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A

PROJECT REPORT ON

"HAND GESTURE-CONTROLLED ROBOT USING ARDUINO WITH INTEGRATED CLEANING SYSTEM"

SUBMITTED BY

Seat No.	Name of Students
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Under The Guidance of
DR. A. D. SHIRALKAR

In Partial fulfillment of the requirement for the
Degree of Electrical Engineering

SAVITRIBAI PULE UNIVERSITY, PUNE
(2023-2024)

ALL INDIA SHRI SHIVAJI MEMORIAL SOCIETY'S
INSTITUTE OF INFORMATION TECHNOLOGY, PUNE
ACADEMIC YEAR 2022-2023

SDG 9: Industry, Innovation and Infrastructure

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Department of Electrical Engineering

VISION

To be known for imparting quality education in the field of electrical engineering and preparing competent professionals with high human values to serve society.

MISSION

- To train the graduates with the latest technologies through industry institute interactions and experiential teaching learning practices to meet the emerging global challenges.
- To enhance engineering skills, employability skills, and research through professional activities.
- To develop globally competent electrical engineers with professional ethics and commitment to society.

PROGRAM EDUCATION OBJECTIVES

Graduates will

- Investigate problems in electrical engineering and provide effective solutions.
- Excel in professional careers, research, higher studies, and entrepreneurship.
- Engage in lifelong learning by adapting a professional, social, and ethical attitude for contributing to societal needs.

PROGRAM SPECIFIC OUTCOMES

- PSO 1: The graduates will be able to proficiently employ the software tools used in the design and analysis of electrical systems.
- PSO2: The graduates will be able to acquire skills in electric mobility, power quality, and renewable energy.

PROGRAM OUTCOMES (POs)

Graduates will be able to-

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.[**Engineering knowledge]**

- Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. [**Problem analysis]**

- Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public healthand safety, and the cultural, societal, and environmental considerations.[**Design/development of solutions]**

- Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. [**Conduct investigations of complex problems]**

- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. [**Modern tool usage]**

- Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. [**The engineer and society]**

- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. [**Environment and sustainability]**

- Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. [**Ethics]**

- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. [**Individual and team work]**

- Communicate effectively on complex engineering activities with the engineeringcommunity and with society at large, such as, being able to comprehend and write effectivereports and design documentation, make effective presentations, and give and receive clearinstructions. [**Communication]**

- Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. [**Project management and finance]**

- Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. [**Life-long learning]**

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CERTIFICATE

This is to certify that the project report entitled.

"HAND GESTURE-CONTROLLED ROBOT USING ARDUINO WITH INTEGRATED CLEANING SYSTEM"

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B190252557	Ms. Disha Raut

Is a bonafide work carried out by them under the supervision of **Dr. A. D. SHIRALKAR** and it is approved for the partial fulfillment of the requirement of Savitribai Phule Pune University, for the award of the degrees of **Bachelor of Engineering** (Electrical Engineering).

This project report has not been submitted earlier to any other or university for the award of any degree or diploma.

Dr. A. D. Shiralkar
Internal Guide
Department of Electrical Engineering

Dr. A. D. Shiralkar
Head of Department
Department of Electrical Engineering

External Examiner

Dr. P. B. Mane
Principal
AISSMS Institute of Information Technology, Pune.

ACKNOWLEDGEMENT

It is my great pleasure to express sincere and deep gratitude towards my guide **Dr. A. D. Shiralkar**, Assistant Professor Electrical Engineering Department for her valuable guidance and constant support throughout this work.

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The motivation factor for this work was the inspiration given to me by our Honorable Principal **Dr. P. B. Mane.**

Lastly, I am thankful to those who have directly or indirectly supported our work.

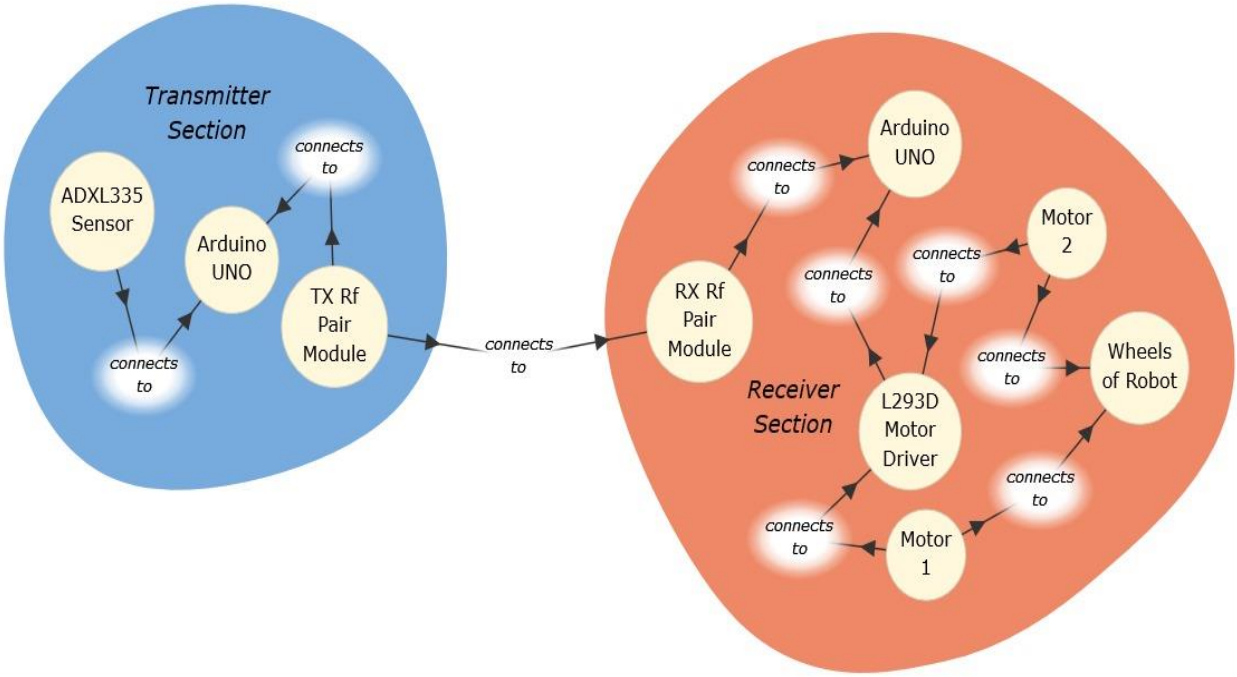
Sign	Sign	Sign	Sign
Sandesh Dongare	**Shannon Dsouza**	**Santwik Khedekar**	**Disha Raut**

