Assumption College Samutprakarn

Project Report

AUTOMATIC GARBAGE COLLECTOR

Multipurpose system

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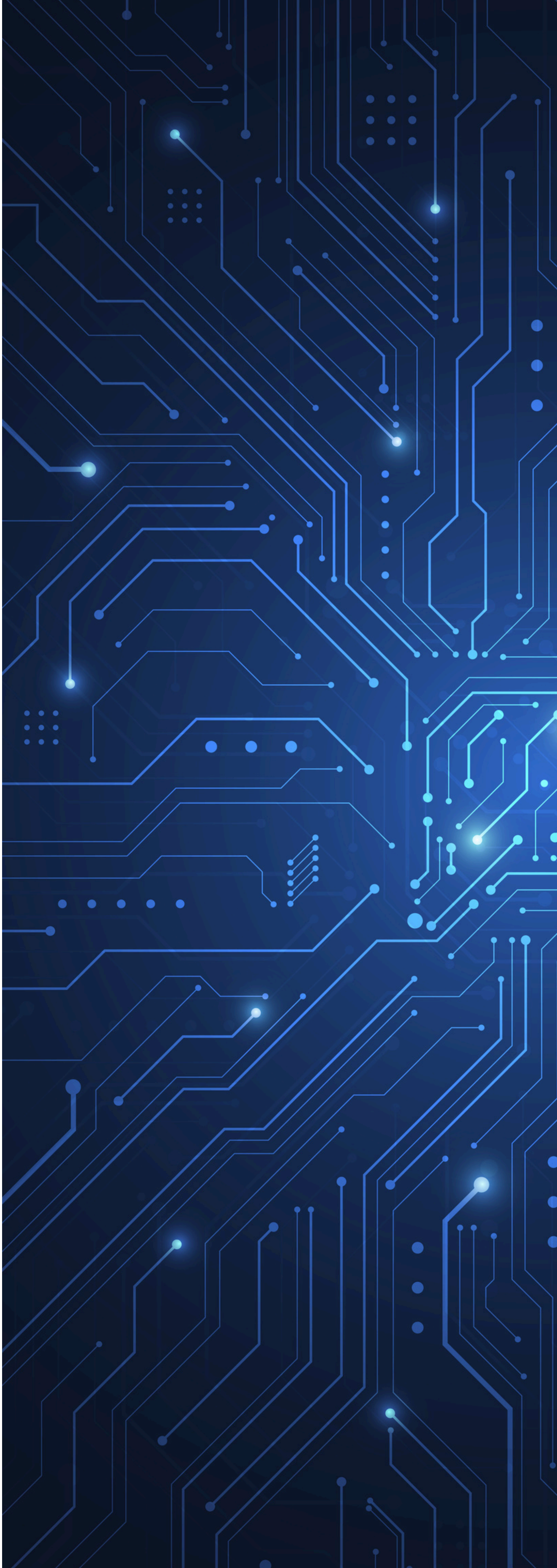
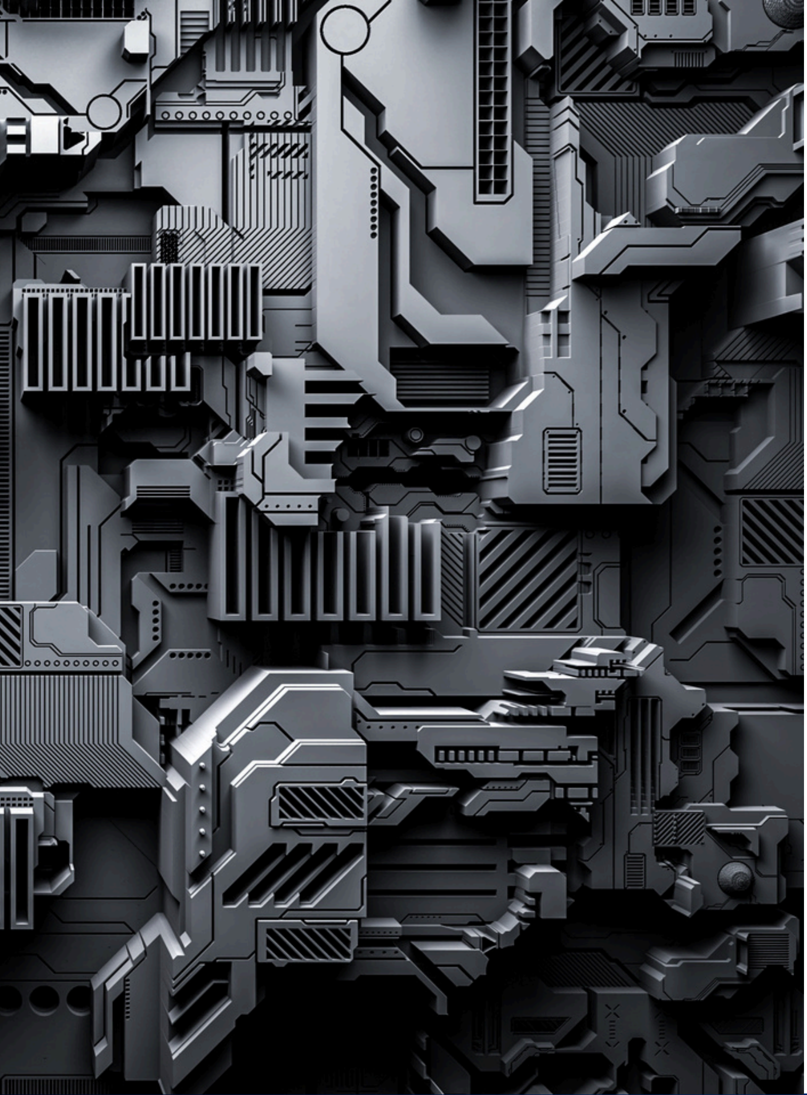


