Railway Track Cleaning Robot

ID3802: Open-Ended Lab Project
Report
Submitted by

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UNDER THE GUIDANCE OF:

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1. Introduction:

The development of transportation infrastructure plays a pivotal role in the overall progress of any country, and rail transportation holds particular significance.

Today, Indian Railways is one of the largest transportation networks in Asia and the world, encompassing an extensive network of over 66,000 kilometres and more than 8,000 stations (Ankit Gupta and Vidya Bhat, 2007). Often referred to as the "Lifeline of the Nation," it serves as the oldest and most expansive network, connecting cities throughout the country.

However, when it comes to cleanliness and sanitation, Indian Railways faces significant challenges. Waste management has emerged as a considerable obstacle, with vast amounts of waste being disposed of on railway tracks. The increase in garbage disposal inconveniences passengers and residents living near railway tracks. Moreover, the lack of cleanliness leads to pollution problems and the spread of harmful microorganisms, posing health risks.

Although the railway department has implemented various initiatives to improve cleanliness across the network, these efforts have not kept pace with the growing demand. Manual cleaning has been the primary method for addressing waste disposal, which has proven detrimental to the health of the workers involved (Thiyagesan Jesin James et al., Year). Recognizing the need for a solution, a robot has been developed to clean railway tracks. This robotic system consists of components such as a waste collecting unit, power supply, cleaning mechanism, disposal mechanism, control unit, and sensing device.

In the vicinity of railway stations, the Indian Railways currently relies on manual scavenging as the primary method for waste collection. Unfortunately, this approach involves the use of inadequate tools such as boards and brooms, and the collected waste is often placed in sacks. Regrettably, the employees engaged in this cleaning process endure unhygienic conditions, leading to various health issues such as respiratory diseases, infections, cardiovascular or musculoskeletal disorders, and even posing risks to their lives. The accumulation of waste on railway tracks is particularly pronounced near stations, creating a challenge for railway officials who strive to provide efficient transportation services. Disposing of this waste from the tracks becomes a difficult task. Additionally, cleaning the railway tracks requires a significant workforce which is always in a shortage and the task must be completed within a short timeframe due to the busy nature of railway stations. Therefore, there is an urgent need for a

cost-effective machine capable of thoroughly cleaning the railway tracks within a brief period. Addressing this need forms the primary objective of this Project.

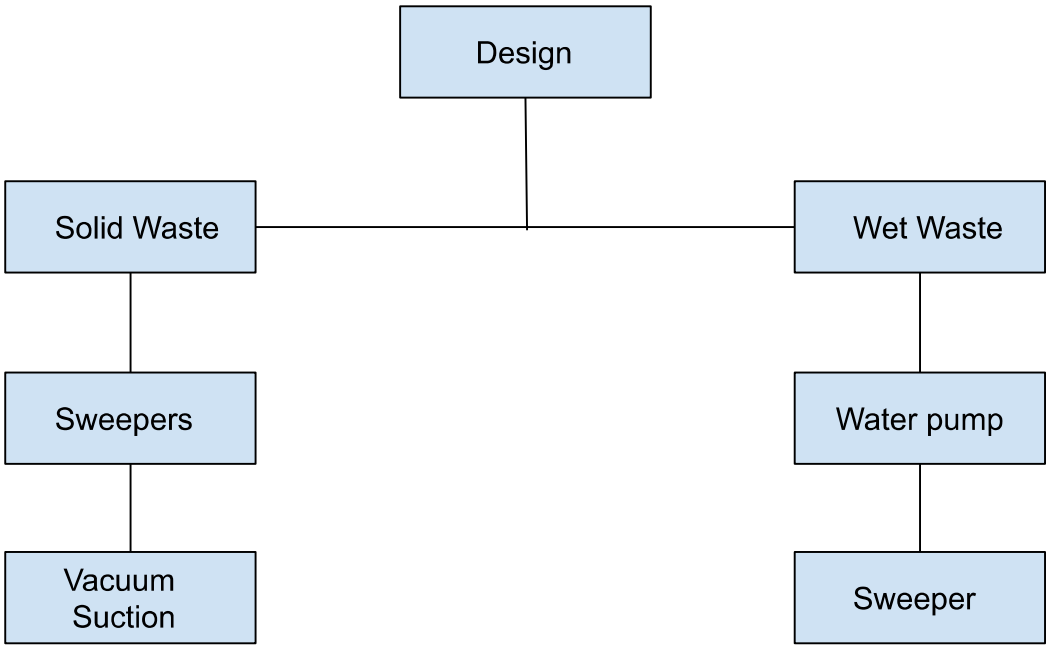
2. Objective:

Cleaning the tracks near the platform.

