DEPARTMENT OF MECHANICAL ENGINEERING

21ARE302

Microcontrollers and Embedded Systems

Nova Robot: An Interactive 3D-Printed Open-Source Robot

Fifth Semester
B Tech. Automation and Robotics Engineering

AMRITA SCHOOL OF ENGINEERING

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Table of Contents

Problem Objective:

Create a fully functional, low-cost, and interactive robot designed to spread joy and foster positive engagement in various settings, such as homes, schools, and hospitals. The robot will serve as an educational and entertaining tool, enabling users to explore robotics, programming, and creativity while positively impacting emotional well-being.

Project Description:

Our team is developing the **Nova Robot**, an interactive, 3D-printed, open-source robot. This project aims to make robotics accessible to everyone, including students, educators, and hobbyists.

The robot will feature customizable 3D-printed components, programmable software, and hardware modules, including sensors, motors, and LEDs. It will be capable of performing tasks such as recognizing gestures, responding to commands, and expressing emotions through movements and lights.

This project is more than just about building a robot—it's about creating a tool for education, entertainment, and emotional connection. By offering the design and code as open-source, we aim to foster a community of innovators who can adapt and expand the robot's capabilities to meet diverse needs.

Applications for the Nova Robot include:

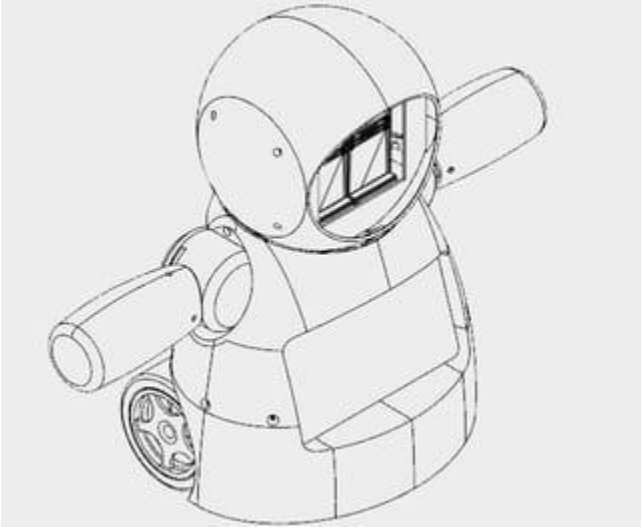
- **Education**: A hands-on learning tool to teach STEM concepts in classrooms or workshops.
- **Companionship**: A fun and interactive companion at home.
- **Therapeutic Aid**: A comforting and engaging presence for individuals in hospitals or care facilities.

Through this project, we aspire to bring technology and creativity together to deliver joy and inspiration, empowering people to explore the exciting world of robotics.

Activities Undertaken:

1. 3D Printing

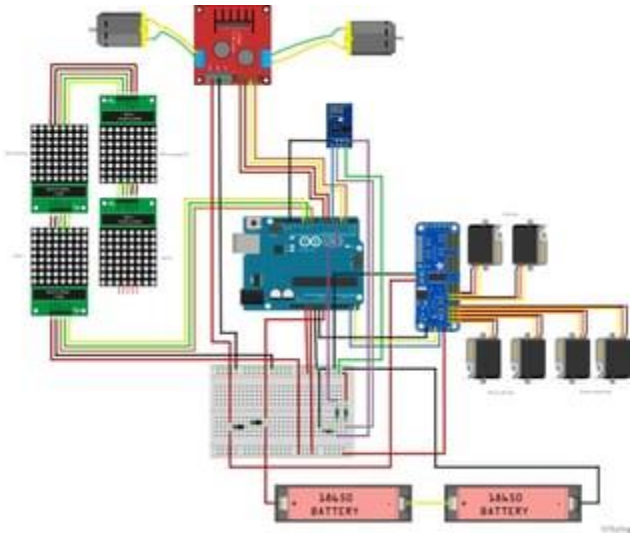
- Designed and printed the robot's body parts using accessible 3D printing technology.
- Focused on optimizing the design for durability and ease of assembly.
- Addressed challenges such as the printing took longer due to the robot's complex design. Overhangs which increased preprocessing time as well as print failures due to filament breakage