ABSTRACT

The motivation behind the Gesture-Controlled Robot with an integrated cleaning system is to simplify household cleaning tasks. Traditional cleaning often requires users to physically move and hold the device, making the cleaning process labor-intensive and time-consuming. This innovation allows users to effortlessly control the robot's movement and cleaning operations through predefined gestures, making the interaction easier. This Gesture-Controlled Robot will be equipped with a soft-bristled cleaning brush, aligning with the growing demand for smart home technologies and promoting energy efficiency and automation in domestic cleaning tasks. This offers a glimpse into the future of intelligent, user-friendly, and autonomous household appliances.

KEYWORDS: robot, gesture-controlled, Arduino Uno, integration, brush.

SYSTEM ORIENTED CONCEPT MAP EXTENSION (SOCME)



SUSTAINABLE DEVELOPMENT GOALS (SDG)

SDG 9: Industry, Innovation and Infrastructure

The Hand Gesture Controlled Robot with an Integrated Cleaning System aligns with SDG 9 by advancing innovation in robotics and automation, contributing to resilient infrastructure and sustainable industrialization. By replacing traditional, labor-intensive cleaning methods with a gesture-controlled robot, the project fosters technological progress and enhances productivity. Utilizing an Arduino-based platform makes this technology accessible, encouraging further innovation and development. This project supports economic growth by reducing manual labor, creating opportunities for skill development in robotics and automation, and ensuring that technological advancements are inclusive and beneficial for all.

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LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Robotics is a field where engineering meets innovation, focuses on creating, building, and guiding robots to perform tasks independently or alongside humans. Recent breakthroughs in artificial intelligence (AI) have propelled robotics into a new era, allowing robots to perceive and interact with their surroundings intelligently. Through AI algorithms, robots are now capable of learning, recognizing objects, and understanding human language, empowering them to adapt and operate autonomously in various scenarios. The traditional methods for controlling robots typically involve remote controllers, complex programming. However, these methods can create barriers for user friendly interaction. Addressing this need, the project aims to bridge the gap between humans and robots through the natural language of gestures. The project's main objective is to develop a hand gesture-controlled robot that responds to specific user gestures. The project seeks to provide a user-friendly and engaging method for controlling robots in real-time. It uses Arduino, an open-source electronics platform and integrating sensors capable of recognizing hand gestures. It also provides an integrated brush which is fixed on the robot which makes household chores more interactive and engaging.

In addition to introducing the project's purpose and goals, this report provides an overview of its key components and methodology. It includes a review of relevant literature to explain the project's approach. Method details, such as how the transmission and receiving systems work, along with the cleaning mechanism, are also covered. Furthermore, a detailed list of components is included, explaining what they are and how they function. The report wraps up with a discussion on how the project can be applied practically.

1.1 MOTIVATION

The motivation behind this report lies in the pursuit of creating a more intuitive, user-friendly, and efficient cleaning experience. Hand gestures provide a natural and seamless means of communication, eliminating the need for complex remote controls or direct physical manipulation. This also fulfills the need for people with mobility challenges, making cleaning tasks more accessible to a diverse range of users. Traditional cleaning often requires manual operation and constant monitoring, limiting their efficiency and adaptability. Also, if we compare the vacuum cleaners available now are all automated, which has increased the cost. Having an automated vacuum cleaner at that price has become a luxury. So, the project aims to combine gesture control technology powered by Arduino with the integrated soft bristled brush cleaning system and create a user-friendly experience with simple hand movements and make cleaning fun and interactive and at a low cost.

1.2 PROBLEM STATEMENT

The conventional methods of controlling robots through programming or remote devices lack intuitive and seamless human interaction. This paper aims to address this limitation by designing a hand gesture-controlled robot. The challenge is to develop a system that can accurately recognize and interpret hand gestures, allowing users to control the robot effortlessly and naturally. This technology could potentially transform human-robot interaction and find applications in diverse fields.

1.3 OBJECTIVES

- To develop a hand gesture recognition algorithm to interpret different hand movements for controlling the robot's forward, backward, left, right, and stop actions.
- To eliminate the errors for smooth functioning.
- To implement real-time response, ensuring the hand gesture-controlled robot responds smoothly to user gestures.
- To create a user-friendly interface, allowing users of all ages to interact.

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1.4 THESIS OUTLINE

1. The project thesis is divided into seven chapters, covering all topics in detail.

2. The first chapter provides an introduction to the project, including an overview, theory, objectives, and problem statement.

3. The second chapter presents a literature review that guided the project.

4. The third chapter describes the research methodology, including the proposed system, flow chart, circuit diagram, and a brief explanation of the system's operation.

5. The fourth chapter outlines the system requirements, detailing the necessary hardware and software for the proposed system.

6. The fifth chapter details the results and experimental setup of the proposed system.

7. The sixth chapter offers the conclusion and discusses the future scope of the project.

8. The seventh and final chapter lists the references for the literature review.

CHAPTER 2: LITURATURE REVIEW

1. Paper describes Implementation of Robot Control Using Human Hand Gestures. This paper describes a system that uses human hand gestures to control a robot, employing sensors to capture and interpret movements in real-time.