INTRODUCTION

The automatic garbage collector robotie is designed to keep the environments clean, efficient, and eco-friendly. The robot is equipped with smart sensors, advanced navigation, and waste-picking abilities, enabling it to roam parks, streets, and public spaces to collect and dispose of litter. Not only does the robot help reduce the workload of human cleaners, but it also promotes a cleaner, greener future by efficiently handling. This project aims to make our environment become safetier.



OBJECTIVES

- Motor working by a function of an IR sensors
- Able to separate the waste by it size
- Able to tracking a line while avoiding obstacles
- Test and optimize for accuracy in waste separation

KEY COMPONENTS

Sensors

Ultrasonic Sensor:

- Usage: Use the ultrasonic sensor for obstacle detection and distance measurement. This would allow the robot to detect obstacles from a greater distance, enhancing its navigation capabilities and preventing collisions.

IR Sensor:

- Usage: Utilize the IR sensor for line-following functionality. It can track the line on the ground, helping the robot stay on course as it moves along a designated path.

Actuators

Buzzer:

- Usage: The buzzer can be used as an alert system. For example, it can emit a sound when the robot encounters an obstacle or completes a waste collection cycle. This can improve interaction and alert the user if something goes wrong.

LED and Neopixel Ring:

- Usage: The LED and neopixel ring can act as visual indicators. For instance, use different colors to represent the robot's status (e.g., green for operational, red for error, blue for obstacle detection). The Neopixel ring could also indicate sorting results, changing colors based on the type of waste detected.

Motors and Servo:

- Usage: Use motors for movement and servo motors to control the mechanism for picking up and dropping waste. The servo could also help in precise positioning of waste in different bins based on its classification.

Switch:

- Usage: Use the switch to power on/off specific functions, such as enabling/disabling waste sorting or obstacle avoidance modes. This can be useful for manual control during testing or demonstration.