2. Circuit Design Assembly

- The system was initially designed to be controlled by a single Arduino, but it was found that it required splitting into **two parts**: one for the motors connected to a separate Arduino and the rest of the assembly connected to an **ESP** for Wi-Fi control. The **Arduino** is now only used to provide the power supply.
- The entire **circuit was reworked**, and the code was customized to meet the new requirements.
- During the assembly, issues arose such as **diodes and resistors burning out**, and **wires burning** due to improper connections and power surges.
- The **battery voltage** was unstable, leading to inconsistent performance across components.
- The **LED matrix** was not blinking as expected and instead fluctuated, requiring further debugging of the wiring and code.
- **Individual servo codes** were adjusted to allow for precise control of each servo motor.

- **Bluetooth control** was implemented to manage the robot's movement, allowing for remote operation and easier testing.



3. Software Development

Interface Development

- Developed 3 interfaces:
  - 2 control interfaces
  - 1 user interface
- The user interface is displayed through a mobile app attached to the Nova Robot's body. Along with user interface we have created a **chatbot** by linking with an API so that the robot is able to give its responses on its own to the questions asked by the user.

Frontend Development:

- Used HTML and CSS frameworks for the design and layout of the interface.
- Flutter was used to create an interactive and informative page for the users.
- The webpage, accessed through the app, displays information about Amrita School of Engineering, Amritapuri campus, including:

  - Faculties
  - Courses available
  - Layout of the college to help guide visitors.

Backend Development:

- Developed the backend to support communication between the robot's hardware and the mobile app interface.
- Enabled the app to control the robot and display the relevant information about the college.

Interface:

Motor control interface:

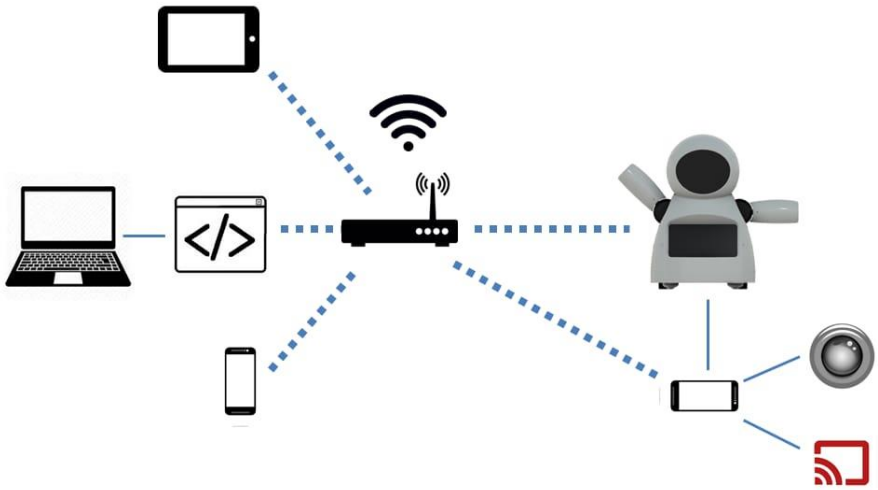
- The Arduino UNO is programmed to utilize the HC-05 Bluetooth module for establishing a connection with an external device, such as a mobile phone.
- This setup enables voice-command control and remote access using an existing mobile application designed for robot motion control.

