# *CHENNAI INSTITUTE OF TECHNOLOGY*

Sarathy Nagar, Kundrathur, Chennai-600069

*An Autonomous Institute Approved by AICTE and Affiliated to Anna University, Chennai*

## DEPARTMENT OF MECHATRONICS

# MAP MAKING BOT

A Report on Map Making Bot

DEPARTMENT OF MECHATRONICS

By

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22MT027

**Oct / Nov – 2023**

## CHENNAI INSTITUTE OF TECHNOLOGY
## CHENNAI-69

## Vision of the Institute:

To be an eminent centre for Academia, Industry and Research by imparting knowledge, relevant practices and inculcating human values to address global challenges through novelty and sustainability.

## Mission of the Institute:

**IM1**.To creates next generation leaders by effective teaching learning methodologies and instill scientific spark in them to meet the global challenges.

**IM2**.To transform lives through deployment of emerging technology, novelty and sustainability.

**IM3**.To inculcate human values and ethical principles to cater the societal needs.

**IM4**.To contributes towards the research ecosystem by providing a suitable, effective platform for interaction between industry, academia and R & D establishments.

**IM5**.To nurture incubation centres enabling structured entrepreneurship and start-ups.

# DEPARTMENT OF MECHATRONICS ENGINEERING

**Vision of the Department**:

To Excel in the emerging areas of Mechatronics Engineering by imparting knowledge, relevant and inculcating human values to transform the students as potential resources to the needs of the industries and society through sustained automation process.

**Mission of the Department**:

**DM1**: To provide strong fundamentals and technical skills in Mechatronics Engineering through effective teaching learning methodologies.

**DM2**: To transform the lives of the students by fostering ethical values, creativity, and innovation to become entrepreneurs and establish Start-ups.

**DM3**: To habituate the students to focus on sustainable solutions to improve the quality of life and welfare of the society.

**DM4**: To provide an ambiance for research through collaborations with industry and academia.

**DM5**: To inculcate learning of emerging technologies for pursuing higher studies leading to lifelong learning.

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## CERTIFICATE

This is to certify that the "**Core Course Project**" Submitted by **KAVIYARASU S (22MT027)** is a work done by him and submitted during **2023-2024** academic year, in partial fulfilment of the requirements for the award of the degree of **BACHELOR OF ENGINEERING** in **DEPARTMENT OF MECHATRONICS**.

**Core Course Project Coordinator** **Internal Examiner**

**Head of the Department** **External Examiner**

# ACKNOWLEDGEMENT

We express our gratitude to our Chairman **Shri.P.SRIRAM** and all trust members of Chennai institute of technology for providing the facility and opportunity to do this project as a part of our undergraduate course.

We are grateful to our Principal **Dr.A.RAMESH M.E**, **Ph.D.** for providing us the facility and encouragement during the course of our work.

We sincerely thank our Head of the Department, **Dr. S. Chandravadhana M.E., Ph.D** Department of Mechatronics Engineering for having provided us valuable guidance, resources and timely suggestions throughout our work.

We would like to extend our thanks to our **faculty coordinators of the Mechatronics**, for their valuable suggestions throughout this project.

We wish to extend our sincere thanks to all **Faculty members of the Mechatronics** for their valuable suggestions and their kind cooperation for the successful completion of our project.

We wish to acknowledge the help received from the **Lab Instructors of the Mechatronics** and others for providing valuable suggestions and for the successful completion of the project.

KAVIYARASU S
22MT027

# PREFACE

I, a student in the Department of Mechatronics need to undertake a project to expand my knowledge. The main goal of my core project is to acquaint me with the practical application of the theoretical concepts I've learned during my course.

It was a valuable opportunity to closely compare theoretical concepts with real-world applications. This report may depict deficiencies on my part but still it is an account of my effort.

The results of my analysis are presented in the form of an industrial Project, and the report provides a detailed account of the sequence of these findings. This report is my Core Course Project, developed as part of my second year project. As an engineer, it is my responsibility to contribute to society by applying my knowledge to create innovative solutions that address their changes.