Control Unit

ESP32 Microcontroller :

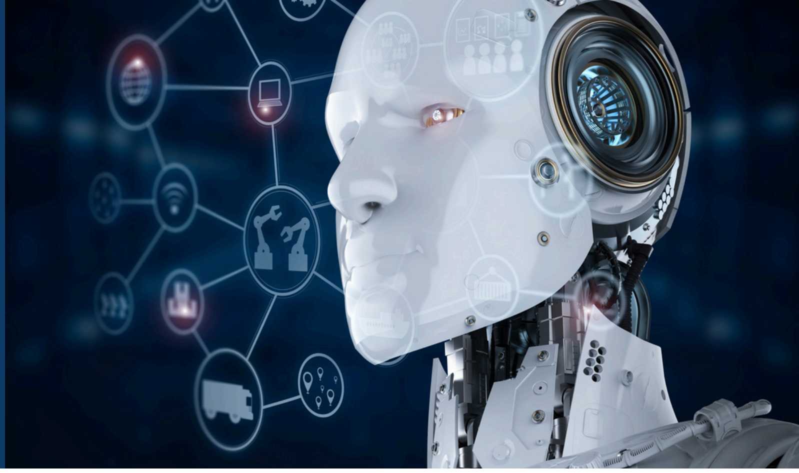
- Usage: act as the core of the system, controls and coordinates all the devices including sensors , lights also motor in the robot

Display Unit

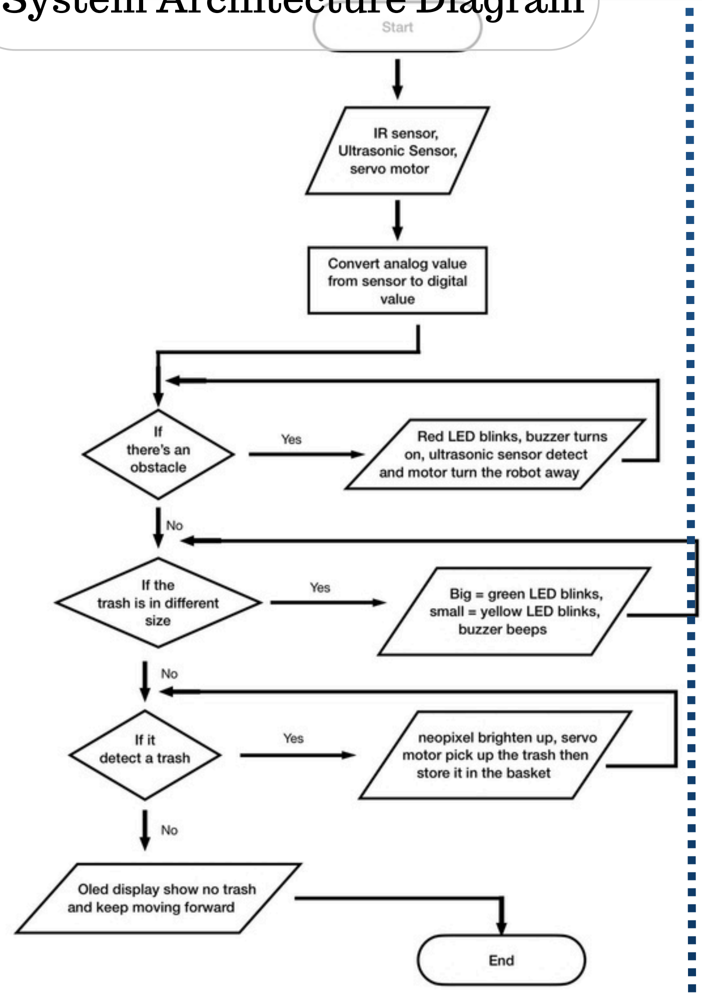
OLED Display:

- Usage: Display real-time data on the OLED, such as waste size, the number of items collected, and obstacle proximity. It could also show the current mode (e.g., "Waste Collection" or "Obstacle Avoidance") or display error messages when sensors detect an issue.