Nova Robot Body Control Interface:

- It involves work from both frontend development and backend development.
- This interface was developed to provide manual control for robot's actions (HAND AND SHOULDER MOVEMENT) as well as facial reactions (EYES AND MOUTH)

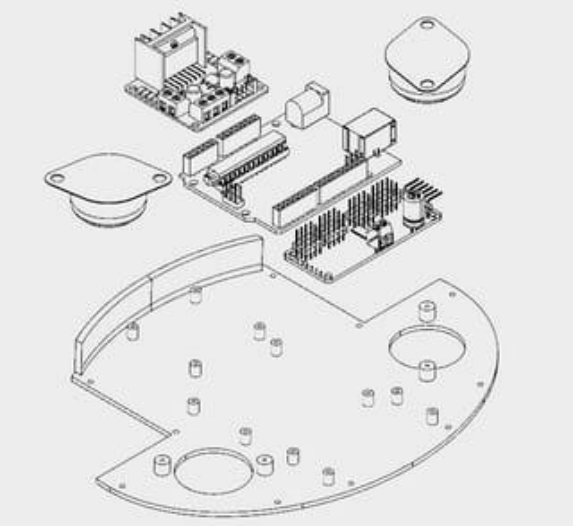
Chatbot Integration:

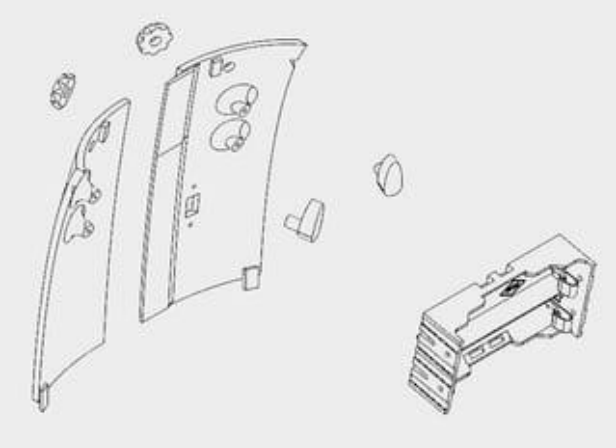
- Developed a chatbot linked with an API.
- The robot can autonomously respond to user questions through the chatbot. Points are awarded based on tasks completed or areas explored.



4. Assembly

- The assembly process began by securing parts using superglue due to the unavailability of M2 screws.
- During the assembly, it was discovered that the Thingiverse file was missing some parts. These missing components were found from another source and printed.
- Extensive preprocessing was done to ensure all parts were properly aligned and ready for assembly, ensuring smooth integration of all components.





Challenges and Accomplishments:

1. 3D Printing

From CAD Drawings to Physical Parts

Challenges

- Printing small, intricate parts proved challenging due to precision limitations of the 3D printer.

- The process was time-consuming, requiring multiple iterations to perfect the prints.
- Sticking parts together required careful alignment, and adhesives were prone to shifting under pressure.

Accomplishments

- Successfully printed components with improved settings after trials.
- Developed a reliable method for assembling printed parts with precise alignment.
- Achieved durable and aesthetically pleasing 3D-printed structures for the robot's framework.

2. Circuit Assembly

Wiring the Heart of Nova Robot

Challenges

- Lack of prior experience with circuits made the process steep learning curve.
- Difficulties in understanding servo motor connections and controlling them effectively.
- Encountered hardware failures, including damaged diodes, which disrupted progress.

Accomplishments

- Mastered the basics of circuit design and servo motor connections.
- Successfully rebuilt and optimized the circuit after initial setbacks.
- Ensured a reliable and functional electrical system that powered the robot seamlessly.

3. Software Development

Bringing Nova Robot to life with code

Challenges

- First-time experience designing a chatbot presented hurdles in understanding software architecture.
- Debugging was a tedious process due to our limited familiarity with coding practices.

Accomplishments

- Designed and implemented a fully functional chatbot that interacts effectively.
- Learned and applied key software development principles, boosting team coding skills.
- Integrated the chatbot smoothly with the hardware components of Nova Robot.

4. Assembly

Piecing Together Precision

Challenges

- Assembling the robot required fitting circuits within a confined space, which was intricate and prone to connection disruptions.
- Ensured that all components were securely fixed without compromising functionality.

Accomplishments

- Achieved a compact and robust assembly that housed circuits, 3D parts, and motors efficiently.
- Overcame space constraints through creative adjustments and meticulous planning.
- Delivered a fully operational Nova Robot with a sleek and functional design.