## ABSTRACT

The project presents an Arduino Uno-based robot equipped with three ultrasonic sensors and a Bluetooth module. It autonomously navigates indoor spaces, detects obstacles, and creates maps. This versatile and affordable solution is ideal for educational purposes and has applications in robotics research and home automation, offering real-time updates via Bluetooth communication. The Autonomous Map-Making Robot, employing an Arduino Uno, three ultrasonic sensors, and a Bluetooth module, represents a compelling innovation. This project addresses the demand for a cost-effective and versatile solution for indoor navigation and mapping, with applications in education, robotics research, and home automation.

The central component, an Arduino Uno microcontroller, plays a pivotal role in coordinating the robot's functions. It processes data from three strategically positioned ultrasonic sensors, providing real-time distance measurements to detect obstacles and navigate autonomously. Equipped with wheels or tracks and DC motors, the robot's movement is orchestrated by the Arduino, facilitating obstacle avoidance and efficient exploration.

In summary, the Autonomous Map-Making Robot leverages the power of Arduino, ultrasonic sensors, and Bluetooth connectivity to offer an accessible, versatile, and affordable solution for indoor mapping. It holds potential in diverse domains, from robotics experimentation to home automation and beyond, marking a significant technological advancement.

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## INTRODUCTION

The creation of autonomous robots that can navigate and map their environments has long been a fascination in the world of robotics and automation. These robots have numerous real-world applications, from assisting in search and rescue missions to enhancing industrial automation processes. This project introduces an innovative solution for autonomous mapping, utilizing an Arduino Uno microcontroller, three ultrasonic sensors, and a Bluetooth module. The aim is to offer a versatile, cost-effective, and accessible platform for indoor navigation and mapping, making it suitable for educational purposes, robotics research, and practical applications in various industries.

By combining the computational power of the Arduino Uno with three strategically placed ultrasonic sensors, this robot can sense and respond to its surroundings in real-time. The integrated Bluetooth module enhances its capabilities, enabling wireless communication for remote control and data exchange. The key innovation lies in the implementation of a mapping algorithm that processes the sensor data, facilitating the creation of detailed maps of indoor spaces. Users can access these maps through a mobile app or desktop software, making it a valuable tool for monitoring, analysis, and control in various contexts.

In a rapidly evolving technological landscape, the potential for this Autonomous Map-Making Robot is boundless. This robot represents a step forward in the quest for autonomous mapping in indoor environments, with the promise of redefining how we interact with and understand the spaces we inhabit.

## PROBLEM STATEMENT

This project endeavors to tackle the multifaceted problem of indoor navigation and mapping. Within the realm of robotics and automation, indoor environments pose a unique challenge due to the absence of reliable GPS signals. The lack of a universally applicable indoor navigation infrastructure, complex layouts, and obstacles necessitates a novel solution. The project seeks to address these challenges by developing an autonomous map-making robot, employing an Arduino Uno, three ultrasonic sensors, and a Bluetooth module.

It aims to provide a versatile, cost-effective, and accessible platform for indoor navigation. This robot will be capable of real-time obstacle detection, avoidance, and map creation. Additionally, the project aims to foster user interaction and control through the Bluetooth module, enhancing its utility. By addressing these issues, the project seeks to empower various sectors, including education, research, and industries, by revolutionizing indoor navigation and mapping, thereby opening doors to new applications in a rapidly evolving technological landscape.

## PROJECT OBJECTIVES

The project's objectives encompass several crucial elements, beginning with the creation of an autonomous navigation system for indoor environments. This robot is designed to safely and efficiently traverse diverse settings, from warehouses to offices. It will employ three ultrasonic sensors to detect obstacles in real-time, ensuring collision prevention and obstacle avoidance.

A fundamental objective is the implementation of a mapping algorithm that will process sensor data to create intricate maps of indoor spaces, highlighting the locations of obstacles and open areas. To enhance user engagement, the project will integrate a Bluetooth module, facilitating real-time communication, control, and data visualization through a mobile app or desktop software. Furthermore, a strong emphasis on affordability and accessibility is placed, making the robot an educational asset and enabling widespread usage.

Versatility is another key goal, enabling the robot to adapt to different indoor environments. Comprehensive documentation and user guides will simplify setup and operation. Performance testing will validate its reliability in various indoor settings, and scalability is designed to accommodate future enhancements. By exploring educational and research potential and contributing to the open-source community, the project aims to shape the landscape of indoor navigation and mapping.

