McGill - RoboHacks 2025
Technical Challenge

Mount Royal Revival Project: An Autonomous Reforestation Mission

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1. Introduction

1.1 Purpose

The Mount Royal Revival Project aims to design and develop an autonomous robot capable of assisting reforestation efforts on Mount Royal by navigating mapped terrain, identifying suitable planting zones, and accurately depositing seeds while avoiding restricted areas. The project simulates real-world sustainable engineering solutions for environmental restoration.

1.2 Scope

The project includes the following key functionalities:

- Autonomous navigation through a mapped environment.
- Sensor-based identification of planting zones.
- Precise seed deposition in designated areas.
- Avoidance of restricted zones to prevent ecological damage.
- Sustainable design choices, including recyclable materials and energy efficiency.
- Environmental data collection by visiting the lake zone (Optional).

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2. System Requirements

2.1 Functional Requirements

- The robot must **autonomously** navigate the designated area.
- Color sensors must **distinguish planting zones (green/blue) from restricted areas (red)**.
- The robot must **accurately deposit** two seeds per valid zone without spillage.
- The system must ensure **smooth and controlled movement**.
- The robot must remain within the allowed **10-minute runtime limit**.

2.2 Non-Functional Requirements

- The robot should be **lightweight**, with a higher score for reduced weight.
- The design should favor **recyclable and eco-friendly materials**.
- Components should be **energy-efficient**, using rechargeable batteries.
- The robot should be **easily disassembled** for recycling and reusability.

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3. System Constraints

3.1 Hardware Constraints

The following components were used to build the robot:

- **Microcontroller:** Arduino Nano
- **Motors:** Two powered motors for movement and one servo for seed deployment
- **Sensors:** Two infrared (IR) sensors for path following, two color sensors for planting zone detection
- **Power:** 9V rechargeable battery with a battery connector
- **Chassis:** Lightweight materials such as cardboard or popsicle sticks to reduce environmental impact
- **Mobility:** Two wheels and one caster wheel for smooth navigation

3.2 Software Constraints

- The robot must be programmed in **C++ (Arduino framework)**.
- The code must be optimized to fit within the **Arduino Nano's memory limit**.
- The system should allow for **serial debugging** via the Arduino IDE.
- The use of **open-source libraries** (e.g., Servo, IR sensor libraries) is encouraged.

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4. Project Design and Sustainability Choices

4.1. Project Design

As illustrated in the following images, the robot is designed to autonomously navigate along a black path while ensuring the precise planting of seeds in designated areas, such as green and blue zones. The robot's structure consists of two powered motors connected to two wheels, along with a bearing to facilitate stable movement. Mounted on the upper section of its body is a breadboard affixed with an Arduino Nano Board, which serves as the central processing unit. This board is responsible for interfacing with all necessary digital and analog input/output ports, as well as power it connections.

Additionally, the system integrates a motor driver that regulates power distribution from a rechargeable battery to the two motors. For path-following and planting execution, the robot is equipped with two infrared (IR) sensors that continuously track the black path to maintain proper movement. Furthermore, a color sensor is implemented to detect planting zones (green and blue) and trigger the seed planting mechanism via a servo motor positioned at the rear of the robot.

This configuration ensures efficient seed placement while maintaining accurate trajectory control. The entire system has been developed to function autonomously, leveraging sensor-driven decision-making and motorized execution.