SYSTEM ARCHITECTURE



System Architecture Diagram



INPUT STAGE

IR sensor, Ultrasonic sensor and servo motor will input the analog value from inside the cabinet. Processing stage system will convert analog value to digital value after that the robot will pick up the trash and if there is an obstacle the robot will turn away and get back on track.

Description of system flow

PROCESS STAGE

In the processing stage, the robot converts sensor signals into digital data to guide its actions.

Obstacle Detection: The ultrasonic sensor triggers the red LED and buzzer, and the robot turns to avoid obstacles.

Trash Identification: It identifies trash size with green or yellow LEDs and a buzzer beep.

Trash Collection: The servo motor picks up trash and stores it.

Line Following: IR sensors keep the robot on track.

This enables effiaccient trash collection and obstacle avoidance.

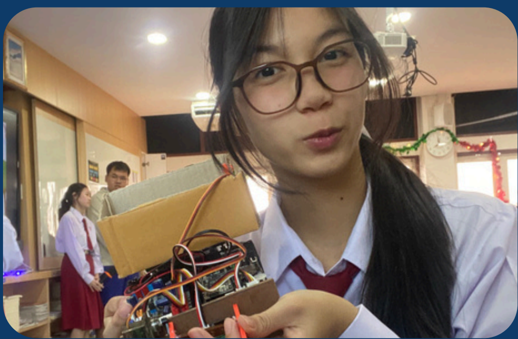
OUTPUT STAGE

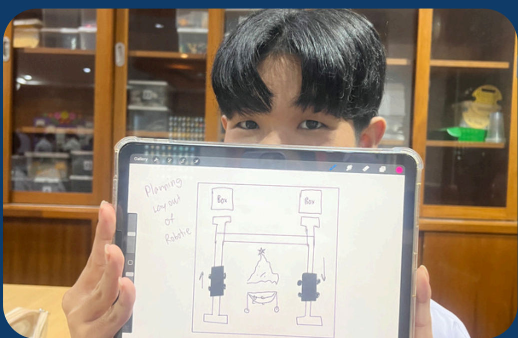
Ultrasonic sensor, servo moter and IR sensor will work together , If there's an obstacle Red LED blinks, buzzer turns on, ultrasonic sensor detect and motor turn the robot away and if the sensor detect that trash is in different size the light will turn on Big = green LED blinks, small = yellow LED blinks and buzzer beeps also if it detect some trash , neopixel brighten up, servomotor pick up the trash then store it in the basket of its back and keep following the line for finding more new trash by using IR sensor

METHODOLOGY

COLLECTING THE COMPONENTS

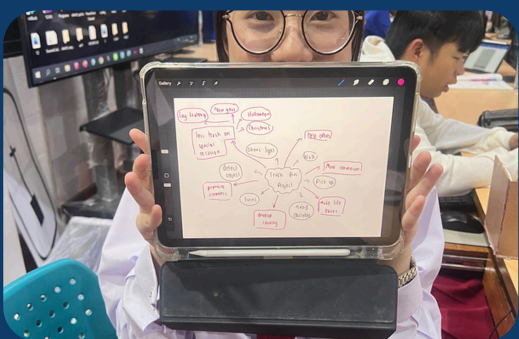
We discussed each component's role and functionality, ensuring everything connects seamlessly to achieve the robot's purpose. At the core of the system is the ESP32 microcontroller, which acts as the brain, managing all the sensors, motors, and logic. The ultrasonic sensor (HC-SR04) is crucial for obstacle detection, using its TRIG_PIN and ECHO_PIN to calculate distances. To ensure the robot stays on track, IR sensors (LEFT_IR_PIN and RIGHT_IR_PIN) are employed for line-following tasks. Movement is handled by a motor driver (L298N), which controls two DC motors to enable forward, backward, and turning motions. For added functionality, a waste collection mechanism may be included, using a motor (WASTE_COLLECT_PIN) to activate a trash-collecting system. All components work together efficiently, with proper GPIO pin assignments and a well-planned power supply. This interconnected design showcases how thoughtfully chosen components can enable precise obstacle avoidance, path tracking, and optional waste collection.