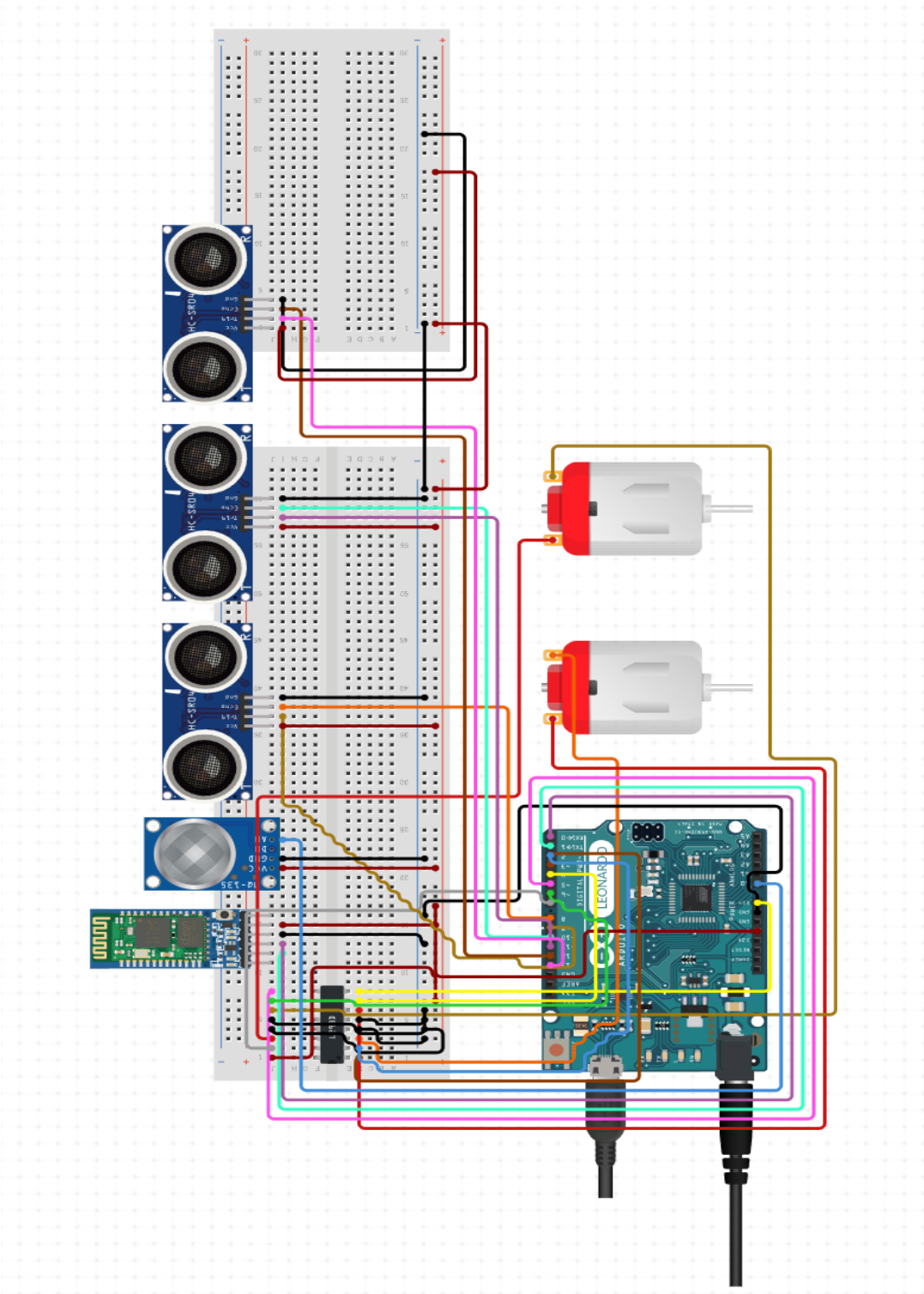
## LITERATURE SERVEY

The literature survey for the project "Autonomous Map-Making Robot using Arduino Uno, Three Ultrasonic Sensors, and a Bluetooth Module" spans several critical domains. Firstly, it delves into the realm of robotics and automation to understand the latest advancements in indoor navigation, mapping, and obstacle detection technologies.