- To remove the solid wastes (plastic bottles, wrappers, plates, packets …etc).
- Wash the track with high-pressure water sprinklers to remove sticky and wet waste.

3. Methodology:

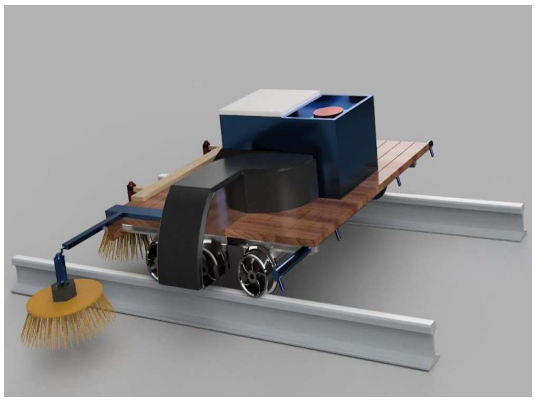
The primary objective of this project is to create a cost-effective and highly efficient self-cleaning device capable of removing dry and wet waste from railway network tracks. The operational process, including a detailed flowchart, will be elucidated below. Furthermore, this report will present the design of a prototype machine, accompanied by relevant figures.

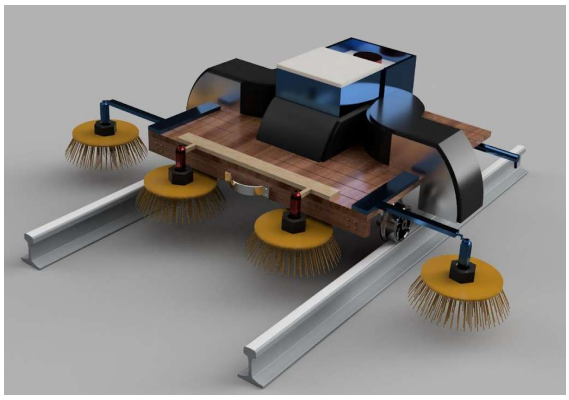


Flow chart of the methodology.

4. Our Work:

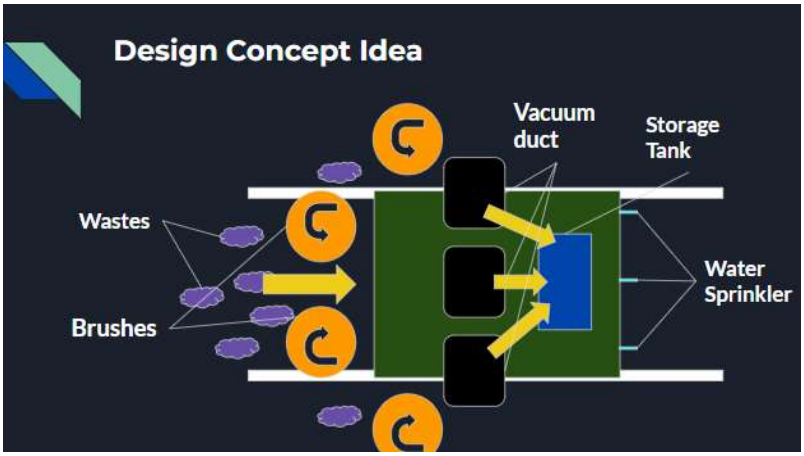
a. CAD Modelling:





The preliminary design of the robot was made in Fusion 360 software, the machine comprises four rotating brushes, two cuboid-shaped compartments, a small water tank, a vacuum suction pump and duct, a jet with a nozzle, and two pairs of freely moving wheels to facilitate smooth movement on the track.

Working Process- The basic working process of this robot includes first guiding the dry waste towards the vacuum suction ducts, there are 3 ducts in total- 2 at the sides and one at the centre where the waste is sucked and stored in a storage tank, then a centrifugal water pump discharges water (which can be mixed with disinfectant or detergents) at high pressure into the nozzles to spray at a high velocity to remove wet or sticky waste.



b. Prototyping

i. Materials Used and Dimensions-

Description-The base frame and supporting elements are made of (20x20) and (30x30) aluminium profiles, 12v Lead acid batteries to power the robot, Dc motors are used to rotate the brushes (60rpm) and for locomotion(45rpm), a radial vacuum impeller made of mild steel and a high rpm RS-775 DC motor is used for vacuum suction, the base of the cart is made of acrylic sheet. An Arduino-controlled circuit with motor drivers is used for the control part.