2. Paper describes Real-Time Target Detection and Localization for Controlling a Distant Mobile Robot. The authors present a method for detecting and localizing targets to control a mobile robot remotely, using image processing techniques for real-time navigation.

3. Paper describes Modeling and Designing a Gesture Control Robot. This paper provides a theoretical framework for designing a robot that can be controlled through hand gestures, focusing on the necessary components and their interactions.

4.Paper describes Emotional Interaction Between Mobile Robot and Human Using Hand Gestures. The goal is to demonstrate how mobile robots can emotionally interact with humans through elaborate hand gestures, enhancing user engagement.

5.Paper describes Controlling Robotic Arm Movements with an Accelerometer/Gyroscope-Based Gesture Controller. The research details how a robotic arm can be controlled using a gesture controller with accelerometers and gyroscopes, translating hand motions into precise arm movements.

6.Paper describes Creating a Programmable Component for Hand Sign Response. This paper outlines the development of a programmable component that responds to hand signs, enabling customized gesture-based interactions.

7.Paper describes System with 120 Gestures and 10-Meter Communication Range for Mobile Robot. The system recognizes 120 distinct hand gestures to control a mobile robot within a 10-meter range, offering versatile and responsive control for remote operations.

CHAPTER 3: RESEARCH METHODOLOGY OF PROPOSED SYSTEM

The project is divided into 3 sections to make it simple and prevent complexity. First section includes transmitting unit and its components. Second section consist of receiving unit. Third section encompasses integration with soft bristled brush.

The first section includes the transmitting section which includes-

Accelerometer ADXL335, Arduino Uno Atmega328, RF transmitter TX (433MHz). The ADXL335 is a compact and energy-efficient 3-axis accelerometer sensor, perfectly suited for applications such as hand gesture-controlled robots. It possesses the capability to detect acceleration across the X, Y, and Z axes. The Arduino Uno, based on the ATmega328P chip, interfaces with the ADXL335 accelerometer, which provides three-axis analog outputs corresponding to hand gestures. An RF pair module is a wireless communication device that consists of a transmitter and a receiver module. RF pair modules typically operate in the 433 MHz or 2.4 GHz bands. They are ideal for wireless communication because they are relatively free from interference from other devices.

The second section includes the receiving section which includes-

RF Receiver Module, L293D Motor Driver, DC motors, Arduino Uno Atmega328.

The L293D serves as a dual-channel H-bridge motor driver IC, enabling the management of either two DC motors independently or a single stepper motor.

The third section includes-

This will include the integration of a soft bristled brush which is ideal for removing dust, hair, and other light debris without scratching or damaging the surface for cleaning purposes.

3.1 BLOCK DIAGRAM

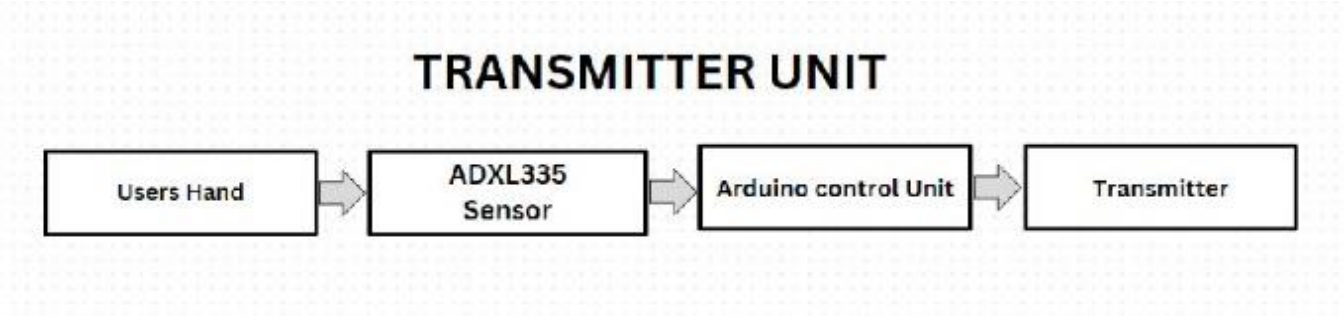

Figure 1: Block diagram of Transmitting Section.

The transmitter unit consists of an ADXL335 accelerometer sensor, an Arduino microcontroller, and an RF transmitter circuit. The ADXL335 accelerometer sensor is a three-axis accelerometer that measures the acceleration of the user's hand. The sensor is connected to the Arduino using wires. The Arduino is a microcontroller that processes the signals from the accelerometer and transmits them to the receiver unit using the RF transmitter circuit. The ADXL335 sensor is connected to the Arduino's analog pins A0, A1, and A2. These pins are used to read the voltage output from the sensor, which corresponds to the acceleration on each axis. The RF transmitter circuit is connected to the Arduino's digital pins 12 and Ground (GND). These pins are used to control the serial communication between the Arduino and the RF transmitter module.

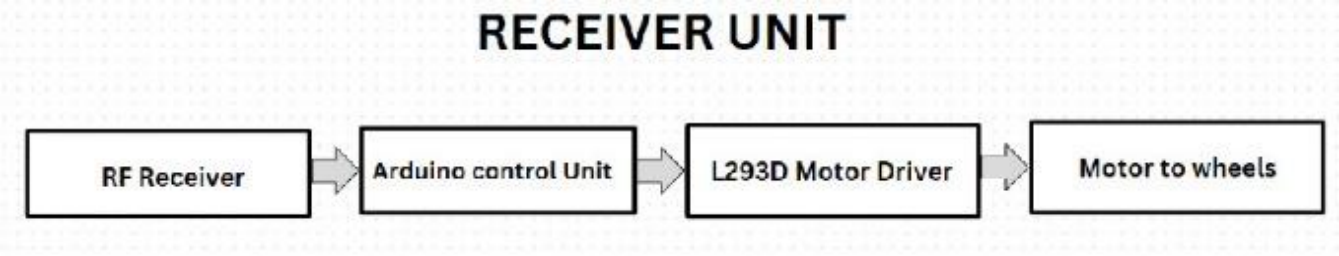

Figure 2: Block diagram of Receiving section.