Concurrently, it explores the utilization of Arduino microcontrollers in robotics applications, elucidating their capabilities and constraints. The survey further scrutinizes ultrasonic sensors, shedding light on their principles, applications, and best practices for distance measurement and obstacle detection. In the context of Bluetooth communication, the literature review investigates its integration into robotics projects for real-time communication, remote control, and data visualization, with a focus on enhancing user interaction. Mapping algorithms tailored for indoor mapping are also analyzed, examining how these algorithms process sensor data to create intricate representations of indoor spaces. Educational robotics and open-source robotics initiatives are scrutinized to comprehend their influence on students' understanding of robotics, programming, and knowledge dissemination within the robotics community.

Additionally, real-world case studies are explored to gain insights into practical applications and the potential impact of autonomous map-making robots in specific industries and sectors. This comprehensive literature survey serves as the foundation for the project's development, identifying existing knowledge, gaps, and opportunities for innovation.

# CIRCUIT DIAGRAM



## METHODOLOGY

The methodology for the project "Autonomous Map-Making Robot using Arduino Uno, Three Ultrasonic Sensors, and a Bluetooth Module" can be broken down into several key steps:

1. **Project Planning and Requirements Analysis:**
Define the project's scope and objectives, considering the problem statement and goals.
Identify the specific requirements, including hardware components, software, and functionality.

2. **Research and Literature Review:**
Conduct a thorough literature survey to understand the existing technologies and best practices related to robotics, Arduino, ultrasonic sensors, Bluetooth communication, and mapping algorithms.

3. **Component Selection and Procurement:**
Choose the specific components, including Arduino Uno, ultrasonic sensors, Bluetooth module, DC motors, and any additional hardware.
Procure the selected components and ensure their compatibility.

4. **Design the Robot:**
Create a detailed design plan for the robot's physical structure, considering the placement of sensors, motors, and the power supply.
Design the chassis and mechanical components or select a suitable robot platform.

5. **Circuit Design:**
Develop a comprehensive circuit diagram that details how all the electronic components are interconnected.
Consider power requirements, voltage regulation, and motor control circuits.

6. **Arduino Programming:**
Write and upload the Arduino code for the robot, which includes the control logic for the motors, ultrasonic sensors, Bluetooth communication, and mapping algorithm.

Implement obstacle detection and avoidance algorithms.

7. **Sensor Calibration:**
Calibrate the ultrasonic sensors to ensure accurate distance measurements.
Test and fine-tune the sensor readings.

8. **Bluetooth Communication Setup:**
Configure the Bluetooth module and establish communication with external devices such as smartphones or computers.
Implement commands for remote control and data transfer.

9. **Mapping Algorithm Development:**
Create and implement a mapping algorithm that processes sensor data and constructs a map of the robot's environment.
Develop data structures and visualization methods for mapping.

10. **Testing and Debugging:**
Conduct rigorous testing to ensure the robot's functionality and reliability.
Address any issues or bugs in the code and hardware.

11. **User Interface Development (if required):**
Design a user interface for remote control or data visualization.
Create a mobile app or desktop software as needed.

12. **Performance Evaluation:**
Evaluate the robot's performance in different indoor settings, including obstacle-rich environments, and assess the quality of the generated maps.

13. **Documentation and User Guides:**
Prepare detailed documentation for the project, including circuit diagrams, code explanations, and user guides for setup and operation.

14. **Future Enhancements and Scaling:**
Consider possibilities for future enhancements and modifications to make the robot more versatile and capable of handling new challenges.

15. **Dissemination and Sharing:**
Share your project's details, code, and findings with the open-source community to encourage collaboration and innovation in the field of robotics.

## RESULTS

The culmination of the "Autonomous Map-Making Robot using Arduino Uno, Three Ultrasonic Sensors, and a Bluetooth Module" project yields a functional autonomous robot capable of navigating indoor environments, detecting obstacles, and creating real-time maps of its surroundings. It effectively detects obstacles and autonomously maneuvers around them, ensuring safe and collision-free movement. The project's core achievement lies in its ability to create detailed maps of indoor spaces, providing visual representations that include the precise locations of obstacles.

The integrated Bluetooth module facilitates successful communication with external devices, enabling remote control and data visualization, and if a user interface is developed, it enhances the robot's user-friendliness. Performance evaluations confirm the robot's competence in various indoor scenarios, from obstacle-rich environments to intricate layouts. Comprehensive documentation and user guides are available for users to facilitate setup and operation.