Cart Dimension:

Length = 70 cm
Width = 50 cm
Thickness = 8 mm (Acrylic sheet)

Sweeper:

Diameter = 8 inch
Angular speed = 60 rpm

Vacuum Pump:

Speed = 5000 rpm

Tank: Acrylic

Length = 20 cm
Width = 20 cm
Height = 18.5 cm

Duct: Diameter = 4 inch

Powered Wheels: Diameter = 4 inch rubber

Castor Wheels : Diameter = 3 inch, Height = 4 inch

DC Motors:

4 Nos, 60 rpm,
2 Nos, 45 rpm

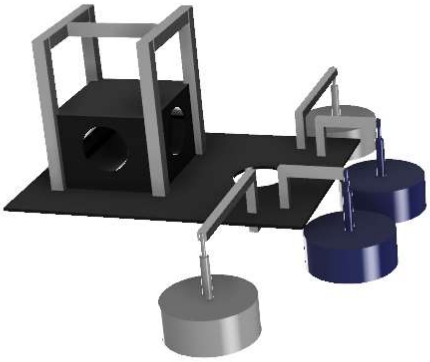
Impeller: Diameter = 6 x 3 inch

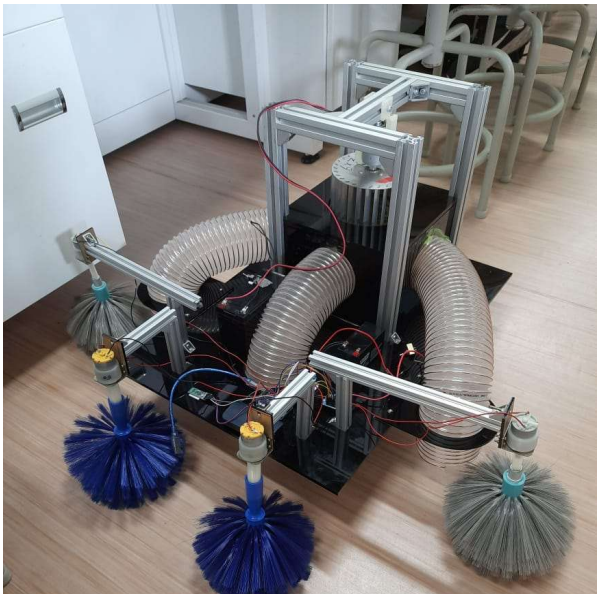
Battery: 12 v either lead acid

Motor driver: L293N

Bluetooth module: HC-05.

