



EcoSweep: Universal Cleaning Robot

1. The Idea

EcoSweep is a **multi-terrain cleaning robot** designed to automate cleaning in homes, offices, public spaces, and even outdoor environments. Unlike traditional cleaning robots that only work on smooth floors, EcoSweep can **adapt to multiple terrains**—from tiles, carpets, and wooden floors to semi-rough outdoor surfaces like pavements.

It combines **manual, semi-automatic, and AI-powered autonomous cleaning modes**, giving users flexibility based on their needs.

2. The Problem It Solves

Cleaning is a **time-consuming and repetitive chore**. Current cleaning robots in the market are:

- Limited to **flat indoor floors** only.
- Expensive and not easily affordable for common households.
- Not customizable or modular for different needs (indoor, outdoor, industrial, or public cleaning).

This creates a **gap**: there is no affordable, versatile cleaning solution for households, small businesses, and institutions that need multi-purpose, reliable cleaning.

EcoSweep solves this by offering:

- **Affordable automation** for cleaning.
- **Multi-surface adaptability** (indoor + outdoor).
- **Modular design** that can expand with future features like AI vision, smart navigation, and IoT integration.

3. How It Works

EcoSweep runs in three phases:

1. **Manual Mode** – Users control the robot directly from a mobile app (via Bluetooth to Raspberry Pi → Arduino Mega → motors/servo).
 - a. Drive system: 4 DC tire motors.
 - b. Arm system: 5 DOF robotic arm for sweeping/collecting waste.
 - c. Controlled via a joystick-style app.
2. **Semi-Automatic Mode** – Robot uses onboard sensors (ultrasonic, IR, MPU6050, compass, GPS) to assist navigation and avoid obstacles while still being guided by the user.
3. **Autonomous AI Mode (Future)** – With Raspberry Pi and camera vision, EcoSweep will detect dirt, plan paths, and clean automatically without human intervention.

4. Core Components

- **Controllers:**
 - Arduino Mega 2560 → Low-level motor and servo control.
 - Raspberry Pi 4 → Bluetooth receiver, communication hub, AI (future).
- **Actuation:**
 - 4 DC tire motors (movement).
 - BTS7960 motor drivers.
 - PCA9685 servo driver + 5 servos for robotic arm.
- **Sensors:**
 - Ultrasonic (obstacle detection).
 - IR sensors (line following).
 - NEO-6M GPS (outdoor tracking).
 - MPU6050 + HMC5883L compass (stability & orientation).
- **Power:**
 - LiPo battery for motors.
 - Li-ion battery with LM2596 buck regulator for sensors and controllers.
- **Weight:** ~3.75 kg

5. Key Benefits & Impact

- ✓ **Reduces human effort** – Automates cleaning tasks.
- ✓ **Affordable solution** – Designed with cost efficiency in mind.
- ✓ **Versatility** – Works both indoors and outdoors.

Eco-friendly – Can be upgraded with dust collection, water spraying, or smart waste disposal.

Future-ready – Modular for AI, IoT, and smart city integration.

Scalability – Can be adapted for homes, schools, offices, hospitals, and public spaces.

6. Future Potential

- **AI-powered navigation & dirt detection** using camera + computer vision.
- **Smart connectivity** (IoT + WiFi/MQTT) for remote monitoring.
- **Industrial adaptation** – Larger models for warehouses, stations, airports.
- **Government/municipal deployment** – Roadside and public cleaning robots.

7. Why EcoSweep is Impactful

EcoSweep is **not just a robot**—it's a **step towards smart, automated, and eco-friendly cleaning solutions**.

It addresses:

- The **everyday struggle of household chores**,
- The **lack of affordable automation**, and
- The **growing demand for smart sustainable solutions** in urban areas.

By combining **innovation, affordability, and adaptability**, EcoSweep has the potential to transform how we approach cleaning in both homes and society at large.