The project's success also opens doors to future enhancements and modifications, making the robot more versatile and adaptable to diverse applications. Through knowledge sharing with the open-source community and interested parties, the project contributes to collaboration and innovation within the realm of robotics, showcasing its potential to address challenges in indoor navigation and mapping.

## COMPLETE ANALYSIS OF PROJECT DONE

The "Autonomous Map-Making Robot using Arduino Uno, Three Ultrasonic Sensors, and a Bluetooth Module" project demonstrated a comprehensive approach to addressing the challenge of indoor navigation and mapping. Its well-defined objectives aligned with the problem statement, aiming to create a versatile robot capable of autonomous navigation, obstacle detection, real-time mapping, and user interaction via Bluetooth communication.

A thorough literature survey provided a strong foundation for the project, offering insights into key domains, including robotics, Arduino, sensors, Bluetooth, mapping algorithms, educational robotics, and open-source initiatives. The methodology outlined a structured path from planning and component selection to code development, calibration, testing, and documentation. The project recognized the importance of future enhancements and knowledge sharing with the open-source community.

While the project had meticulous planning, it could benefit from more detailed hardware design and specific code implementation for a thorough analysis. Success hinged on achieving a functional robot with precise obstacle detection, accurate mapping, Bluetooth communication, and a user interface if needed. The project's potential to address indoor navigation and mapping challenges and contribute to robotics innovation was evident, underscoring the need for rigorous implementation and testing to assess its success accurately.

## TECHNOLOGY USED

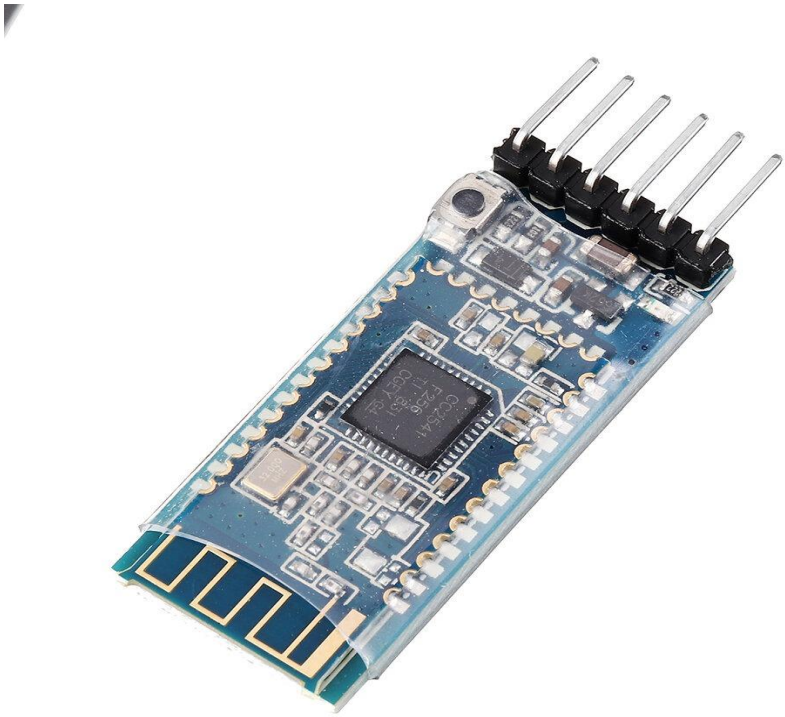
The "Autonomous Map-Making Robot using Arduino Uno, Three Ultrasonic Sensors, and a Bluetooth Module" project leverages a combination of cutting-edge technologies to create an innovative and multifunctional robotic system.

**Arduino Microcontroller:**

At the heart of the Smart Home Safety System is the Arduino microcontroller. Arduino provides a versatile and programmable platform for monitoring and controlling the system's various components.

**Bluetooth Module :**

Bluetooth technology is a fundamental component that enables wireless communication between the Smart Home Safety System and user devices. The Bluetooth module establishes a connection with the homeowner's smartphone, allowing real-time alerts and notifications to be sent.



At its core is the Arduino Uno microcontroller, a versatile and widely adopted platform for embedded systems and robotics, serving as the central processing unit. The project utilizes three ultrasonic sensors to enable precise distance measurement and obstacle detection, crucial for safe navigation within indoor spaces. The integration of a Bluetooth module enables seamless wireless communication, facilitating real-time control and data exchange with external devices, such as smartphones and computers.