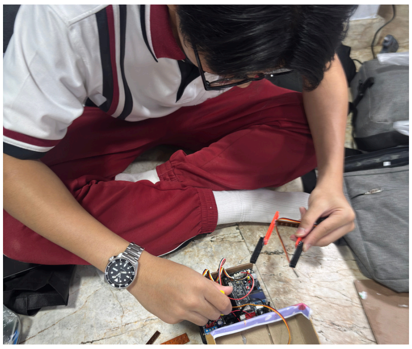
PLANNING THE LAYOUT

Our group discussed in detail how to set up the components for the garbage collection robot to ensure both functionality and efficiency. We agreed that the ESP32 microcontroller should be placed at the center to allow for easy wiring and connectivity to all sensors and motors. To enhance user interaction, a display could be added to show the robot's name or status. The ultrasonic sensor for garbage or object detection was decided to be positioned at the front of the robot, allowing it to effectively detect obstacles or trash. For movement, the DC motors and the motor driver were strategically placed to ensure balanced operation. Additionally, we discussed the placement and material of the trash can at the back of the robot. The trash can should be strong, lightweight, and durable enough to hold various types of waste without compromising the robot's stability. These design choices aim to create a robot that not only works well in collecting trash but is also reliable and practical in real-world use.



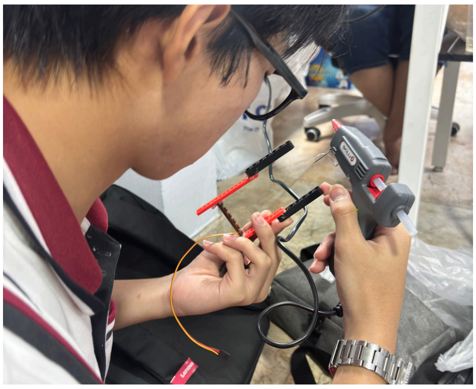
METHODOLOGY

Placing all the components



First, assemble the car with 2 motors attached to the wheels and frame. On the frame of the car there will be ikb. board and ipst wifi board and battery rail. In the picture, they are assembling the car and connecting each board together.

Our cars will have additions to make them able to collect garbage. By adding two parts. The first part is the garbage bin which consists of a motor to empty the garbage. The second part is the garbage collection arm that is being assembled. In this picture we will use Lego and three motors to collect garbage and release it.



In this project, we use Futureboard as a base and cardboard as a trash can instead of plastic to save money and employ environmentally beneficial products. We'll cut the cardboard box into equal squares.

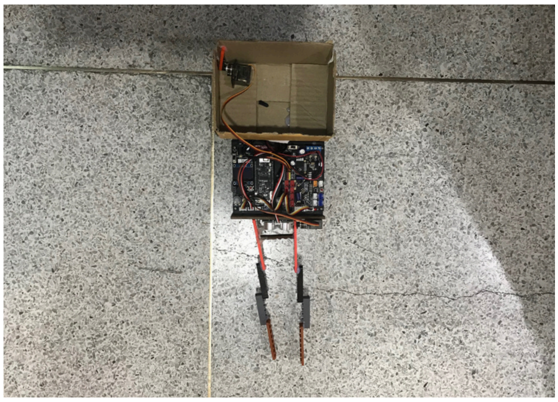
The cardboard will then be cut into five equal pieces and assembled into a trash can, which will be decorated to look lovely, including the outside of the simulated field.

