / 160 kbps, Synchronous: 1Mbps/1Mbps
- Security: Authentication and encryption
- Profiles: Bluetooth serial port
- Power supply: +3.3VDC 50mA
- Working temperature: -20 ~ +75 Centigrade
- Dimension: 26.9mm x 13mm x 2.2 mm



Fig- 3.7: Bluetooth Module

Chapter 4 Result and Discussion

4.1 Result

The results of a Voice Control Robotic Hand project demonstrate the system's ability to accurately interpret voice commands and perform corresponding hand movements. Below are the typical outcomes and observations you might find:

Accurate Command Execution: The robotic hand performs tasks like opening and closing fingers, making a fist, or other predefined gestures based on voice input.

Commands such as "Open hand," "Close fist," or "Point index finger" are recognized and executed.

Wireless Control: Voice commands transmitted via Bluetooth or other wireless technologies ensure the system operates without physical connections.

Smooth Movements: The actuators (servos or motors) enable precise and smooth hand movements.

Performance Metrics: The system successfully identifies voice commands in a controlled environment (e.g., 85%–95% recognition accuracy). Accuracy may reduce in noisy environments if noise-cancellation techniques are not implemented.

Response Time: Time taken to process a voice command and execute the action is typically 1–2 seconds, depending on hardware and software optimization.

Range: Bluetooth modules like HC-05 allow control within a 10-meter range, while BLE or Wi-Fi can offer greater flexibility.

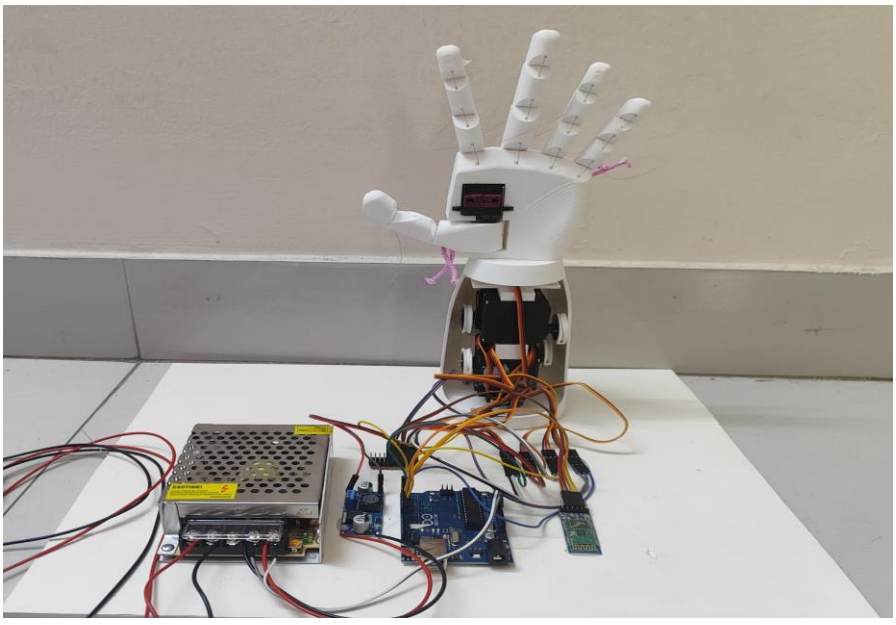


Fig-4.1: Project Picture

Gesture Imitation: The hand can imitate basic gestures, such as waving, grasping an object, or pointing.

Grip Control: Successful demonstration of gripping objects of varying sizes and weights (within the motor's capacity).
Interactive Control: The robotic hand can serve as an assistive device for physically challenged individuals.
Technical Outcomes: Hardware (microcontroller, Bluetooth module, actuators) and software (voice recognition algorithm) work seamlessly.
The Voice-Controlled Robotic Hand Project successfully bridges voice recognition and robotics, showcasing real-time command execution. The results highlight its feasibility for applications in prosthetics, human-computer interaction, and educational projects. While functional in its current state, the project offers significant scope for improvement and scalability.

4.2 Discussion

The Voice-Controlled Robotic Hand project represents a significant step in integrating human-computer interaction with assistive robotics. The following aspects of the project can be discussed to evaluate its design, performance, applications, and limitations. The project showcases a practical application of voice recognition and robotics in an intuitive way, enabling users to control the robotic hand using simple spoken commands. This approach eliminates the need for complex physical interfaces, making the system more user-friendly. The Voice-Controlled Robotic Hand project is a testament to the possibilities of combining voice recognition and robotics. While it effectively demonstrates basic functionality and potential applications, there is significant room for advancement in precision, adaptability, and scalability. By addressing the identified challenges, this project could evolve into a transformative solution for assistive technology and beyond.