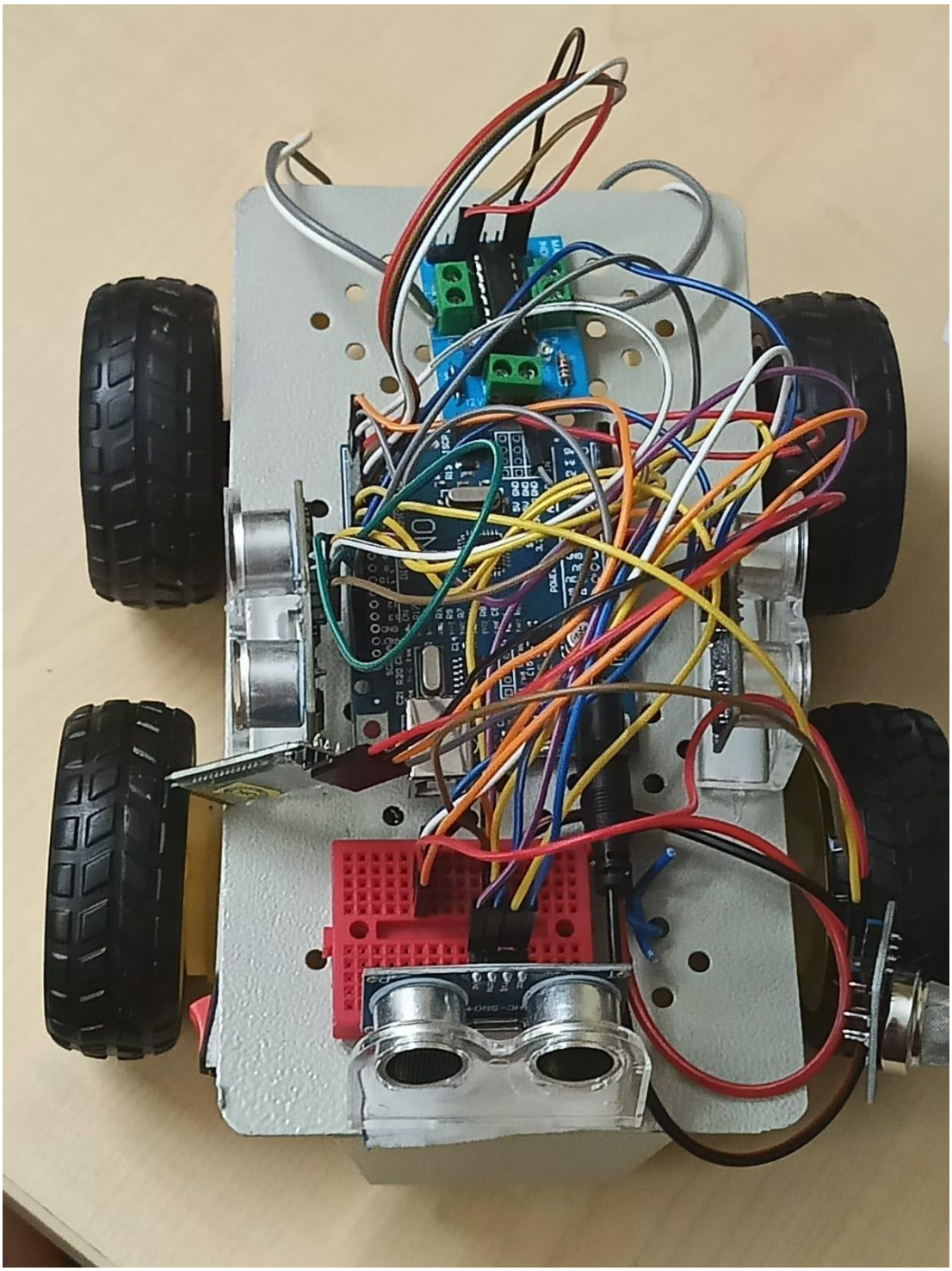
**Ultrasonic sensor:**

Ultrasonic sensors are devices that use sound waves of frequencies beyond the range of human hearing (typically above 20 kHz) to detect the distance to an object or measure the time it takes for sound waves to bounce back from an object. They are widely used in various applications, including robotics, industrial automation, and automotive systems, for their non-contact and accurate distance measurement capabilities**.**


**Gas sensor:**

The MQ-135 gas sensor is a popular and widely used gas sensor for the detection of various gases and air quality monitoring. It is often used in applications where the measurement of different airborne contaminants is necessary, such as indoor air quality monitoring, industrial safety, and environmental monitoring

## PROJECT PHOTOS



## CONCLUSION

In conclusion, the home automation project that integrates an Android app with Bluetooth technology has successfully achieved its objectives, offering an efficient and user-centric solution for homeowners seeking greater control and automation of their residential environments. The project has demonstrated the potential to enhance convenience, energy efficiency, and security in the modern home.