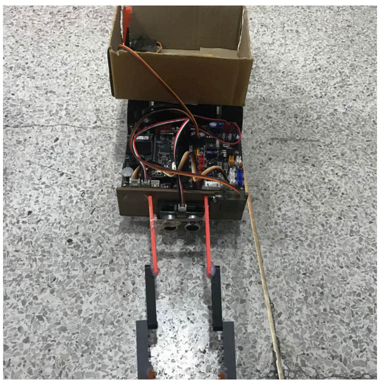
METHODOLOGY

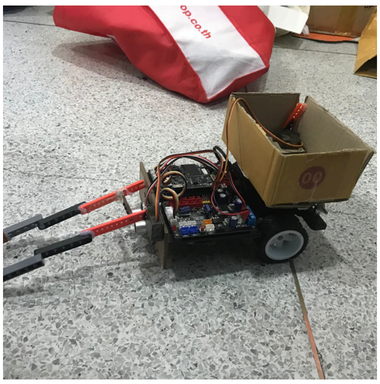
Finalizing Prototype

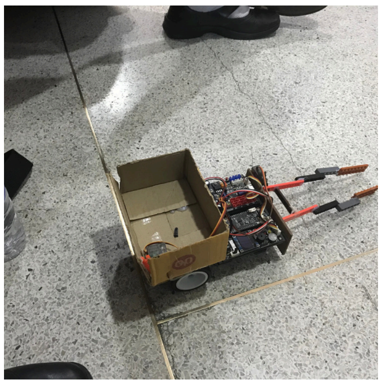
After gathering and assembling all the required equipment, we transported it to the simulation field for setup. Once everything was properly arranged, we positioned the robot at its designated starting point to prepare for the initial testing phase. The goal of this test was to evaluate whether the robot could move and perform according to the intended design specifications. We carefully monitored its movements, checked for any irregularities, and ensured that its responses aligned with the pre-defined parameters. This step was crucial for identifying any potential issues and ensuring the robot's functionality met expectations before proceeding to more complex tasks

By the end of Week 7, we had successfully constructed a robust and organised prototype. All components were successfully installed and logically structured, ready for programming and testing in the subsequent step.









PROGRAMMING, INITIAL TESTING, AND SYSTEM INTEGRATION

PROGRAMMING AND INITIAL TESTING

Week 10

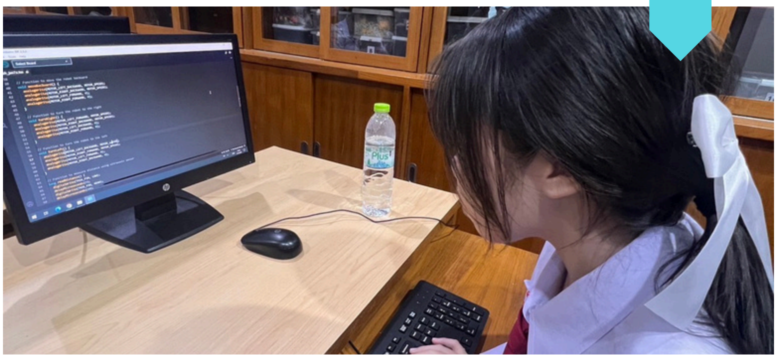
Week 11

During Week 10, our primary focus was to write and debug the initial code for the components of our automatic garbage collector robot project. We began by reviewing the system requirements and determining the necessary code to control the various sensors and actuators involved. The ESP32 microcontroller was chosen as the central controller, responsible for managing inputs from the ultrasonic sensors, motor drivers, and the robot's movement.

Each component required specific programming to ensure proper functionality. For instance, the ultrasonic sensor was programmed to detect obstacles and measure distance, which would allow the robot to navigate efficiently. The motor drivers were coded to control the movement of the robot, enabling it to travel to designated garbage collection points. We also wrote control code for the servo mechanism used to pick up the garbage at these points.

Using the Arduino IDE, we uploaded the code and conducted debugging in small increments. Some challenges arose, such as inaccurate distance measurements and unexpected motor behavior, but these were addressed by fine-tuning the sensor calibration, adjusting motor parameters, and ensuring all wiring connections were correct.