In the Receiver circuit setup, the functionality revolves around the coordination of several key components.

Initially, the transmitter unit sends a signal wirelessly, which is captured by the RF receiver module. This received signal is then relayed to the Arduino microcontroller for processing. Upon interpretation of the data, the Arduino generates corresponding control signals, which are transmitted to the L293D motor driver. Acting as an intermediary, the motor driver regulates the voltage supplied to the two DC motors, thereby dictating their direction and speed. Consequently, the movement of the motors propels the robot in accordance with the instructions received from the Arduino. This sequential process illustrates the orchestrated interaction between the components to enable the desired functionality of the circuit.

3.2 CIRCUIT DIAGRAM

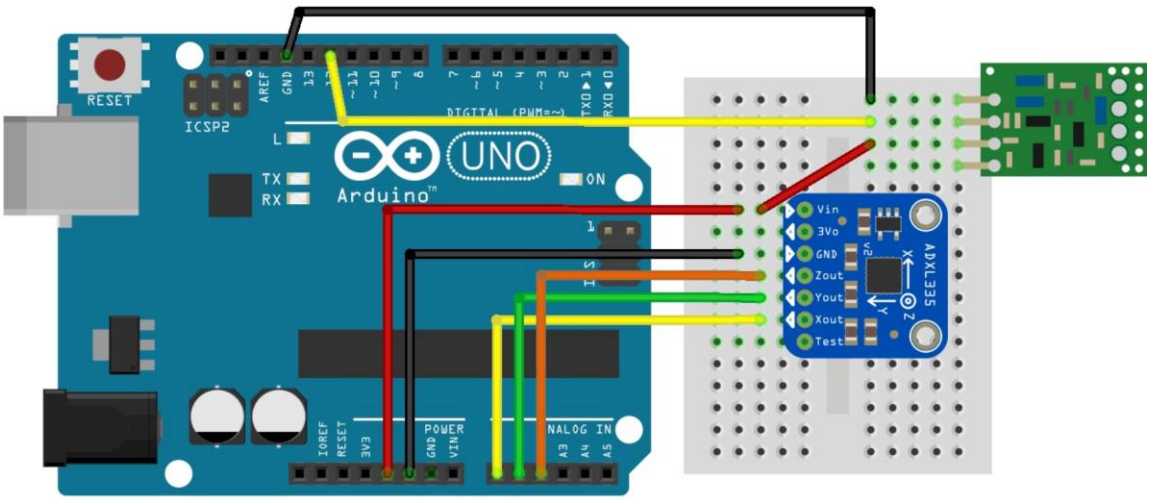

Figure 3:Transmitting unit

The transmitter unit consists of an ADXL335 accelerometer sensor, an Arduino microcontroller, and an RF transmitter circuit.

The ADXL335 accelerometer sensor is a three-axis accelerometer that measures the acceleration of the user's hand. The sensor is connected to the Arduino using wires. The Arduino is a microcontroller that processes the signals from the accelerometer and transmits them to the receiver unit using the RF transmitter circuit.

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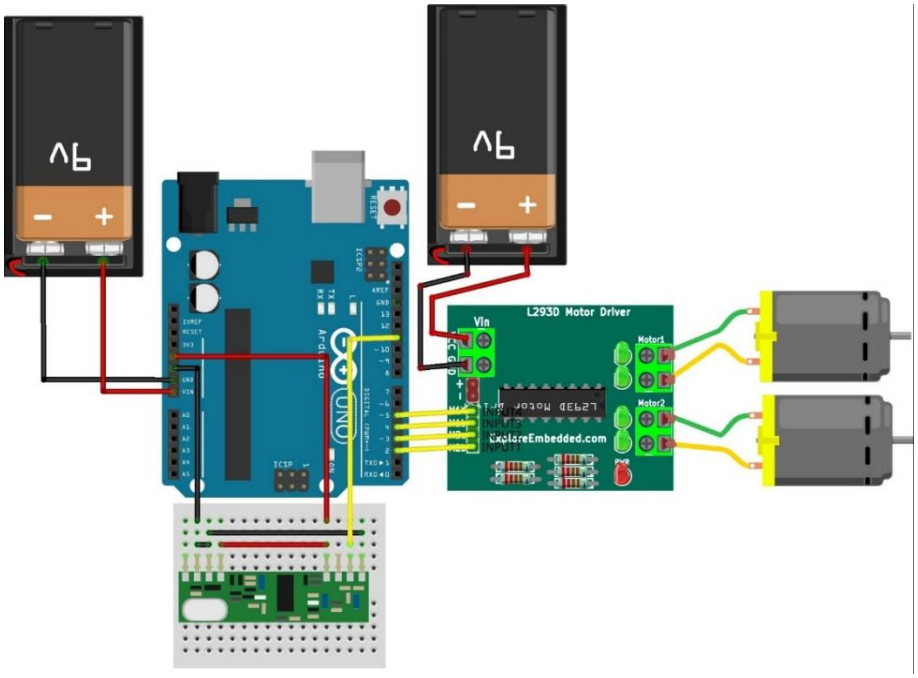

Figure 4:Receiving unit

In the Receiver circuit setup, the functionality revolves around the coordination of several key components. Initially, the transmitter unit sends a signal wirelessly, which is captured by the RF receiver module. This received signal is then relayed to the Arduino microcontroller for processing. Upon interpretation of the data, the Arduino generates corresponding control signals, which are transmitted to the L293D motor driver. Acting as an intermediary, the motor driver regulates the voltage supplied to the two DC motors, thereby dictating their direction and speed. Consequently, the movement of the motors propels the robot in accordance with the instructions received from the Arduino. This sequential process illustrates the orchestrated interaction between the components to enable the desired functionality of the circuit.