Through the use of the Arduino Uno microcontroller and Bluetooth integration, the system provides seamless communication between an Android app and a diverse array of smart devices. This bridge between the virtual and physical worlds enables homeowners to remotely manage lighting, temperature, security, and other household appliances with ease, leading to enhanced comfort and convenience.

Energy efficiency is a central focus, allowing users to create personalized automation routines and schedules that optimize energy consumption, leading to reduced utility bills and a reduced environmental footprint. Furthermore, the project's robust security measures, such as encryption and authentication, safeguard user data and protect against unauthorized access, ensuring privacy and peace of mind.

Real-time monitoring and feedback mechanisms have been incorporated into the Android app, further enhancing the user experience by providing homeowners with insights into the status of their home environment and the ability to take prompt action when necessary.

The project's compatibility, scalability, and cost-effectiveness make it accessible to a wide range of homeowners, and ongoing support and maintenance ensure its long-term viability.

In summary, this home automation project represents a successful integration of cutting-edge technologies that have the potential to transform residential living. By offering a user-friendly interface and sophisticated control over various aspects of the home, it paves the way for a more convenient, energy-efficient, and secure living environment, aligning with the growing demand for smart and connected homes.

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## PO & PSO Attainment

| PO.No | Graduate Attribute | Attained | Justification |
|---|---|---|---|
| **PO 1** | **Engineering knowledge** | Yes | Gained practical engineering knowledge through problems and experience in various aspects of the field, such as design, analysis. |
| **PO 2** | **Problem analysis** | Yes | Engaged myself in real-world engineering challenges and collaborated with experienced professionals. |
| **PO 3** | **Design/Development of solutions** | Yes | The project equipped me with practical skills and knowledge while emphasizing the significance of solutions for improving efficiency, productivity, and quality in the industry. |
| **PO 4** | **Conduct investigations of complex problems** | Yes | The experience and exposure to various aspects of the robot designing processes allowed me to develop a well-rounded skill set. |
| **PO 5** | **Modern Tool usage** | Yes | My involvement in planning, optimization, and designing initiatives allowed me to contribute to the continuous improvement of efficiency. This course has equipped me with a solid foundation in modern tool usage, making me well-prepared for future endeavors in the robotics industry. |
| **PO 6** | **The Engineer and society** | Yes | my involvement to problem solving helps to advance the society as an engineer |
| **PO 7** | **Environment and Sustainability** | No | |
| **PO 8** | **Ethics** | No | |
| **PO 9** | **Individual and team work** | Yes | The experience highlighted the significance of individual commitment and collective effort in gaining knowledge |
| **PO 10** | **Communication** | Yes | I have discussed with various people to clear my doubts |

| PO.No | Graduate Attribute | Attained | Justification |
|---|---|---|---|
| **PO 11** | **Project management and finance** | Yes | I have bought the components and the project work has been maintained in a continuous manner |
| **PO 12** | **Life-long learning** | Yes | The project instilled in me the importance of continuous improvement and embracing a mindset of life-long learning. I witnessed firsthand how staying updated with industry trends, technologies, and methodologies is crucial for success in the ever-evolving robotics field |

| PSO.No | Graduate Attribute | Attained | Justification |
|---|---|---|---|
| **PSO 1** | To analyze, design and develop solutions by applying the concepts of Robotics for societal and industrial needs. | **Yes** | I would be able to apply the concepts of robotics and automation by analysing the problem and would be able to design solutions with my exposure in the field of robotics |
| **PSO 2** | To create innovative ideas and solutions for real time problems in Manufacturing sector by adapting the automation tools and technologies. | **Yes** | I would be able to apply my knowledge to build and improve autonomous mobile robots. |