Chapter 5: Conclusion & Recommendation

5.1 Advantage

- Enables users to control the robotic hand without the need for physical contact, making it ideal for multitasking and remote applications.
- Accessibility for People with Disabilities.
- Voice commands create an intuitive and natural way to interact with the system, requiring minimal training or technical knowledge.
- Automates repetitive or precise tasks with speed and accuracy, saving time and reducing human effort.
- Useful in various settings, such as homes, hospitals, factories, and laboratories, where hands-free operation can enhance safety and productivity.

5.2 Application

- Enables individuals with physical impairments to perform daily activities such as gripping objects, eating, or using tools.
- Acts as a prosthetic hand, improving independence and quality of life.
- Handles repetitive tasks like picking, placing, or sorting items, increasing efficiency and reducing fatigue for workers.
- Performs tasks in environments unsafe for humans, such as handling toxic substances or working in high-temperature zones.
- Assists surgeons by holding tools or performing precise movements during operations.
- Helps patients undergoing physical therapy by assisting in movement exercises.

5.3 Future Scope

The Voice-Controlled Robotic Hand Project lays the groundwork for innovative applications in robotics and voice recognition. To enhance its capabilities and broaden its usability, several areas of future work can be explored:

- Enhanced Voice Recognition
- Adaptive Command Learning
- Multimodal Control

5.4 Conclusion

The Voice-Controlled Robotic Hand Project successfully demonstrates the integration of voice recognition technology with robotics to create an intuitive, functional, and versatile system. By translating voice commands into precise mechanical movements, the project highlights the potential for natural and accessible human-machine interaction.

This innovative approach offers significant benefits, such as enabling hands-free operation, improving accessibility for individuals with disabilities, and automating repetitive tasks in industrial settings. The system's ability to perform tasks efficiently and accurately validates its design and implementation.

References:

[1] Ahmet, V. & Hilmi, K. (2016). Design of Voice Controlled Vehicle", International Conference on Advances Automotive Technologies 2016, Yildiz Technical University, Instanbul, Turkey, AAT2016.

[2] Alka, N. U. (2017). A Voice Controlled Pick and Place Robotic Arm Vehicle using Android Application. Unpublished, M.Eng. Mini Project,
Abubakar Tafawa Balewa University, BauchiNigeria.

[3] Bharat, S. A., Sabya, S. P., Ashish, S. & Patil, M. V. (2015). Robotic Arm Wirelessly Controlled by Android Application". International Journal of Engineering and Technical Research (IJETR),Vol.3.ISSN: 2321-
0869.

[4] Butkar, V. D., Devikar, S. R., Jaybhaye, V. B. & Shilpa, P. (2014). Android Based Pick and Place and Place Robot", International Journal of Informative and Futuristic Research, IJIFR/V2/E4/011, Vol.2, pp. 859-867, ISSN: 2347-1697.

[5] Kannan, K. & Selvakumar, J. (2015). Arduino Based Voice Controlled Robot", International Research Journal of Engineering and Technology (IRJET), Vol. 02, p-ISSN: 2395- 0072, e-ISSN:2395-0056.

[6] Muhammed, J. N., Neetha, J., Muhammed, F., Midhun, M., Mithun, S. & Safwan, C. N. (2015). Wireless Control of Pick and Place Robotic Arm Using an Android Application", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. (An ISO 3297: 2007 Certified Organization).

[7] Omijeh, B. O., Uhunmwangho, R. & Ehikhamenle, M. (2014). Design Analysis of a Remote Controlled Pick and Place Robotic Vehicle", International Journal of Engineering Research and Development, Vol.10, pp57-68, EISSN: 2278-067X, P-ISSN: 2278- 800X.

[8] Ritika, P. & Narender, K. (2014). Android Mobile Phone Controlled Bluetooth Robot Using 8051 Microcontroller", International Journal of Scientific Engineering and Research (IJSER), Vol.2. ISSN: 2347-3878.

[9] Shamsheer, V. (2013). Hand Gestures Remote Controlled Robotic Arm. Advance in Electronic and ElectricEngineering. Vol. 3(5), pp 601-606, ISSN 2231-1297.

[10] Subhash, P. R. (2014). Voice Controlled RoboticVehicle", International Journal of New Trends in Electronics and Communication (IJNTEC), Vol. 2, ISSN: 2347 – 7334.

