McGill - RoboHacks 2025
Technical Challenge

Mount Royal Revival Project: An Autonomous Reforestation Mission

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1. Introduction

1.1 Purpose

The objective of this project is to design and implement a robotic musical instrument control system capable of generating sound using a drumming mechanism and a flute system. The drumming must produce physical beats, while the flute should generate sound through a speaker connected to the AUX port. The system must also integrate an emergency stop function using a touch sensor to immediately halt all movements and sounds.

1.2 Scope

This project includes the following components:

- A robotic system controlled via joysticks and buttons.
- A servo motor-driven drumming mechanism.
- A flute sound generation system utilizing an audio speaker.
- A safety mechanism (emergency stop) to immediately halt operations.
- A system architecture using Arduino microcontrollers and sensors for real-time control.
- A low-cost structure using cardboard and tape for housing the components.

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2. System Requirements

2.1 Functional Requirements

- The system must control two motors for movement and drumming.
- The flute system must produce a distinct fourth note sound when activated.
- The joystick should control motor movements based on user input.
- The system must respond to button presses and trigger actions accordingly.
- The emergency stop button must instantly halt all functions.
- Serial communication must log system states for debugging.

2.2 Non-Functional Requirements

- The response time for joystick input to motor action should be within 100 ms.
- The system should be energy-efficient and run on battery power.
- The hardware must be low-cost while ensuring durability.
- The project should use open-source libraries for easy modification.

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3. System Constraints

3.1 Hardware Constraints

1. Arduino microcontrollers (e.g., Arduino Uno) for processing inputs and outputs.
2. Servo motors for drumming actuation.
3. Joystick controllers for user input.
4. Push buttons for triggering functions.
5. Touch sensor for emergency stop.
6. 3.5mm AUX output for flute sound generation.
7. Cardboard and tape for structural support.

8. Power source (Battery or external supply).

3.2 Software Constraints

1. The system must be programmed in C++ (Arduino framework).
2. The code must be optimized to fit within the Arduino memory limit.
3. The Servo and ezButton libraries will be used for motor and button control.
4. Serial debugging should be available via the Arduino IDE.

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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.