CHAPTER 4: SYSTEM REQUIREMENT

1) Hardware Requirement

The project utilizes an Arduino UNO and an ADXL335 Triple Axis Accelerometer to enable gesture-based control of a two-wheel drive robot car chassis. Wireless communication is achieved through an RF433 MHz Transmitter and Receiver module, while motor control is handled by an L293D Motor Drive Module. A 9V battery powers the system, with connectivity facilitated by a battery snap connector and jumper wires on a 170-point mini breadboard.

Sr. No.	**Name Of Component**	**Quantity**
1	Arduino UNO	2
2	ADXL335 Triple Axis Accelerometer	1
3	2WD Two Wheel Drive Robot Car Chassis	1
4	170 Points Mini Breadboard	3
5	Jumper wires	-
6	RF433 MHz Transmitter Receiver Wireless Module	1
7	L293D Motor Drive Module	1
8	9V Battery	4
9	Battery Snap Connector to DC Barrel Jack Adapter	1

2) Software Requirement: Arduino IDE

The Arduino IDE was chosen for its user-friendly interface and extensive support for the Arduino hardware platform. It simplifies coding and debugging with features tailored for beginners and experienced developers alike. Additionally, its vast library ecosystem and active community support make it an ideal choice for developing and refining the gesture-controlled robot project.

4.1 ARDUINO UNO ATMEGA328P FOR TRANSMITTER RECEIVER UNIT

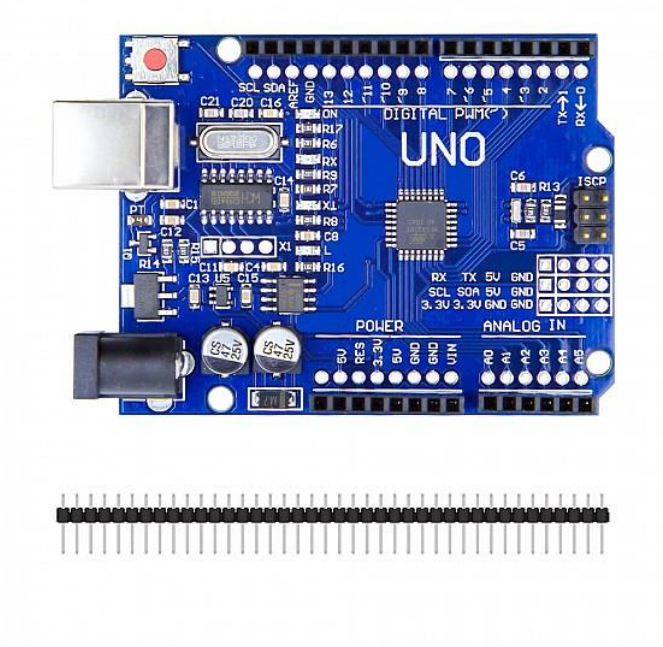

Figure 5:Arduino UNO

The Arduino UNO is a microcontroller board based on the ATmega328P. It is equipped with a 16 MHz ceramic resonator, 6 analog inputs, 14 digital input/output pins (with 6 of them configurable as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. It comes fully equipped to support the microcontroller, requiring only a USB cable to connect to a computer or an AC-to-DC adapter or battery for power. In this paper it is responsible for interpreting the hand gestures and translating them into motor commands for the robot to follow. It serves as the central processing unit for our hand gesture-controlled robot, interpreting commands from the ADXL335 accelerometer and controlling the robot's movements via the L293D motor driver. Communication with the robot is facilitated through the RF pair module.

4.2 ADXL SENSOR FOR TRANSMITTER UNIT

Figure 6:ADXL Sensor

The ADXL335 represents a compact, energy-efficient 3 axis accelerometer sensor, well-suited for integration into hand gesture-controlled robots. It possesses the capability to detect acceleration across all 3 axes - X, Y, and Z, within a range of ±3 g. This means that it can measure acceleration up to 3 times the acceleration of gravity. The ADXL335 sensor is connected to the Arduino board, which reads the sensor data and processes it to identify the desired robot movement. Subsequently, the Arduino board produces PWM signals to manage both the direction and speed of the motors in the robot.[15]

Features of ADXL sensor:-

- It offers 3-axis sensing capabilities. Housed in a compact, low-profile 4 mm × 4 mm × 1.45 mm LFCSP package.
- It operates at low power, typically consuming 350 μA.
- Compatible with single-supply operation ranging from 1.8 V to 3.6 V.
- It withstands shock of up to 10,000 g.

- Demonstrates excellent temperature stability.
- Allows bandwidth adjustment with a single capacitor per axis.
- Compliant with RoHS/WEEE standards, ensuring lead-free composition.