Appendix:

Program:

```
#include <Servo.h>
#include <SoftwareSerial.h>

SoftwareSerial mySerial(7, 8);  // RX, TX
char command;
char c;
String voice;

Servo pinky;    // create servo object to control a servo
Servo middel;   // create servo object to control a servo
Servo index;    // create servo object to control a servo
Servo thumb;    // create servo object to control a servo
Servo thumblr;  // create servo object to control a servo


int thembservo;
int themblrservo;
int indexservo;
int middelservo;
int ringservo;
int pinkyservo;

void setup() {
  Serial.begin(9600);
  mySerial.begin(9600);


  pinky.attach(10);   // attaches the servo on pin 9 to the servo object
  middel.attach(9);   // attaches the servo on pin 9 to the servo object
  index.attach(6);    // attaches the servo on pin 9 to the servo object
  thumb.attach(5);    // attaches the servo on pin 9 to the servo object
  thumblr.attach(3);  // attaches the servo on pin 9 to the servo object

  pinky.write(0);      //Range 0-150
  middel.write(0);     //Range 0-180
  index.write(180);    //Range 180-0
  thumb.write(0);      //Range 0-90
  thumblr.write(120);  //Range 160-90
}
```

```
void loop() {

  while (mySerial.available()) {
    delay(10);
    c = mySerial.read();

    if (c == '#') {
      command = c;
      break;
    } else if (c != '*') {
      voice += char(c);
    }
  }

  if (voice.length() > 0) {
    Serial.println(voice);
  }


  // thembservo

  if (voice.equalsIgnoreCase("Ham aap") || voice.equalsIgnoreCase("thumbs up") ||
voice.equalsIgnoreCase("Khan sahab") || command == '1' || voice.equals("Ham aap") ||
voice.equals("thumbs up") || voice.equals("Khan sahab")) {
    // thembservo = 0;
    // themblrservo = 120;
    thumb.write(0);      //Range 0-90
    thumblr.write(120);  //Range 160-90
  }

  if (voice.equalsIgnoreCase("thumbs down") || voice.equalsIgnoreCase("songs down") ||
command == '2' || voice.equals("thumbs down") || voice.equals("songs down")) {
    // thembservo = 90;
    // themblrservo = 0;
    thumb.write(90);   //Range 0-90
    thumblr.write(0);  //Range 160-90
  }

  // indexservo

  if (voice.equalsIgnoreCase("index of") || voice.equalsIgnoreCase("index up") || command ==
'3' || voice.equals("index of") || voice.equals("index up")) {
    // indexservo = 180;
    index.write(180);  //Range 180-0
```

```
  }

  if (voice.equalsIgnoreCase("index down") || voice.equalsIgnoreCase("index Don") ||
voice.equalsIgnoreCase("index done") || command == '4' || voice.equals("index down") ||
voice.equals("index Don") || voice.equals("index done")) {
    // indexservo = 0;
    index.write(0);  //Range 180-0
  }

  // middelservo

  if (voice.equalsIgnoreCase("middle of") || voice.equalsIgnoreCase("middle up") || command
== '5' || voice.equals("middle of") || voice.equals("middle up")) {
    // middelservo = 0;
    middel.write(0);  //Range 0-180
  }

  if (voice.equalsIgnoreCase("middle down") || voice.equalsIgnoreCase("Middleton") ||
voice.equalsIgnoreCase("middle done") || command == '6' || voice.equals("middle down") ||
voice.equals("Middleton") || voice.equals("middle done")) {
    // middelservo = 180;
    middel.write(180);  //Range 0-180
  }

  // pinkyservo

  if (voice.equalsIgnoreCase("Pinky aap") || voice.equalsIgnoreCase("Pinky up") || command
== '7' || voice.equals("Pinky up") || voice.equals("Pinky aap")) {
    // pinkyservo = 0;
    pinky.write(0);  //Range 0-150
  }

  if (voice.equalsIgnoreCase("Pinky down") || voice.equalsIgnoreCase("Pinky Dan") ||
voice.equalsIgnoreCase("Pinky Don") || command == '8' || voice.equals("Pinky Don") ||
voice.equals("Pinky Dan") || voice.equals("Pinky down")) {
    // pinkyservo = 180;
    pinky.write(180);  //Range 0-150
  }

  // allservo

  if (voice.equalsIgnoreCase("all up") || voice.equalsIgnoreCase("all of") || command == '9' ||
voice.equals("all up") || voice.equals("all of")) {

    pinky.write(0);      //Range 0-150
```

```
   middel.write(0);     //Range 0-180
   index.write(180);    //Range 180-0
   thumb.write(0);      //Range 0-90
   thumblr.write(120);  //Range 160-90
  }

  if (voice.equalsIgnoreCase("all down") || voice.equalsIgnoreCase("all done") || command ==
'10' || voice.equals("all down") || voice.equals("all done")) {


   pinky.write(180);   //Range 0-150
   middel.write(180);  //Range 0-180
   index.write(0);     //Range 180-0
   thumb.write(90);    //Range 0-90
   thumblr.write(0);   //Range 160-90
  }

  command = 's';
  voice = "";
}
```