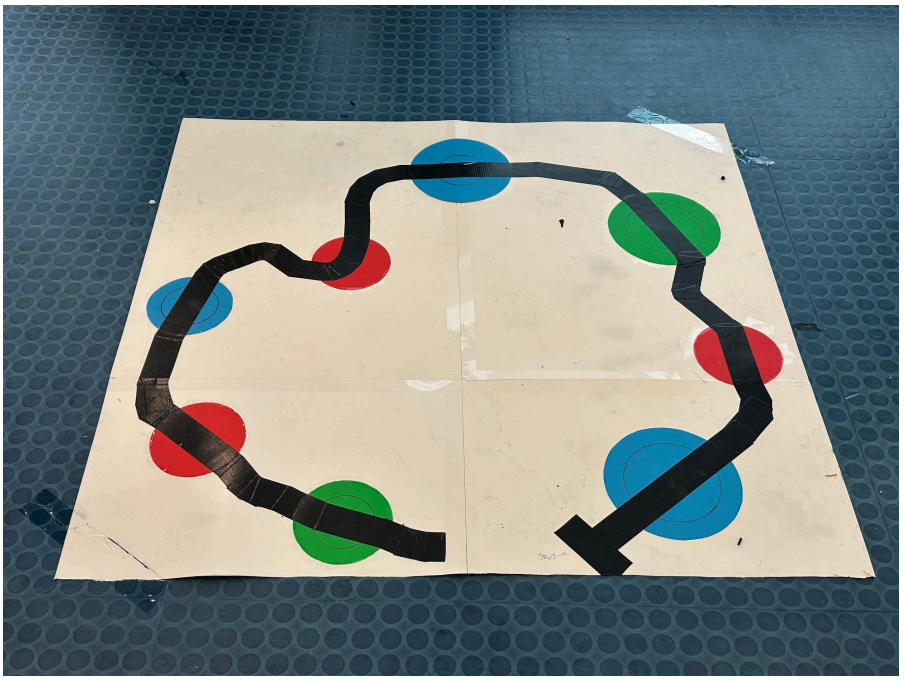

Fig. 1 - Course

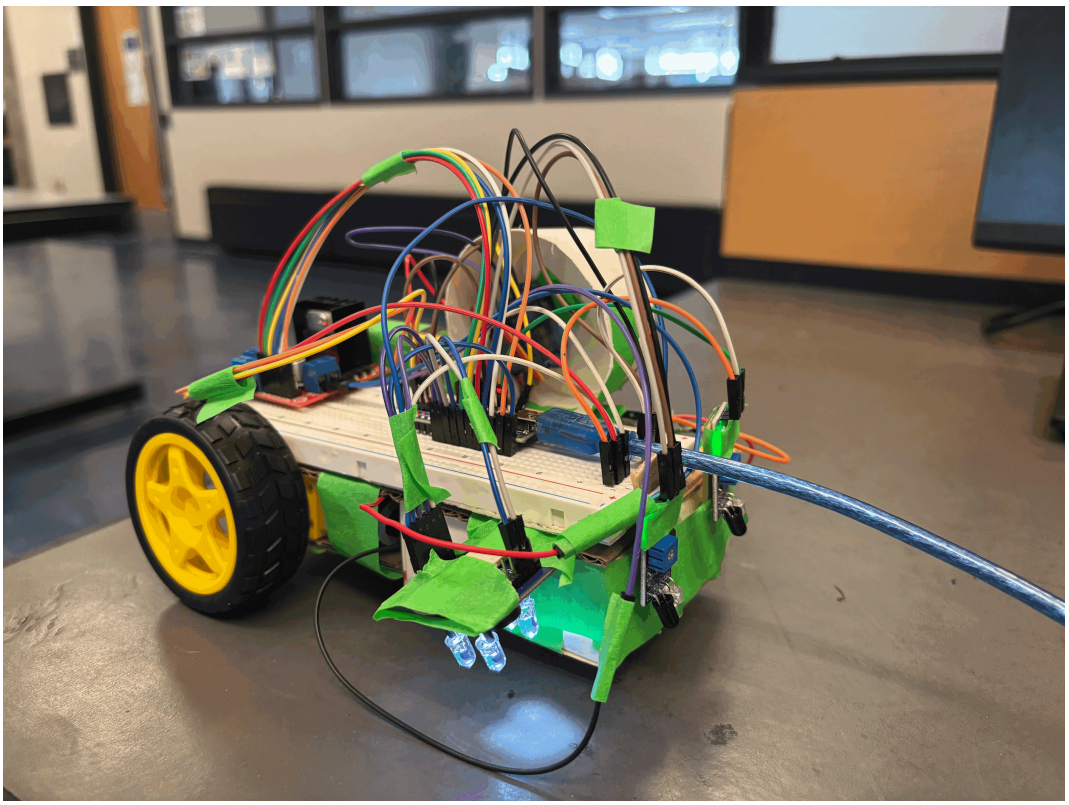

Fig. 2 - Robot body

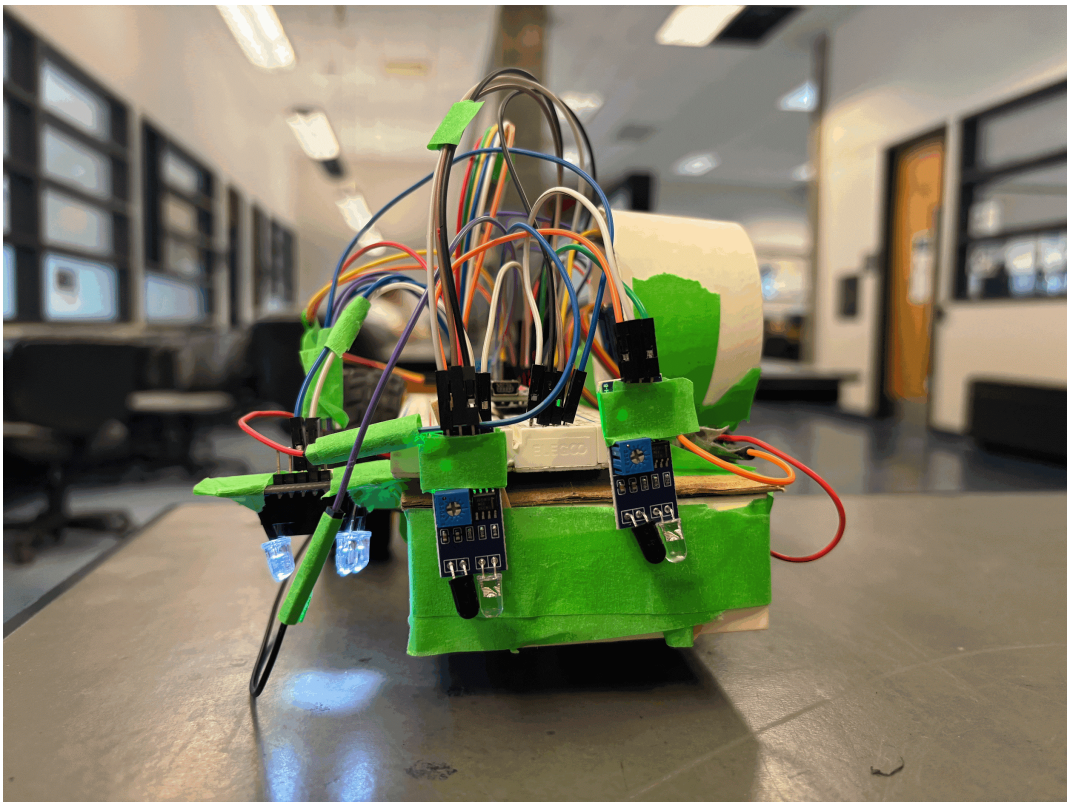

Fig. 3 - Robot body front view

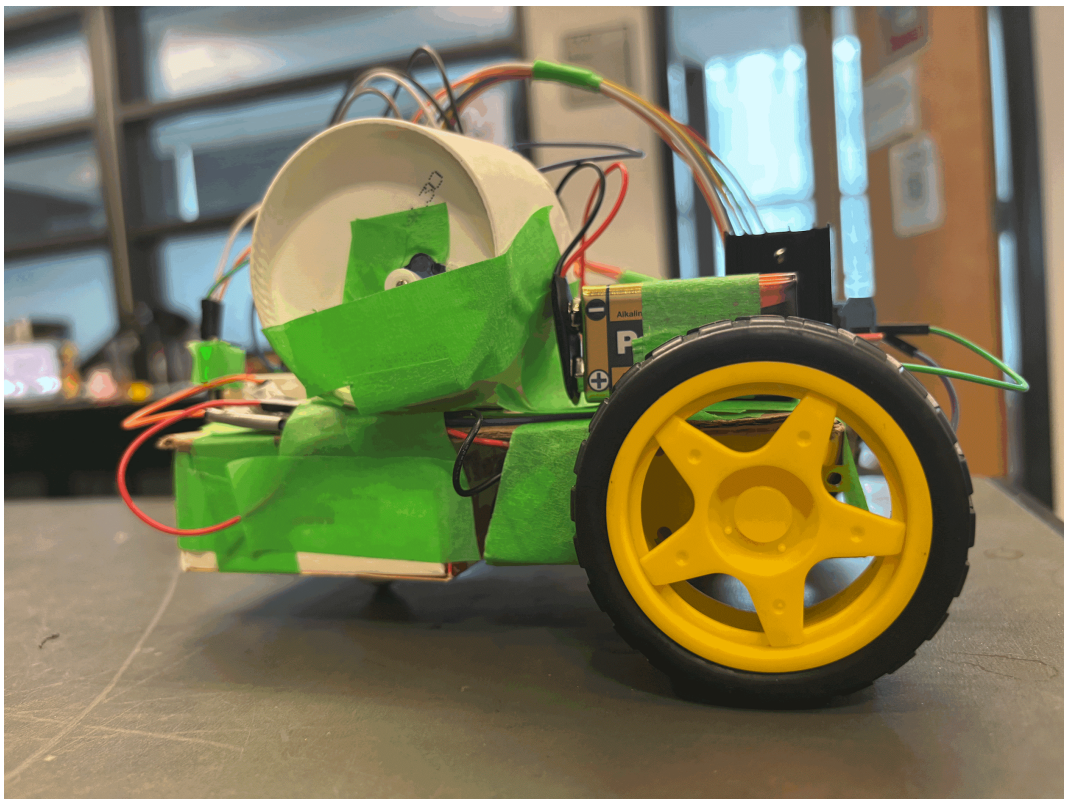

Fig. 4 - Robot body side view 1

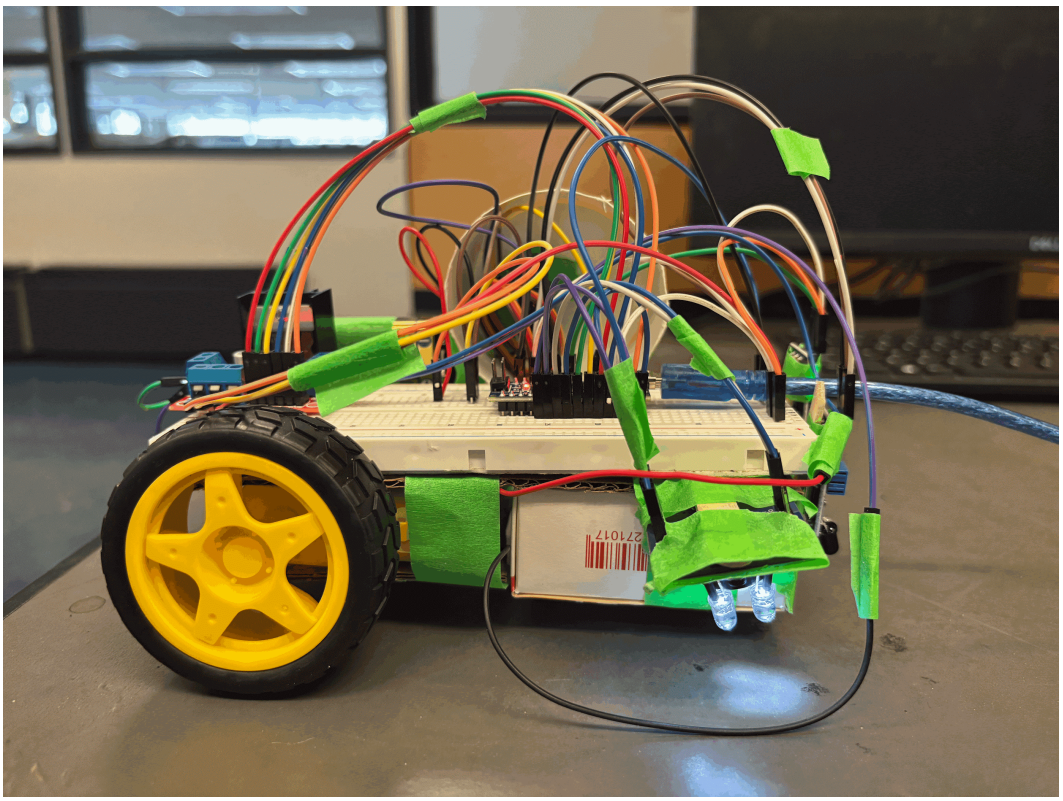