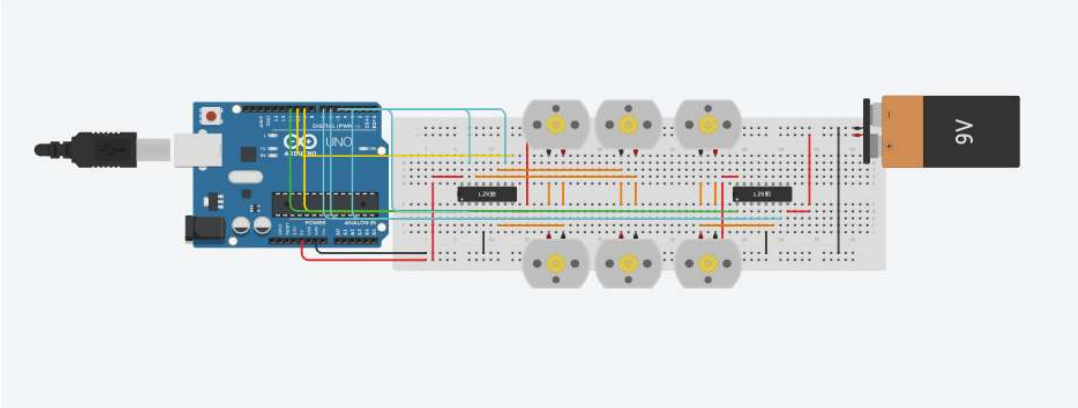
ii. Assembling





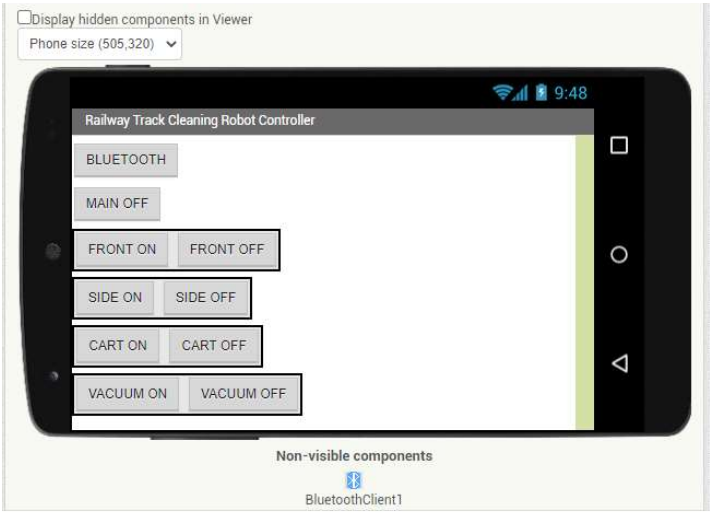
CAD model and Prototype final design

iii. Circuit connections



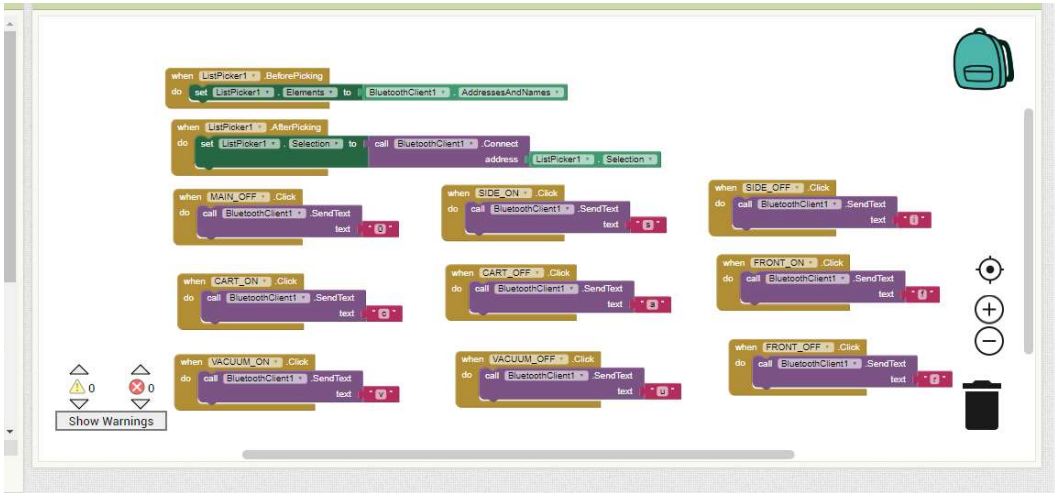
Circuit diagram

The basic circuit diagram for the robot is shown above. We used 2 L293D motor drivers to control the 4 sweepers in the front and side. We implemented a Bluetooth control to this robot where we can control turn on/off these motors.



App UI

We made a basic app from the MIT App Inventor. The app has basic features of connecting to Bluetooth and through serial communication with Arduino, it can control the robot.



App block code.

5. Result and Discussion-

The prototype was tested and the results were,

- The Bluetooth control was successful, the test for the 4 sweepers which are connected to Bluetooth.

- A powerful dc motor with high rpm could not be found at the required budget, so the vacuum suction with the RS775 motor that is used is not enough to suck medium-weight material, because the pressure developed by the impeller is not enough and needs more pressure drop to suck heavy-weight materials although it it is able to suck lightweight wastes like small papers, polythene covers and some lightweight materials.

- The sweeper mechanism was successful in gathering solid waste.

6. Conclusion:

- Our objective of making a small scaled prototype of a machine that cleans railway tracks near the platforms was partially completed.
- We would like to conclude that objective to clean the solid waste (papers, plastic covers, wrappers) from the tracks is completed.

7. Future Improvements

- Addition of high-speed water jet nozzles to clean sticky and wet waste.
- Implementation of wireless control of vacuum pressure, water pump power and cart speed.
- Addition of image processing to detect and identify wastes and control the sweepers and vacuum according to the need.
- Adding object detection sensors for an emergency stoppage in case of an obstacle.

8. References

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[3] Novel Kumar Sahu, B.Shahique Raza, Ashu Kumar Pandey &Rupendra Marre, “To Study Of Speed Controlled Railway Track Cleaning System“, International Journal of Mechanical And Production Engineering, , Vol. 5,No. 11,ISSN: 2320-2092, pp.52-57.

[4] Balasaheb Kasure , Rohit Sondulkar , Rohit Zagade, Hatim Jalal &, Akash Chavan (2019), “A Review on SemiAutomatic Track Cleaning Machine International Journal of Research in Engineering, Science and Management”, Vol. , No. 2, ISSN : 2581-5792, pp 704- 707.

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[6] P. Vamsi Krishna, Dr. S.Prakash, “Intelligent Railway Track Cleaning Robot with Waste Segregation”, International Journal of Advanced Engineering Technology, Vol.20, No 7s, 2020, pp 4895-4899