4.3 L293D MOTOR DRIVER FOR RECEIVER UNIT

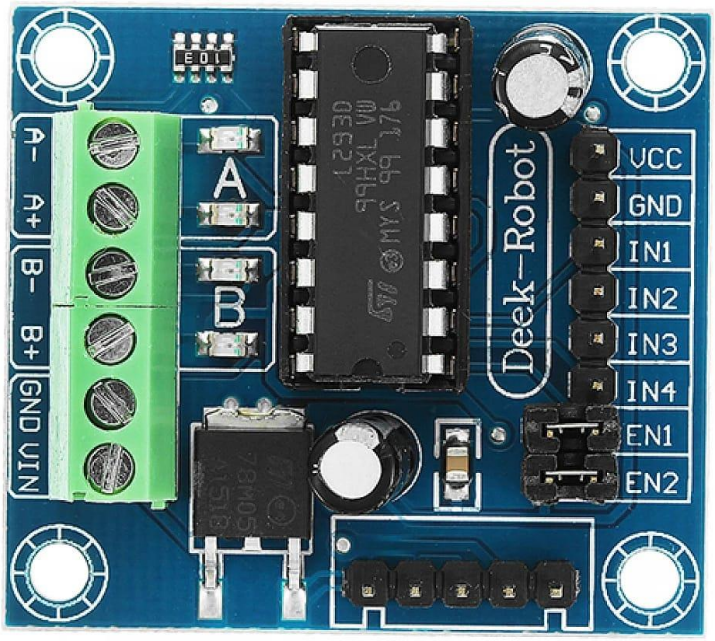

Figure 7:L293D Motor Driver

The L293D functions as a dual-channel H-bridge motor driver IC, facilitating the control of two DC motors. For each motor channel, the L293D provides two inputs, labeled as IN1 and IN2. These inputs dictate the motor's rotational direction. When IN1 is set to a high signal and IN2 to a low signal, the motor rotates in one direction. Conversely, if IN2 is high and IN1 is low, the motor rotates in the opposite direction. When both IN1 and IN2 are low, the motor ceases operation. The L293D also has two outputs for each motor channel: OUT1 and OUT2. These outputs are connected to the motor itself. The L293D uses a variety of internal circuits to control the current flow to the motor, which enables the regulation of both motor speed and torque.

4.4 RF PAIR MODULE FOR TRANSMITTER AND RECEIVER UNIT

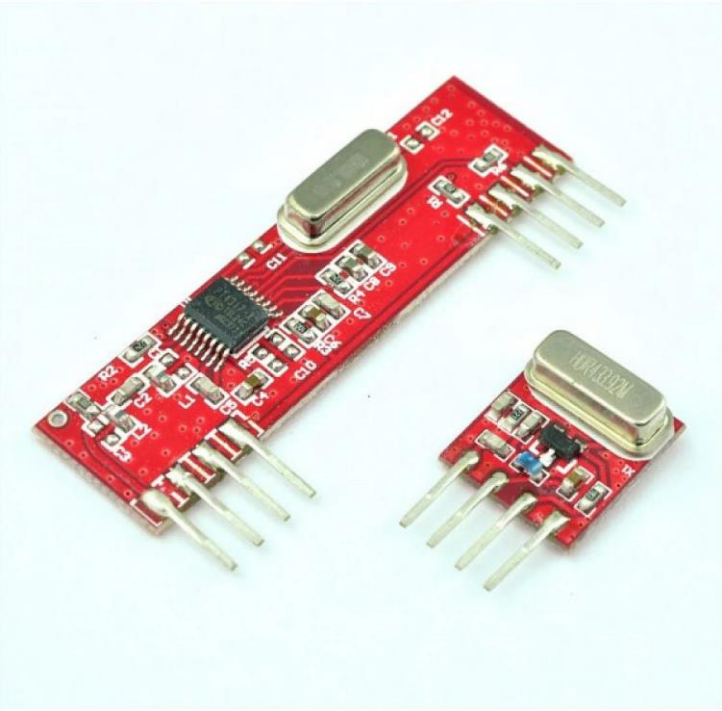

Figure 8:RF pair module

A wireless communication device made up of a transmitter and a receiver module is called an RF pair module.

The frequency ranges in which RF pair modules normally function are 433 MHz and 2.4 GHz. These frequency ranges are comparatively free from other device interference, making them perfect for wireless communication.

Utilizing RF pair modules is quite simple. By connecting the Arduino to the transmitting module, it may communicate the appropriate orders to the transmitter. The commands are then broadcast over the air to the receiving module via the transmitting module. The receiver module is attached to the robot, through which it receives and processes commands. The Arduino controller oversees sending and receiving commands. The intended orders are sent by the Arduino board to the transmitter module, which subsequently sends them to the receiver module via radio transmission. The robot then carries out the instructions that it receives from the receiving module.

When it comes to hand gesture-controlled robots, RF pair modules offer a flexible and dependable method for wireless communication between the Arduino and the robot. They have a broad communication range and are comparatively simple to use.

Specifications of RF Pair model: -

- It provides a range of 100 meters in open space under standard conditions.
- The RX receiver operates at a frequency of 433 MHz with a typical sensitivity of 105 dBm.
- The RX receiver requires a supply current of 3.5 mA and operates at an IF frequency of 1 MHz.
- It operates at an operating voltage of 5V.
- The TX frequency range is 433.92 MHz, with a supply voltage requirement of 3V to 6V.
- The TX module offers an output power range of 4 to 12 dBm.

Features of RF Pair model: -

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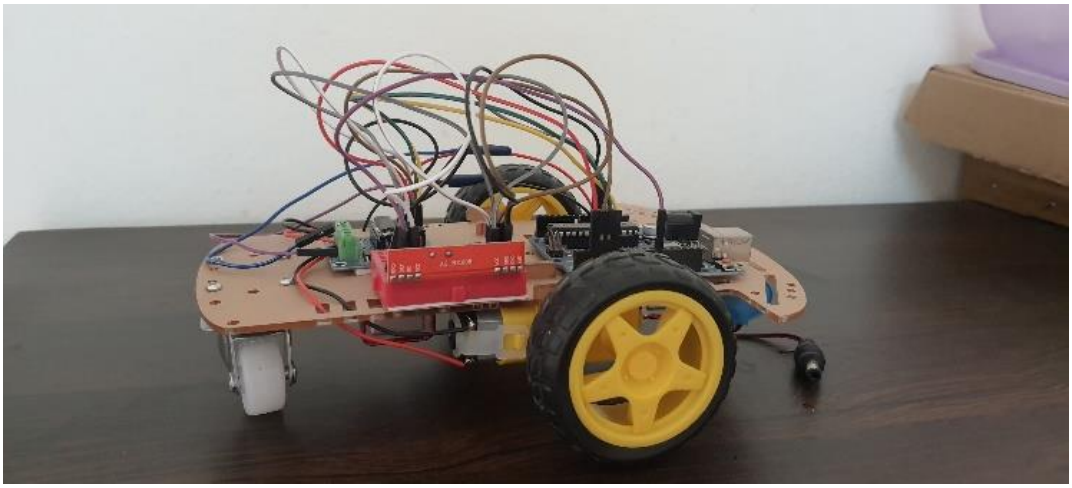
- It operates at an operating voltage of 5V.
- The TX frequency range is 433.92 MHz, with a supply voltage requirement of 3V to 6V.
- The TX module offers an output power range of 4 to 12 dBm.

