1. Project Description

Problem Statement: What problem does your project aim to address?

The environmental crisis is one of the most critical issues of our time, but lack of awareness is still preventing collective action. Many people underestimate the urgency of problems like climate change, deforestation, and pollution, which they often view as distant or unmanageable. Involving young children in environmental education can change this narrative. Children are naturally curious and compassionate, making them ideal advocates for sustainability. Early teaching of the environment instills responsibility and inspires their families and communities. By instilling environmentally conscious habits in the next generation, we create a ripple effect of awareness and hope for a more sustainable future.

Project Overview: What does your project do?

I have re-created the main character "Wall-E" from the Disney-Pixar movie of the same title. The various functionalities are inspired by and re-creating the ones seen from the movie. They have been designed with the younger audience in mind, including functions that will engage them better and make for a better experience. This aids in propagating the message wider and having a greater impact.

I have included the following functionalities:

1. Speaking "Wall-E": speaks the words "Wall-E"
2. Show Head Movement: move his head from left to right
3. Find his friend Eve: Call-out to his friend Eve and try to find her by looking around
4. Dance: Plays "I Like To Move It" song from the movie "Madagascar", and dances to it

Solution: How does your project address the problem?

Wall-E is used as a medium for conveying the urgency of the situation. The movie is set in a future where life on Earth has become close to impossible due to various environmental concerns, mainly waste management. Wall-E is one of the mechanisms deployed for waste management to make the Earth livable again. This glance into a possible future creates a sense of responsibility in the audience. The design is especially so as to facilitate a greater feeling of empathy and responsibility, being cute and relatable. This ignites the passion, especially in the younger audience, to "help Wall-E" and keep the Earth clean. Instilling this education, not just about the issue itself but also the daily practices to combat it, would surely help the cause.

Technology Used: Mention the hardware and software utilized in your project.

Hardware/ Software Deployed	Function
ESP32 Board	<brain>
DC Motors and Motor Driver	To move the robot
Continuous Rotation Servo Motor	To move the head
Speaker, DAC/Amplifier (MAX98357A)	To play Audio
SD Card Reader Module. SD Card	To read Audio files from SD Card
Joystick Module	To control the movements of robot
Pushbuttons	To trigger various functions
ESP-NOW Protocol	To communicate between 2 ESPs (remote and robot)
Audio Files (.wav format)	Files to be played in various functions
Code Files (written in C++)	Programs to combine all functionalities