Fig. 5 - Robot body side view 2

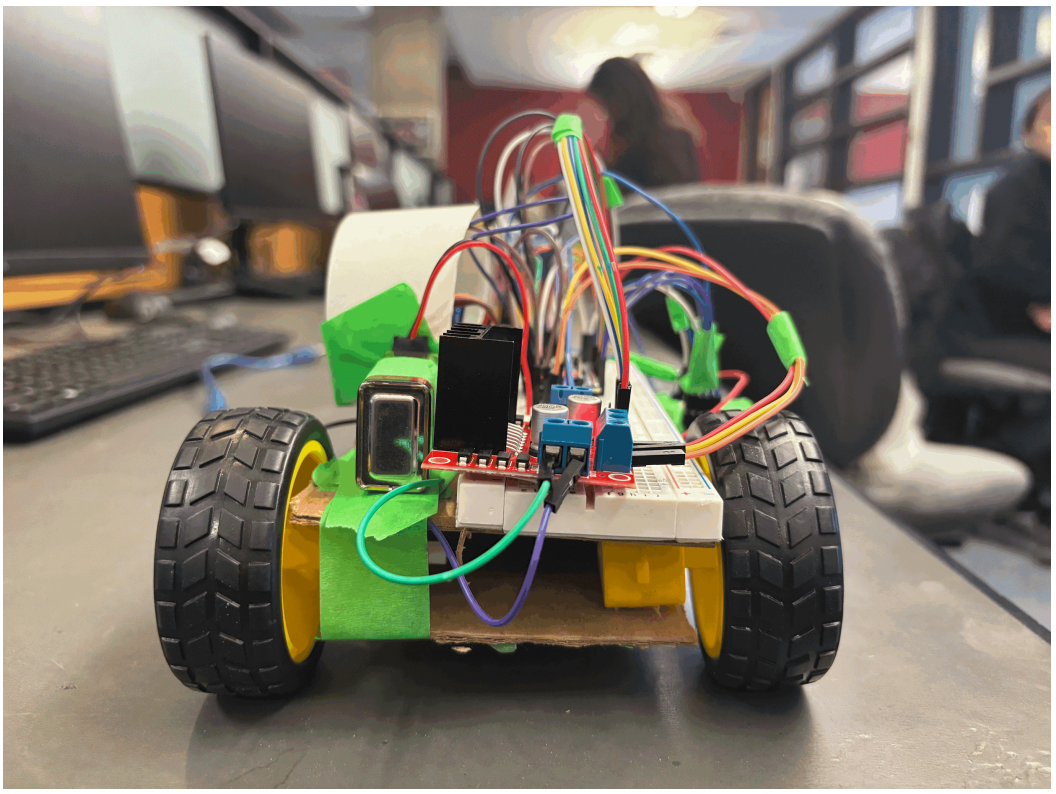

Fig. 6 - Built robot body back view

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

This project aims to create an interactive robotic musical instrument that efficiently integrates motion, sound, and safety mechanisms using cost-effective and sustainable materials. The system design prioritizes functionality, efficiency, and environmental impact while ensuring reliability through Arduino-based control and robust emergency handling. Future improvements could include wireless control, improved material durability, and enhanced sound processing for a more immersive musical experience.