4.5 ROBOT CHASSIS FOR HAND GESTURE ROBOTS

Robot chassis is lightweight and durable for the robot to move easily. The chassis is flexible enough to allow the robot to move freely in all directions. The chassis is stable enough to prevent the robot from tipping over. The wheels allow the robot to move in any direction, including sideways and backwards. The rubber wheels have good traction to prevent them from slipping on smooth surfaces. List of components is mentioned in Table 1.



After connecting Arduino along with the ADXL335 and RF transmitter, to the gloves worn on the hand. When the ADXL335 detects a tilt, it will transmit its data to the Arduino. The Arduino, in turn, will send the information via RF transmitter. For instance, if there is a forward tilt, the Arduino will read 'f' (forward), and the RF transmitter will send this to the receiver unit fixed on the robot chassis. The receiver unit comprises an RF receiver, Arduino, and motor driver. Upon receiving the 'f' signal, the RF receiver will pass it to the Arduino, which will then instruct the motor driver to move the robot forward. This programming logic will be replicated for backward, right, and left directions.

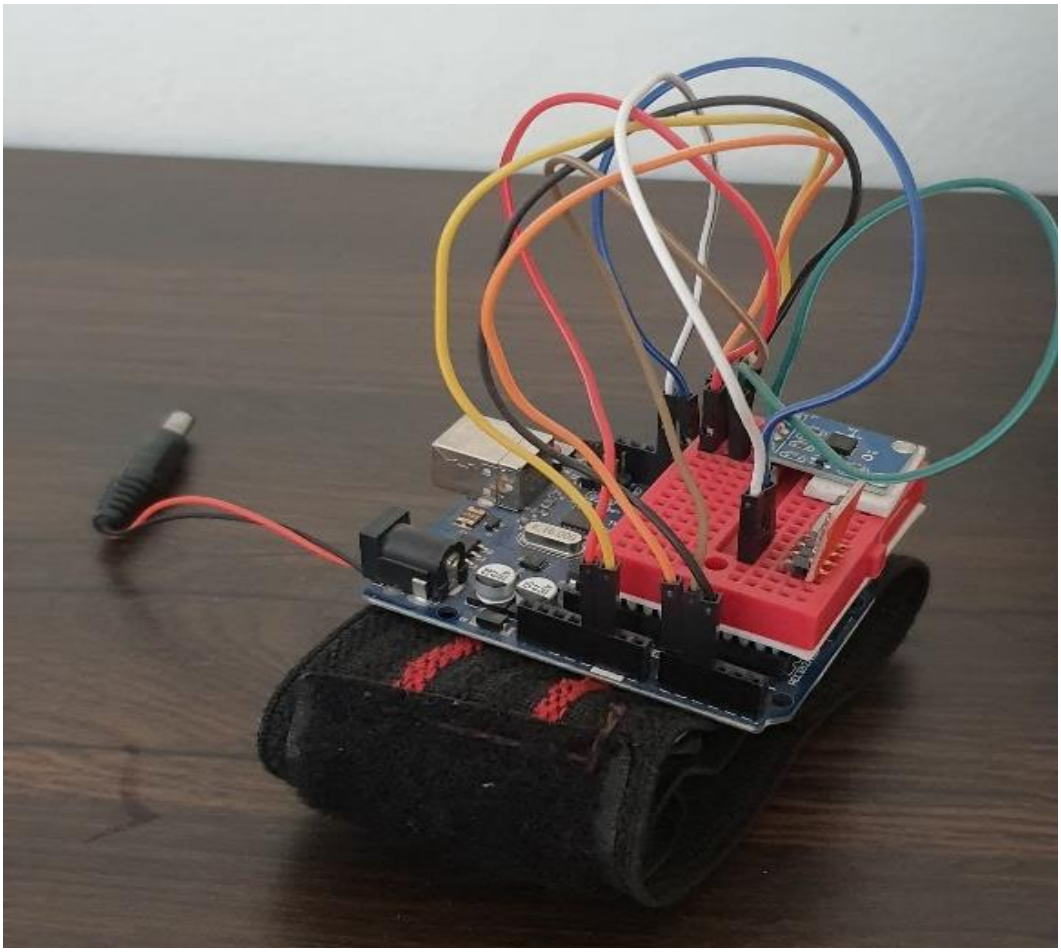


Figure 9:Model image.

CHAPTER 5: RESULT

Transmitter Unit:

In our setup, we utilize two Arduinos—one housed on our hand, and the other mounted on the chassis of our robot. The ADXL335 sensor is interfaced with the Arduino situated on our hand, tasked with detecting tilt movements. Additionally, an RF transmitter is linked to the same Arduino. Whenever a tilt is detected by the ADXL335, it relays this data to the Arduino. Subsequently, the Arduino transmits corresponding characters via the RF transmitter. For instance, upon detecting a forward tilt, the Arduino sends the character "f" to the RF transmitter, which in turn transmits it to the receiver unit.