Application: How could this project be improved or applied in real-world scenarios?
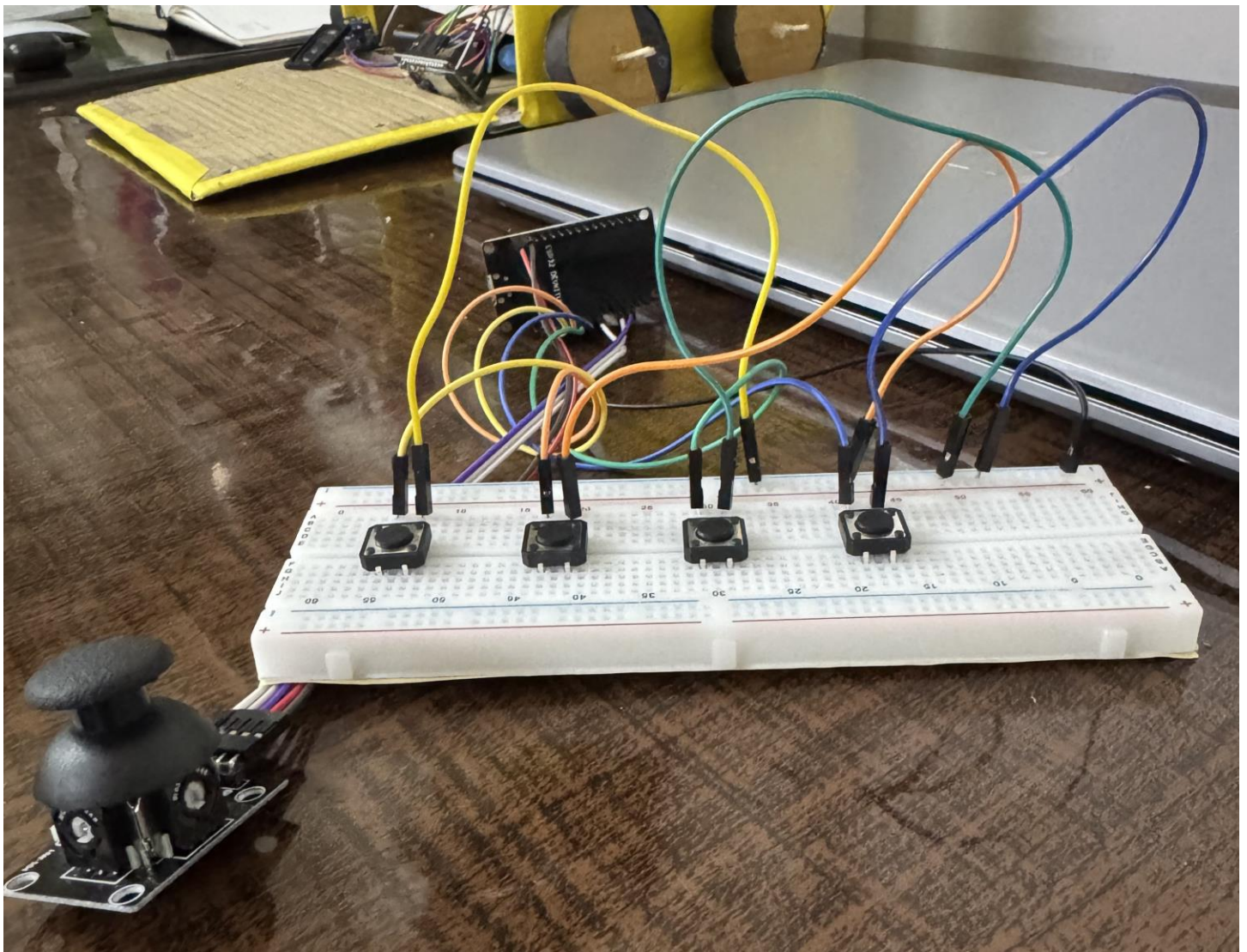
The concept of using technology for waste management would be a great step forward, given the volume of waste generated each day. It is not only hazardous but quite impossible to handle such a quantity by human labor. Deploying autonomous machinery for such a task is not only efficient but may also be made sustainable by using solar energy as a source of power. The highly tedious and non-technical processes may be handled to Wall-E, where we can deploy already popular technology such as object recognition through Machine Learning, and Augmented Reality.
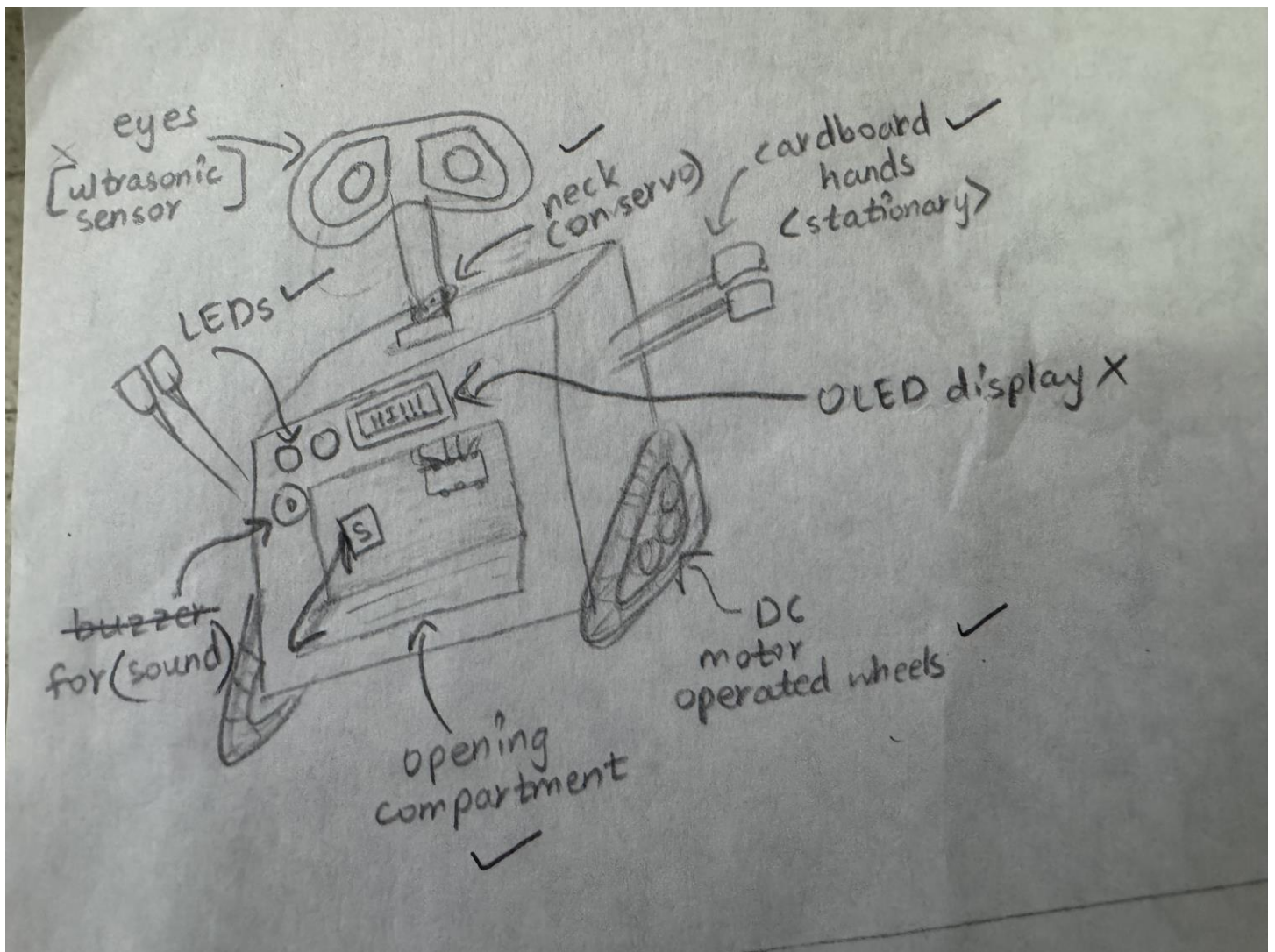
2. Videos/Images