Summary:

The Nova Robot project has been an exciting journey for us, as we worked to create a low-cost, 3D-printed, open-source robot designed to bring joy to various environments. We tackled challenges head-on, from designing and printing intricate components to developing custom software and troubleshooting hardware issues. Along the way, we discovered innovative solutions to overcome obstacles like circuit failures and assembly problems. In the end, we succeeded in building a robot that isn't just functional but also engaging, with applications ranging from education to therapy. This project has shown us how technology can inspire creativity and make robotics approachable for everyone.

Conclusion and Future Work:

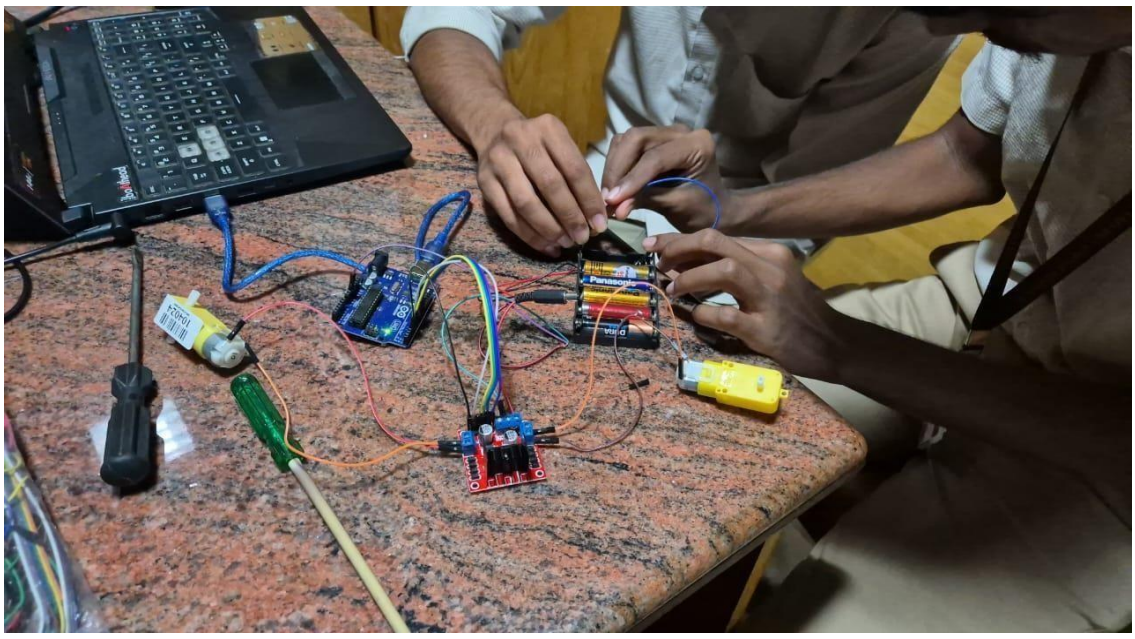
Looking back, the Nova Robot project has been a significant accomplishment for us. We met our goal of building an interactive, accessible robot that can educate, entertain, and bring comfort. But for us, this is just the beginning. There's so much more potential to explore.

In the future, we aim to add features like camera module to receive and record a visual feed, which will be used to collect data on user experiences from facial recognition. This will enable the robot to be much more efficient and allows for implementation of machine learning through image and facial detection. We could also work on developing an AI that will help the robot make its own reactions such as eye and mouth movements based on one-on-one user interaction

We could also work on scaling the design so it can be used for advanced educational purposes or specific therapeutic needs. Building a stronger open-source community is another way we can expand the project's impact, encouraging others to contribute ideas and improvements. Finally, we want to explore eco-friendly materials and powerefficient components to make the robot more sustainable.

