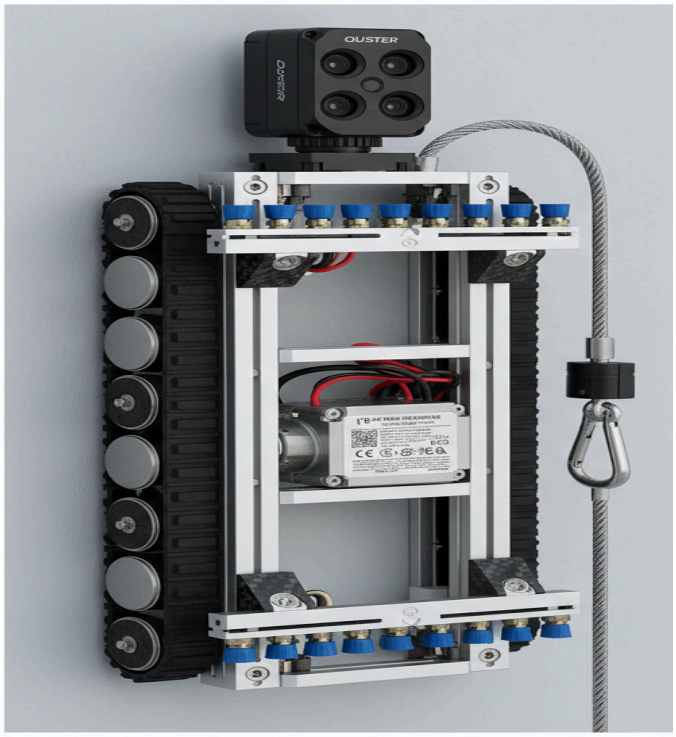
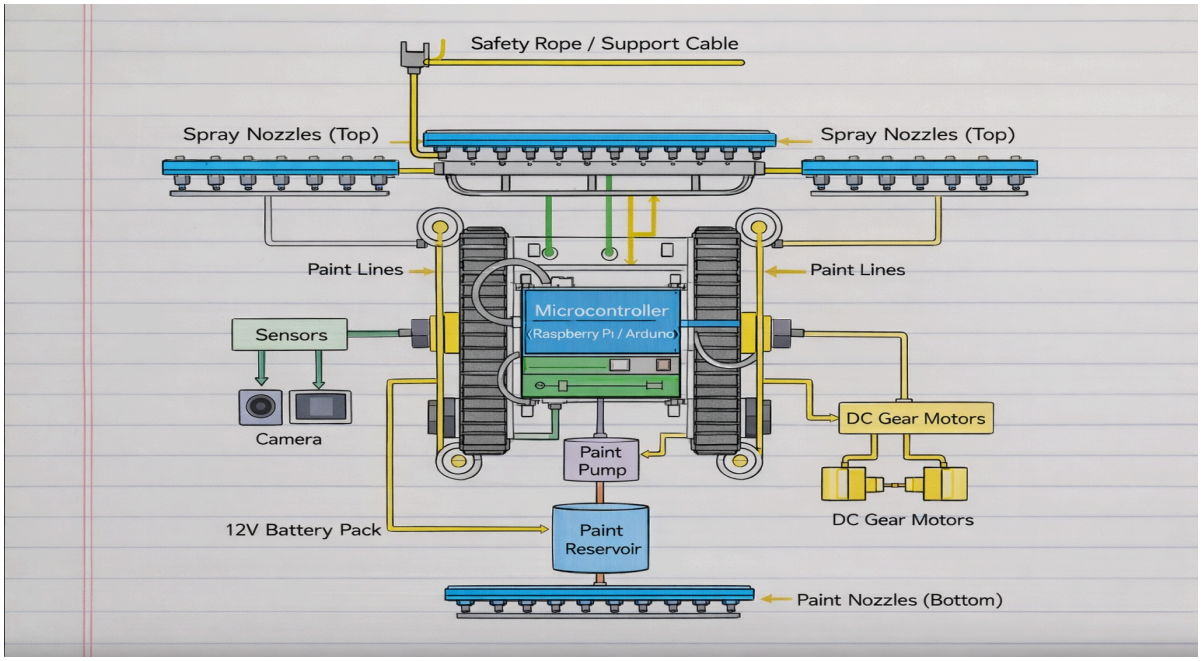
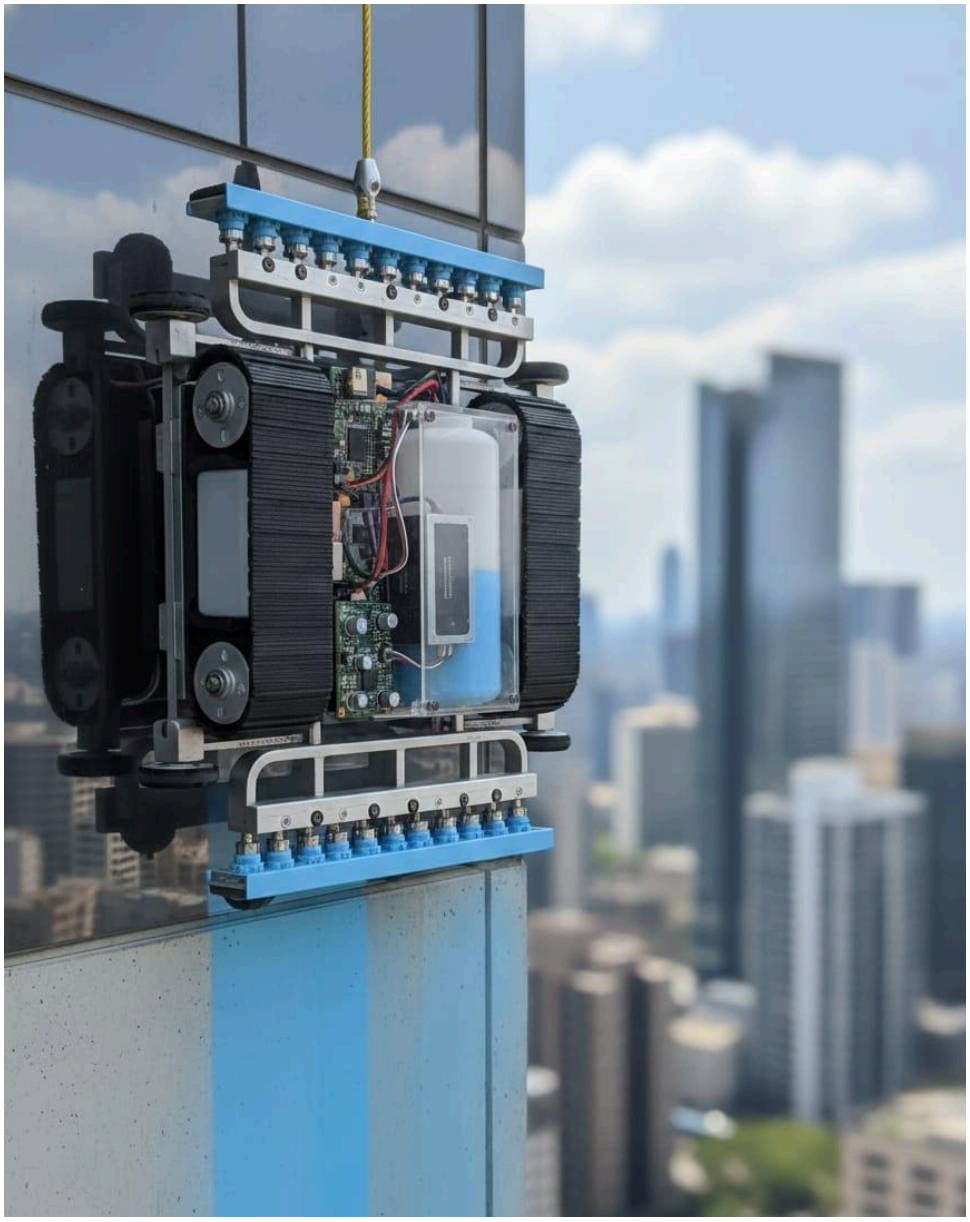
WALL PAINTING ROBOT