Wall-E

WALL-E REMOTE

eyes
[ultrasonic sensor]

neck (on servo)

cardboard hands (stationary)

LEDs

OLED display X

buzzer for (sound)

S

opening compartment

DC motor operated wheels

Wall-E Initial Diagram

Wall-E In Progress

3. Student Reflection

3.1 What did you learn during the course and while working on this project?

During this course, I gained a deep understanding of several foundational and advanced concepts in IoT. A major part of the learning involved working with hardware and programming, where I built and programmed complex circuits. I became proficient in using microcontrollers like the ESP32 and developed the ability to program them for a variety of applications.

One of the most exciting aspects was learning how to enable communication between multiple ESP32 boards, a critical skill for creating interconnected IoT systems. Additionally, I explored and experimented with a wide range of electronic modules, each presenting its own set of challenges, which taught me how to integrate new components into my projects.

Another technical highlight was troubleshooting and debugging circuits, which significantly improved my problem-solving skills. I also developed an understanding of protocols and methods for ensuring seamless data exchange between devices, for example, I2S communication for audio, ESP-NOW protocol, etc.

I also learned valuable life skills such as effective project management, staying persistent in the face of challenges, and the importance of iterative learning to overcome obstacles during the project. This hands-on experience not only strengthened my technical knowledge but also enhanced my confidence in designing and implementing IoT solutions from the ground up.

3.2 What were the key challenges you faced, and how did you overcome them?

There were quite a few boulders that blocked the way during this project. The first major issue I encountered was sourcing the required parts. Despite detailed planning, it took multiple visits to both online and offline stores and a lot of trial and error before I could procure the necessary hardware components.

Unfortunately, hardware failures turned out to be another significant challenge. For instance, I faced an issue where the speaker worked perfectly when the ESP32 was connected to my laptop but failed to work when powered by a battery. This required me to carefully debug and experiment with alternative solutions. Additionally, while I had ordered an 8-ohm 3-watt speaker, I mistakenly received an 8-ohm 10-watt speaker, which led to further adjustments.

Another issue arose when one of the servo motors controlling the robot's neck stopped working just two days after being installed, even though it functioned perfectly during initial testing. This forced me to remove it entirely from the project. Furthermore, the wheels were problematic—the ones that came with the motors didn't fit due to the cardboard base, and the improvised cardboard wheels I created were barely able to support the robot's weight. As if that wasn't enough, I accidentally burnt the motor driver during testing. I had to order a replacement, but the delayed delivery further slowed the project timeline.

The software side also presented its own challenges. Towards the end of the project, an audio file became corrupted, which caused one of the functions to produce a shrill sound instead of playing the intended audio properly. Debugging and fixing this issue while working on other parts of the project required meticulous attention to detail.

Despite these challenges, persistence and a problem-solving mindset allowed me to work through each hurdle. This process taught me how to handle unexpected issues, adapt quickly, and stay committed to completing the project successfully.

3.3 How did this process contribute to your personal and academic growth?

Personal: confidence and ability to work alone enhanced,

Academic: applying the knowledge from IoT module (working on functions etc.), learnt some new things also (incl. Programming functions, and creative things like working with limited res and making do with it)

My first takeaway from this project was management, of time and of tasks. With the whole workload of creating a project from scratch, it takes an efficient breakdown and management of tasks and time. My previous learning of such task breakdown and distribution, as was built during LGP 24, was further reinforced here, with the addition of working individually. I had previously worked on smaller projects, but this particular project boosted my confidence in my ability to create something from the ground up and to do it alone.

As for the academic takeaways, there are definitely quite a few. Wall-E has helped me learn not just technically but also creatively. While building this project, I was able to not only apply the concepts I had learnt through the IoT module of the Continued Learning? but also furthered my technical knowledge. In the creative aspect too, I took a more structured approach to designing, and sticking with the theme of the project have mostly only used material already available to me; the body of Wall-E is made entirely from old, waste cardboard boxes and the paper used was also waste paper from old gift wraps and packaging. Being resourceful in sourcing and using the material helped instill the message of waste management to a personal level, and I hope also serves as another reminder for the cause.