Receiver Unit:

In the receiver unit, another Arduino is interfaced with the robot's chassis, alongside a motor driver responsible for controlling the motor directions. Furthermore, an RF receiver is connected to this Arduino. Upon reception of the transmitted character ("f" for forward movement, for instance), the Arduino interprets this signal. It is programmed to direct the L293D motor driver to execute the appropriate command. For example, upon receiving the "f" character, the motor driver is instructed to propel the robot forward. Similar logic is applied for all other directional commands such as left, right, and backward movements.

CHAPTER 6: CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

In conclusion, the Gesture-Controlled Robot with an integrated cleaning system is a significant step forward. By using simple hand gestures, it offers a hassle-free experience for users. With sensors like ADXL, L293D motor driver, and transmitter and receiver units, along with two Arduino boards for controlling hand gestures and the robot, the report shows a comprehensive approach to robotics. While it's mainly for home cleaning, its potential goes beyond that, promising to make tasks simpler and more efficient in various areas like hospitals, industries etc. The user-friendly design and smart technology will make everyday life easier and more fulfilling.

6.2 FUTURE SCOPE

Smart Navigation and Mapping: Integrate sensors and mapping algorithms to enable the robot to navigate autonomously while avoiding obstacles and efficiently covering cleaning areas.

IoT Connectivity: Implement IoT connectivity to enable remote monitoring and control of the robot via mobile devices, allowing users to schedule cleaning tasks and receive status updates from anywhere.

Multi-Functional Cleaning Attachments: Develop modular cleaning attachments to expand the robot's capabilities, such as mopping, vacuuming, or disinfecting, catering to diverse cleaning needs.

Integration with Smart Home Ecosystems: Integrate the robot with existing smart home ecosystems to enable seamless interoperability with other smart devices and enhance overall home automation capabilities.

Gesture-Based Game Mechanics: Create innovative game mechanics and challenges that leverage hand gestures for player input. From casting spells to swinging swords, navigating obstacles, or performing sports-related actions such as throwing a ball, shooting a basketball, or swinging a golf club, hand gestures offer a new dimension of control and engagement in gaming experiences.

CHAPTER 7: REFERENCES

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APPENDIX

1. BILL OF MATERIAL

Sr. No.	Name Of Component	Quantity	Total Cost (Rs)
1	Arduino UNO	2	900
2	ADXL335 Triple Axis Accelerometer	3	1541
3	2WD Two Wheel Drive Robot Car Chassis	1	234
4	170 Points Mini Breadboard	3	42
5	Jumper wires	-	109
6	RF433 MHz Transmitter Receiver Wireless Module	1	99
7	L293D Motor Drive Module	1	96
8	9V Battery	7	280
9	Battery Snap Connector to DC Barrel Jack Adapter	1	15
10	Cleaning Brush	1	150
	Total cost =		3466 (Rs)

2. PROJECT COMPETITION CERTIFICATE

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Prof. Yogita Kapse	Dr. Prabhakar N. Kota	Dr. Daulappa G. Bhalke	Dr. Virendra V. Shete
COEP Tech. Univ., Pune	MESWCOE, Pune Main Co-ordinator	Hon. Secretary	Chairman

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3. CRITICAL THINKING QUESTIONS

Sr. No.	Question	Answer in brief
1	**Who benefits from this?**	Individuals who require assistance with cleaning tasks but have limited mobility, such as the elderly or people with disabilities, would benefit from this hand gesture-controlled robot.
2	**Who is this harmful to?**	If not properly designed and operated, the robot could potentially be harmful to pets, small children, or fragile objects if it moves unpredictably or with excessive force.
3	**What are strengths and weaknesses?**	Strengths: Increased accessibility for individuals with mobility issues, potential for autonomous cleaning, customizable gestures for control. Weaknesses: Limited range due to RF communication, reliance on gestures may pose a learning curve for users, may not be suitable for complex cleaning tasks or large areas.
4	**What can we do to make a positive change?**	Conduct thorough user testing to ensure safety and ease of use, incorporate safety features such as obstacle detection, and provide clear instructions for operation. Additionally, exploring alternative communication methods such as voice commands could enhance accessibility.
5	**Where are there similar concepts/simulations?**	Similar concepts can be found in various robotics projects focused on assistive technology, home automation, and cleaning robots,gaming.
6	**Where are the areas for improvement?**	Improvements can be made in enhancing the robot's autonomy, increasing its cleaning efficiency, refining gesture recognition algorithms, and expanding compatibility with different environments and surfaces.

7	**When would this benefit our society?**	This technology would benefit society by providing assistance to those who need help with cleaning tasks, thereby promoting independence and improving quality of life for individuals with mobility limitations.
8	**When would this cause a problem?**	Problems may arise if the robot malfunctions or operates unsafely, potentially causing damage to property or injury to individuals.
9	**Why is this a problem/challenge?**	Ensuring the safety, reliability, and effectiveness of the robot while meeting the diverse needs of users presents a significant challenge.
10	**Why is there a need for this today?**	With an aging population and increasing awareness of accessibility needs, there is a growing demand for technologies that assist individuals with daily tasks such as cleaning.
11	**How does this benefit us/others?**	This technology benefits individuals with mobility limitations by providing them with a means to perform cleaning tasks independently, thereby enhancing their quality of life and promoting autonomy.
12	**How do we see this in thefuture?**	In the future, we can expect further advancements in gesture recognition technology, robotics, and automation,leading to more sophisticated and versatile assistive robots that cater to a wider range of needs and tasks in various settings.

PAPER NAME

HAND GESTURE-CONTROLLED ROBOT U SING ARDUINO WITH INTEGRATED CLEA NING SYSTEM

AUTHOR

Sandesh Dongare

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