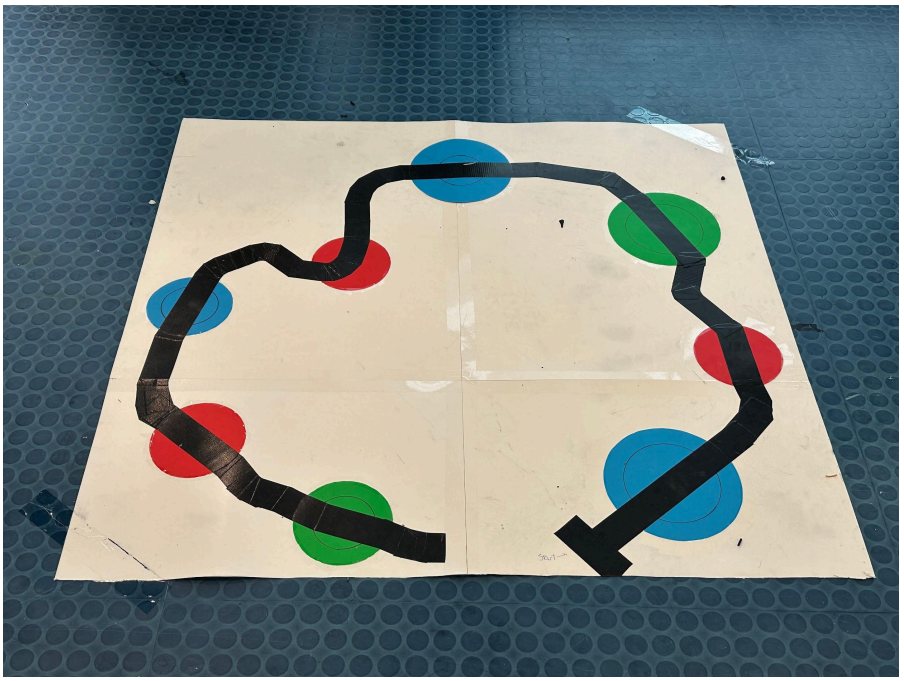

Fig. 1 - Course

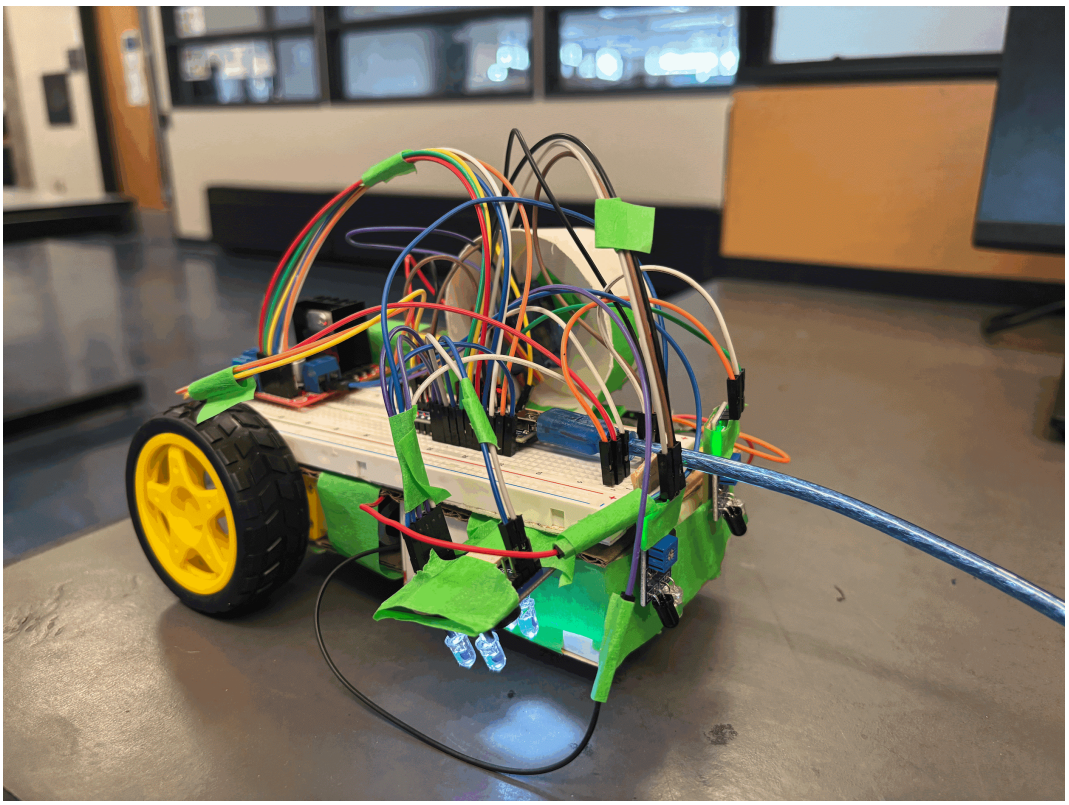

Fig. 2 - Robot body

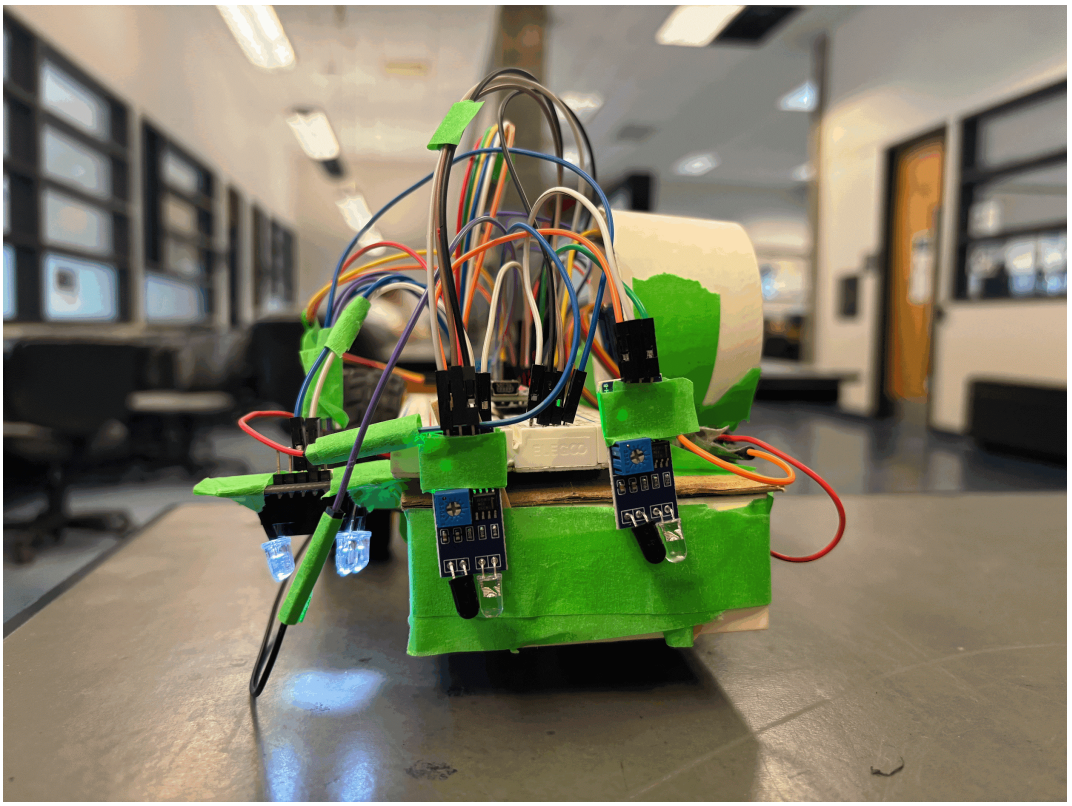

Fig. 3 - Robot body front view

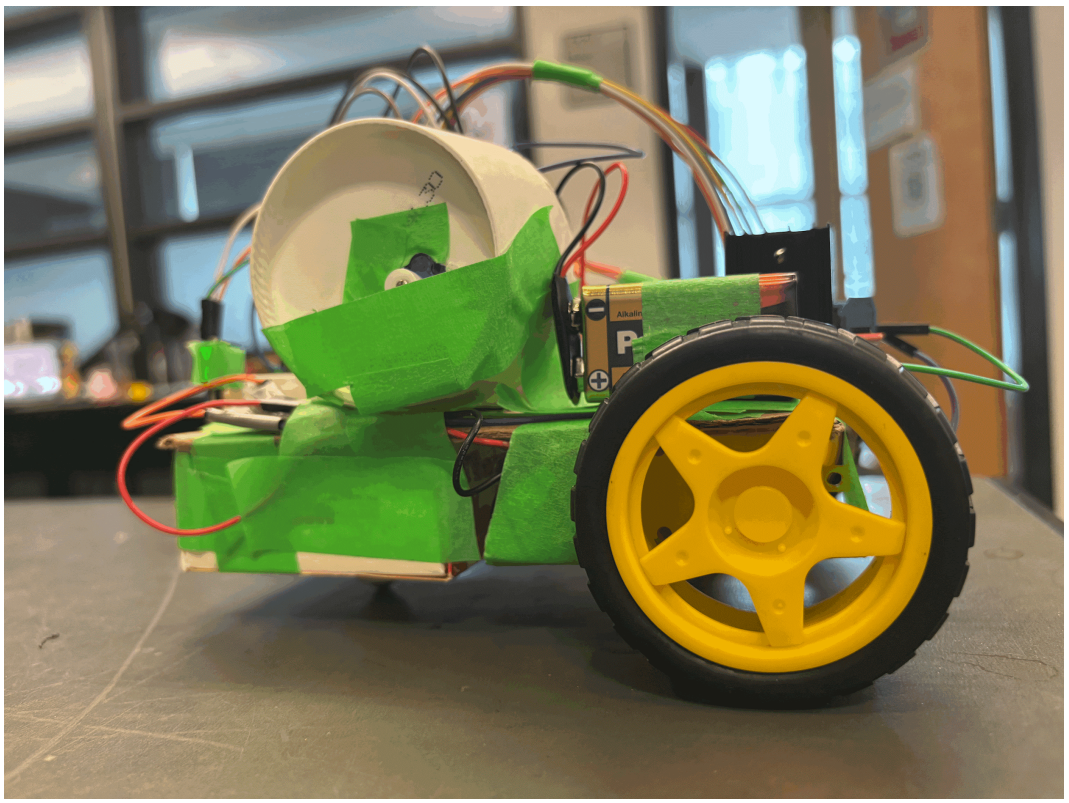

Fig. 4 - Robot body side view 1

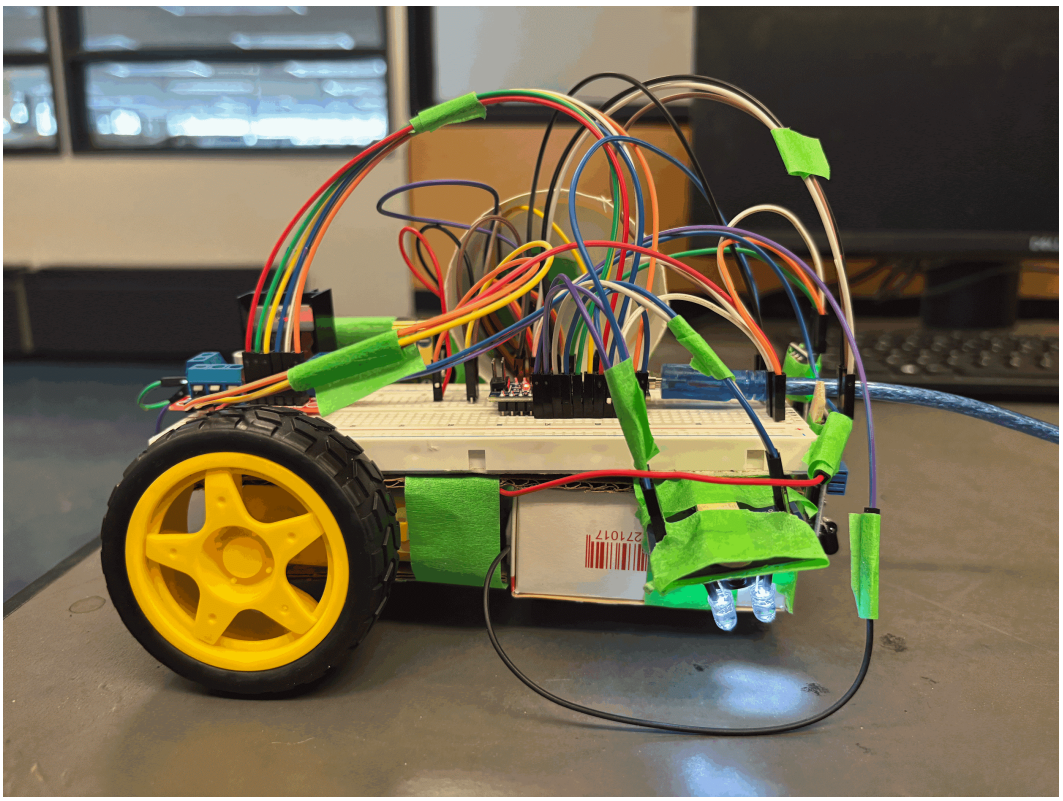

Fig. 5 - Robot body side view 2

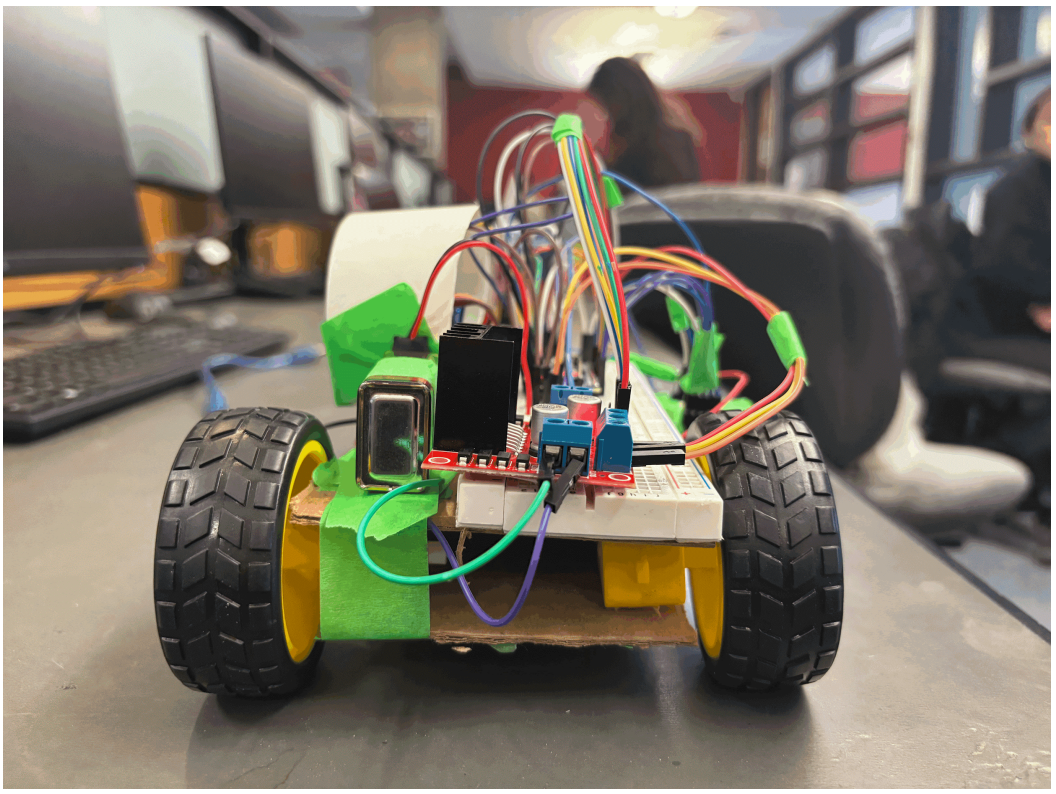

Fig. 6 - Built robot body back view

4.2. Sustainability choices

- **Cardboard and tape**: Used for the structure to keep costs low and reduce environmental impact by using recyclable materials.
- **Electronic components**: Minimal power consumption components such as servos and Arduinos are used to enhance efficiency.
- **Rechargeable batteries**: Used instead of disposable batteries to promote sustainability.

4.3. Energy Efficiency Consideration

- The motors will only be active when needed, reducing unnecessary power usage.
- The microcontroller will use low-power modes when idle.
- The design favors efficient servo motors over power-intensive actuators.
- The use of LED indicators instead of LCD screens minimizes energy consumption.

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5. Conclusion

The **Mount Royal Revival Project** successfully developed an **autonomous reforestation robot** that integrates navigation, planting, and sustainable engineering. The system efficiently identifies planting zones, deposits seeds with precision, and minimizes environmental impact through eco-friendly design choices. Future improvements could include **wireless control**, improved material durability, and enhanced **sensor calibration** for better planting accuracy. This project demonstrates the potential for robotics in **environmental restoration**, providing a scalable solution for future reforestation efforts.