By the end of Week 10, we had successfully uploaded the working code for each individual component and tested them independently to confirm they were functioning as intended. The robot could move towards designated garbage collection points, detect obstacles, and perform actions like picking up the garbage. Our next task will be to integrate these components into a cohesive system during Week 11.



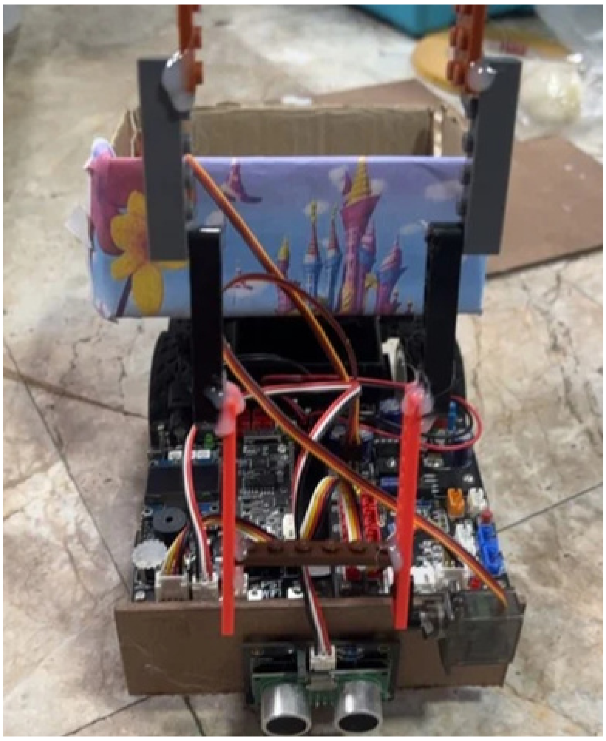
SYSTEM INTEGRATION AND TROUBLESHOOTING

In Week 11, we focused on integrating the components developed in Week 10 into a fully functional automatic garbage collector robot. The ESP32 microcontroller connected the ultrasonic sensors, motor drivers, servo, and other parts to ensure the system worked as a whole.

During this phase, we had to adjust the robot's structure, as the original frame couldn't support the servo motor's required movement for garbage collection. This led us to source a stronger servo motor to ensure precise action.

We also faced power distribution challenges, as some components, like the servo motor and motor drivers, required more power. We optimized the wiring to ensure stable power supply and avoid inconsistencies.

After resolving these issues, we tested the integrated system. The ultrasonic sensor detected obstacles, the motors moved the robot, and the servo functioned properly to pick up the garbage. By the end of Week 11, the system was stable, and we were ready for more advanced testing in the following week.



ADVANCED TESTING AND TROUBLESHOOTING

In Week 12, we conducted advanced testing to ensure our trash-collecting robot functioned reliably under various conditions. Each sensor and actuator was tested for consistent performance, even when exposed to environmental changes. The ultrasonic sensor was evaluated for accuracy in detecting objects at different distances, ensuring precise obstacle detection.

During testing, we encountered issues with inconsistent sensor data, particularly when the power supply fluctuated. To resolve this, we secured the connections and implemented a more stable external power source. Additionally, we noticed delays in the servo motorâ€™s response when handling heavier loads. We optimized the code to enhance the motorâ€™s performance and response time.