1. Shape and Materials

The physical design focuses on stability and weight management to ensure the robot can defy gravity.

- **Chassis:** By using **3D-printed PLA/ABS** or **aluminum**, the robot remains light enough for the motors to lift it without sacrificing the strength needed to hold the internal electronics.
- **Frame:** A **welded steel or mild steel** skeleton acts as the backbone, specifically reinforced to support the weight of the paint reservoir and the high-torque drive system.
- **Surface Adhesion:** To stay attached to the wall, the robot utilizes **magnetic tracks** for steel structures or high-speed **BLDC vacuum fans** that create a low-pressure zone, literally "sucking" the robot against glass or concrete surfaces.

2. Technical/Hardware Components

- **Drive Motors: DC Gear Motors** (like the **N20**) use high gear ratios to provide the "climbing torque" necessary for vertical movement.
- **Painting System:**
    - **Paint Pump:** A **12V DC pump** provides the pressure needed to atomize the paint through the nozzles.
    - **Nozzles: Flat fan nozzles** create a wide, thin "sheet" of spray, which is the most efficient way to get an even coat without streaks.
    - **Actuators: Linear actuators** or stepper-driven rods allow the nozzles to shift precisely, adjusting the spray width or position without moving the entire robot.
- **Power Supply:** While **12V Lithium-Ion batteries** provide mobility, a **safety tether** often carries a power line to ensure the robot never runs out of "juice" mid-wall.

3. Software Components

- **Main Logic:** The "brain" is usually an **Arduino (C/C++)** for low-level motor control or a **Raspberry Pi (Python)** for handling cameras and AI.

- **Path Planning:** The software calculates a **raster scan (snake path)**, ensuring the robot covers every square inch while minimizing overlapping "wet edges".
- **User Interface:** Using **Bluetooth (HC-05)** or **Wi-Fi**, an operator can "remote control" the robot or set boundaries through a dedicated mobile app.

4. Training & Control Method

- **Mapping:** Before painting, the robot uses **LiDAR** or a camera to perform a "reconnaissance" lap, creating a digital blueprint of the surface.
- **AI & Computer Vision:** Tools like a **Raspberry Pi Camera** identify windows and trim in real-time; the AI then "shuts off" the nozzles automatically when passing these areas.
- **Semi-Autonomous Mode:** A human supervisor "trains" the robot by highlighting forbidden zones on a tablet; over time, **Machine Learning** helps the robot optimize its speed based on the wall's texture.

5. Other Important Features

- **LiDAR Sensor:** A **360° RPLIDAR** allows for **SLAM**, meaning the robot knows exactly where it is on a giant skyscraper without needing GPS.
- **Proximity Sensors: Ultrasonic (HC-SR04)** sensors act like "curb feelers," stopping the robot if it gets too close to a ledge or an unexpected obstacle.
- **Safety Features:** A **high-tension steel tether** is mandatory; if the motors fail or the magnets lose grip, this mechanical backup prevents a dangerous fall.
- **Paint Density Sensor:** An **RGB sensor** measures the "color saturation" of the wall behind the robot to verify the coat is thick enough.