👉 So when someone asks “*What is EcoSweep?*”

You can answer:

EcoSweep is a multi-terrain, affordable, and intelligent cleaning robot that reduces human effort, works indoors & outdoors, and is future-ready for AI and IoT integration. It bridges the gap between expensive high-end robots and basic manual cleaning tools—bringing smart cleaning to everyone.

EcoSweep: Q&A Style Explanation

? Q1. What is EcoSweep?

EcoSweep is a **universal cleaning robot** designed to work on multiple terrains (indoors and outdoors). Unlike traditional vacuum robots that are limited to flat indoor floors, EcoSweep can handle **dust, dry waste, and debris** across different surfaces like tiles, pavements, and rough terrain. It combines **mobility, a robotic arm for picking waste, and AI-based automation** for future phases.

? Q2. What problem does EcoSweep solve?

Today's cleaning robots are:

- Limited mostly to **indoor flat floors**.
- Unable to **pick up larger debris** like wrappers, cups, or dry waste.
- Expensive and inaccessible for common households, campuses, and public spaces.

EcoSweep solves this gap by being:

- **Affordable** (using Arduino, Raspberry Pi, modular electronics).
- **Versatile** (works both indoors & outdoors).
- **Hybrid** (combines vacuum-like sweeping + robotic arm for larger waste).
- **Scalable** (from household cleaning to campus, office, and even public place cleaning).

? Q3. How does EcoSweep work?

EcoSweep's workflow:

4. User Control (Phase 1 & 2)

- a. Operated via **mobile app** (Bluetooth connection → Raspberry Pi → Arduino Mega).
- b. Manual joystick control for movement and robotic arm operations.

5. Cleaning Mechanism

- a. **Four-wheel DC motor drive** for terrain mobility.
- b. **Sweeping mechanism + suction fan** for dust/dry waste.
- c. **Robotic arm with 5 servos** (controlled via PCA9685 I2C driver) to pick up large waste.

6. Autonomous Features (Future Phase)

- a. Raspberry Pi with camera + AI for **object detection, navigation, and path planning**.
- b. Sensors (ultrasonic, IR, MPU6050, GPS, compass) for **collision avoidance and positioning**.

? Q4. What makes EcoSweep unique compared to existing robots?

- **Multi-terrain capability** – not limited to indoor floors.
- **Dual cleaning system** – sweeping + robotic arm.
- **Custom single-sided PCB** – avoids wiring mess, ensures reliability.
- **Low-cost design** – uses modular open-source hardware.
- **Expandable with AI** – navigation, vision, smart cleaning.

? Q5. What is the current development stage?

- **Phase 1 (Manual Control) → Done**
 - Raspberry Pi set up as Bluetooth receiver.
 - Commands from mobile app successfully received & forwarded to Arduino Mega.
 - Motors, arm servos integrated.
- **Phase 2 (Semi-automation) → In progress**
 - Robotic arm integration with PCA9685 via I2C.
 - PCB design for clean connections.
 - Full manual testing of all modules together.
- **Phase 3 (AI-enhanced automation) → Future**
 - Camera vision + AI on Raspberry Pi.
 - Self-navigation & smart cleaning.

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Q6. Who can use EcoSweep?

- **Households** – daily floor & waste cleaning.
- **Offices & campuses** – maintenance of lobbies, corridors, classrooms.
- **Public spaces** – parks, pavements, community halls.
- **Municipalities** – low-cost scalable robotic cleaners for smart cities.

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Q7. Why is EcoSweep impactful?

- Saves **time & effort** for individuals and organizations.
- Reduces **manual labor dependency** in cleaning.
- Promotes **sustainability & hygiene** in public and private spaces.
- Provides a **cost-effective alternative** to expensive imported cleaning robots.
- Supports **India's Make in India initiative** by being locally developed.

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Q8. What's next for EcoSweep?

- Completing **Phase 2** with robust manual control of mobility + arm.
- Developing **custom PCB** for reliable long-term use.
- Applying **AI & vision** for autonomous cleaning.
- Seeking **funding, grants, and partnerships** for scaling.