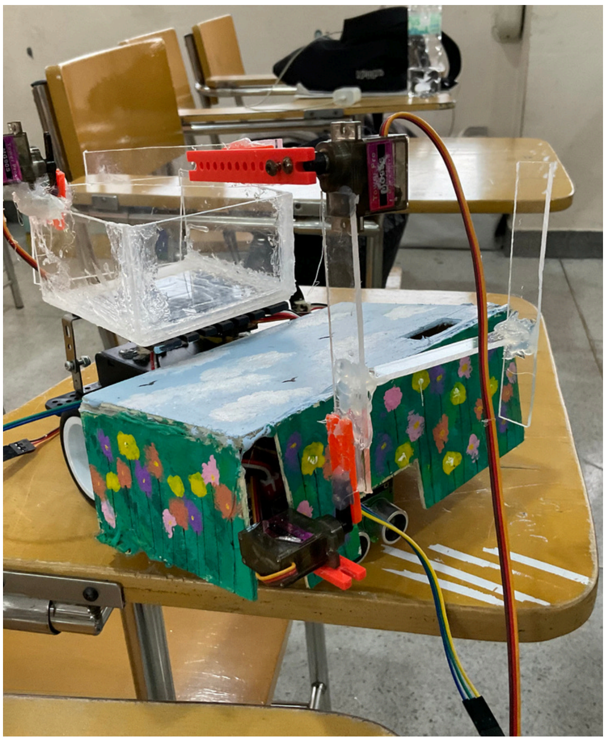
By the end of the week, our system demonstrated greater stability and reliability, setting the stage for further refinements in Week 13.

PROTOTYPE REFINEMENT AND OPTIMIZATION

During Week 13, we focused on refining our trash-collecting robot to improve its structure, stability, and efficiency. We reorganized the wiring on the breadboard to create a cleaner layout and reduce tangling. The sensors were repositioned to enhance accuracy and performance—specifically, the ultrasonic sensor was adjusted to prevent false readings from nearby obstacles.

Additionally, we reinforced the robot’s frame to ensure stability during operation. The NIR sensor and Ultrasonic was securely mounted to provide clear visual feedback, and all wiring was properly secured to prevent disconnections.

After implementing these refinements, we conducted another round of testing. The results demonstrated improved stability, faster response times, and more accurate sensor readings, making the robot more reliable and user-friendly.



CONCLUSION

The progress made in Phase 1 and Phase 2 has significantly advanced our robotic trash collection project, from initial planning and prototyping to system integration and testing.

During Phase 1, we focused on identifying key components, defining objectives, and building the initial prototype of the trash-collecting robot. This stage laid the groundwork for further development by ensuring all necessary components, such as sensors, motors, and collection mechanisms, were selected and prepared.

In Phase 2, we concentrated on programming, testing, and integrating the system to achieve a stable, functional prototype. Through advanced testing and troubleshooting, we addressed key challenges such as navigation accuracy, obstacle detection, power efficiency, and waste collection efficiency. Refinements were made to improve the robot's structure, stability, and usability, ensuring it could efficiently collect and dispose of waste in various environments.

Overall, the project has successfully demonstrated its core functions, including autonomous movement, waste detection, and collection, meeting the initial objectives. The progress made so far provides a strong foundation for further enhancements to improve efficiency, battery life, waste capacity, and adaptability to different terrains.

Further Development

While the robotic trash collection project has met its primary objectives, there are several areas where further improvements can be made to enhance its functionality and efficiency:

Power Optimization	Explore alternative power solutions, such as rechargeable batteries or solar panels, to improve energy efficiency and ensure continuous operation of the robot.
User Interface Development	Develop a mobile or web-based interface to allow users to monitor the robot's performance, track collected waste, and control it remotely, enhancing accessibility and convenience.
Additional Sensors	Integrate more sensors, such as gas, humidity, or light sensors, to expand the robot's capabilities, enabling it to detect different types of waste, environmental conditions, and potential hazards.
Prototype Design	Refine the robot's physical design to make it more compact, durable, and easier to maintain. Structural improvements would enhance both portability and usability, making it more efficient in various environments.
Real-World Testing	Conduct long-term testing in real-world environments, such as parks, streets, and industrial areas, to evaluate the robot's reliability, efficiency, and adaptability under different conditions. This would provide valuable insights for further refinements.
Error Handling and Alerts	Implement advanced error detection and alert systems, such as real-time notifications when sensors malfunction, the waste bin is full, or the power supply is low, ensuring smooth and uninterrupted operation.