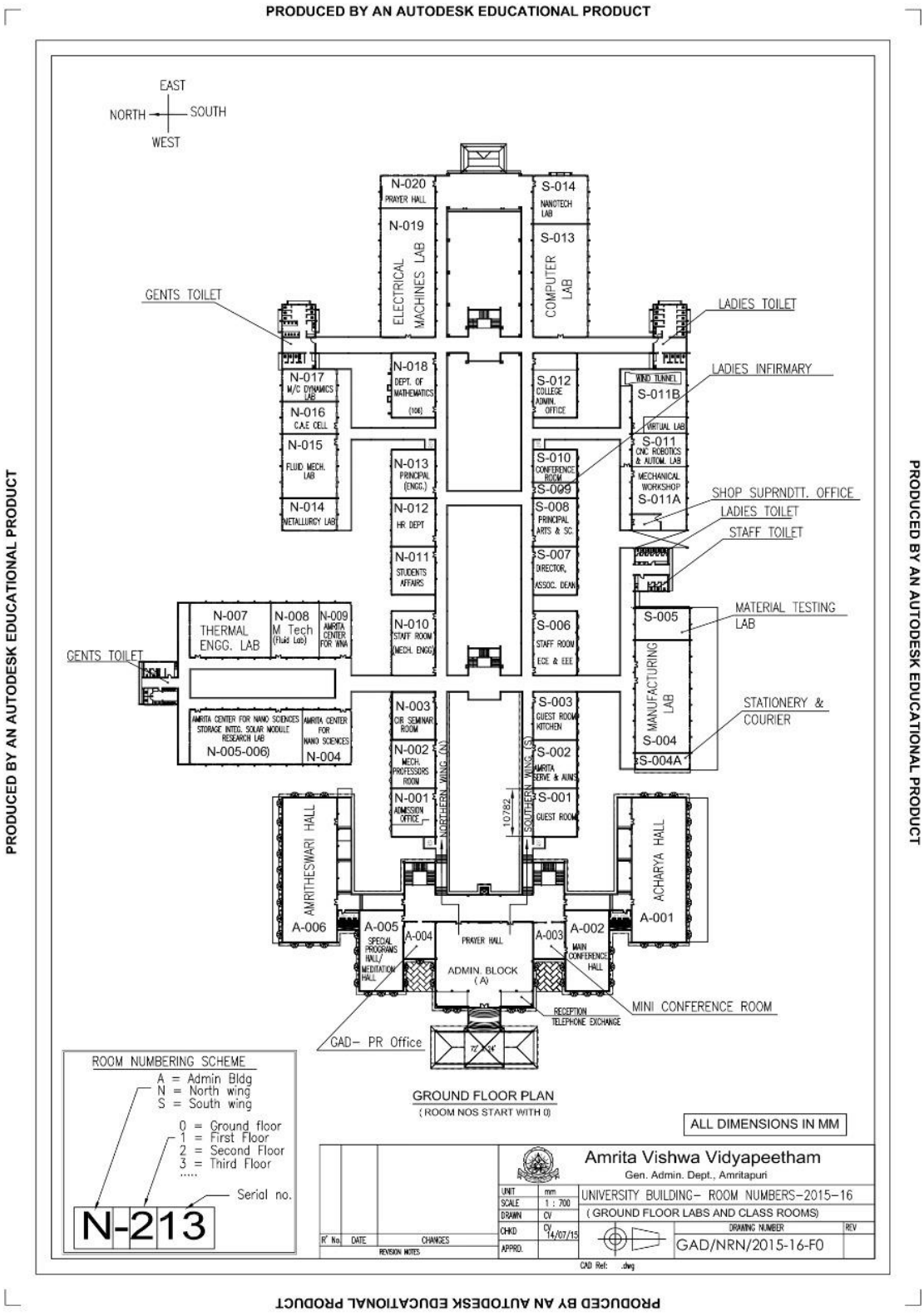
This project has been a fulfilling experience, and with these enhancements, we believe the Nova Robot could become an even more powerful tool for education and emotional connection.

Appendix:




RED
MOMOS

Map of the College Building used to help user find places



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