

# Autonomous Rail Compartment Cleaning Robot

## 1. Problem Statement:

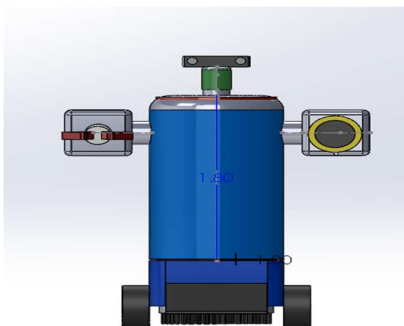
Maintaining the cleanliness and hygiene of rail compartments is a challenging task, especially in busy and high-traffic rail systems especially in India where due to shortage of human work force most of the trains are not cleaned properly. Traditional manual cleaning methods are often time-consuming and may not provide consistently high standards of cleanliness. This research proposal aims to design and fabricate an autonomous rail compartment cleaning robot that can efficiently clean and sanitize train carriages, improving passenger experience and ensuring a healthier travel environment.

## 2. Methods:

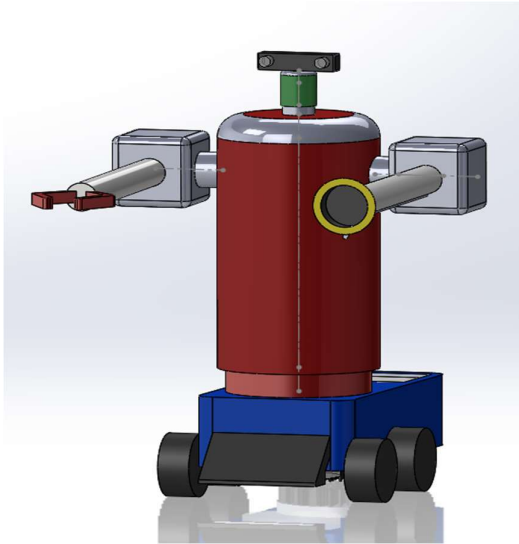
The proposed autonomous rail compartment cleaning robot will employ cutting-edge technology and methods to achieve its cleaning objectives. The key methods and components of the robot include:

- **Navigation and Localization:** The robot will be equipped with advanced sensors, including LiDAR, cameras, and inertial sensors, to navigate and localize itself within the rail compartment. It will utilize SLAM algorithms to map the interior and determine its position accurately.
- **Surface Detection and Assessment:** Computer vision algorithms will be used to detect and assess the cleanliness of surfaces within the rail compartment. The robot will be able to identify areas that require cleaning and prioritize them based on the level of contamination. Moreover, it will be trained on detecting objects like mobile phones, keys and other belongings that passengers might forget.
- **Cleaning Mechanisms:** The robot will be equipped with various cleaning mechanisms, such as brushes, suction systems, and disinfection modules. These mechanisms will be adaptable to different surface types and levels of dirtiness.
- **Autonomous Operation:** The robot will operate autonomously, navigating the rail compartment, cleaning and sanitizing surfaces, and avoiding obstacles or passengers when necessary. It will have the capability to work during off-peak hours to minimize disruption to train schedules.

## 3. Figures:

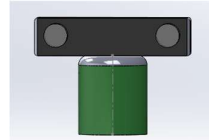


Front View



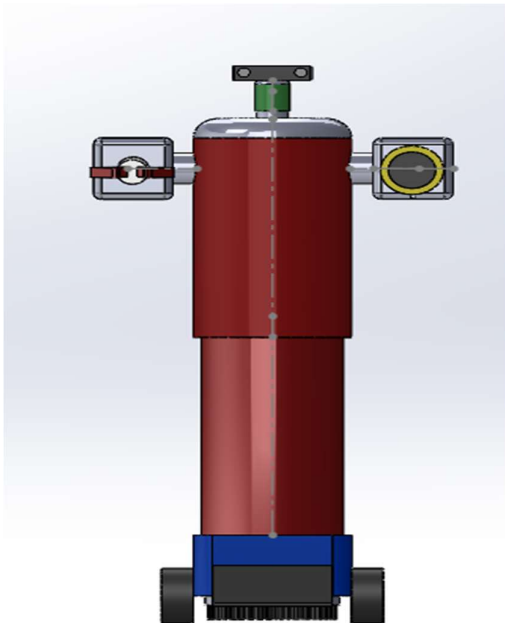
### Isometric View of the robot.

- Here we can see the two robotic arms one consisting of vacuum nozzle and disinfecting tube and other consisting of effector that can pick up items.



### 3D camera setup

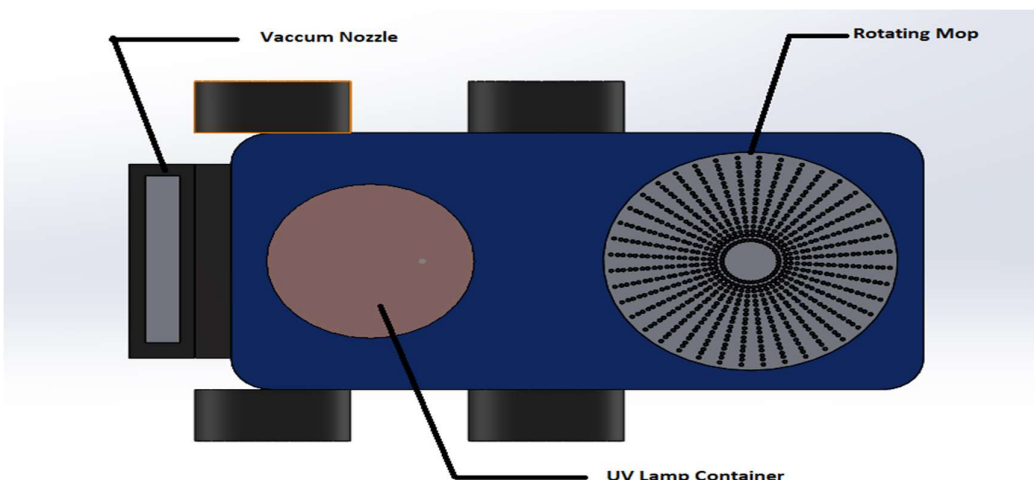
- An object detection model can be trained on everyday objects that are forgotten by passengers so that effectors can pick them up.



### The maximum elongation of the robot

- The robot is capable of elongating its body using a pneumatic actuator.
- This is done so that the robot can reach top berths of the compartment.

**Bottom view showing the cleaning setup.**



#### **4. Applications:**

The autonomous rail compartment cleaning robot has several applications:

**Passenger Trains:** Regular cleaning and sanitization of passenger compartments to enhance travel hygiene.

**Subway Systems:** Maintenance of subway carriages to improve passenger satisfaction and reduce maintenance costs.

**High-Speed Trains:** Ensuring cleanliness and hygiene on high-speed train services.

**Commuter Trains:** Providing a clean and healthy environment for daily commuters.

#### **5. Expected Results:**

The expected results of this research include:

- Development of a fully functional autonomous rail compartment cleaning robot prototype.
- Demonstration of the robot's ability to navigate and clean rail compartments efficiently.
- Improved cleanliness and hygiene of rail compartments, leading to enhanced passenger satisfaction.
- Potential cost savings for rail operators through reduced manual cleaning efforts.
- Improved lost and find capabilities without considering the highly erratic nature of human workers.

#### **6. References:**

1. Lee, In. (2021). Service Robots: A Systematic Literature Review. Electronics. 10. 2658. 10.3390/electronics10212658.