WATER SURFACE CLEANER

MENTOR

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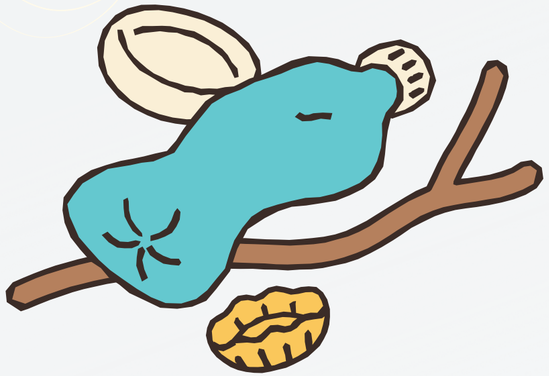
CONTENT

BACKGROUND OF PROJECT



Water pollution in small to medium-sized water bodies like swimming pools, park fountains, and artificial ponds is a growing concern, often caused by floating debris, plastic waste, and leaves. Traditional cleaning methods in India rely on manual labor, which is labor-intensive, inconsistent, and inefficient. Existing mechanized solutions lack automation, energy efficiency, and sustainability. The Water Surface Cleaning Robot addresses these gaps by offering an autonomous, cost-effective solution powered by solar energy. Equipped with ultrasonic sensors for collision avoidance and debris detection, it collects waste using a conveyor system and deposits it into a net. An Android application allows switching between manual and autonomous modes, providing real-time monitoring. Made from corrosion-resistant, recyclable materials, the robot aligns with India's push toward sustainable, green technologies, reducing labor and environmental costs while maintaining water quality in urban and recreational spaces.

PROJECT SCOPE

Our project focuses on developing a water surface cleaning robot optimized for stable water bodies like swimming pools and ponds. The robot is designed to operate autonomously or manually, offering an effective, sustainable, and user-friendly solution for maintaining clean water surfaces in these environments.

OBJECTIVES

1.Create a Functional Prototype: Create a design and construct a water surface cleaning robot prototype that can move around aquatic areas on its own and gather garbage.

2. **Ensure Environmental Compatibility:** Make sure the robot is environmentally compatible by making sure its construction and functioning cause the least amount of harm to ecosystems and marine life, therefore supporting environmental conservation efforts.

3. **Optimize Efficiency and Effectiveness:** By improving navigation, debris identification, and collecting methods, the robot can clean water surfaces more effectively and efficiently. Sensors and energy-efficient parts are used in this.

4. **Assure Affordability and Scalability:** Build a robot that is both affordable and scalable so that a variety of users can utilize it.

5. **Develop an Android Application for Dual-Mode Control:** Create an Android application that allows users to control the robot in both manual and autonomous modes, providing flexibility in operation based on user preferences and environmental conditions.

LITERATURE SURVEY

THEORY ASSOCIATED WITH PROBLEM AREA:

- WATER POLLUTION IMPACT: FLOATING WASTE DISRUPTS ECOSYSTEMS, HARMS MARINE LIFE, AND DEGRADES WATER QUALITY.
- CONVENTIONAL CLEANING CHALLENGES: MANUAL AND SEMI-AUTOMATED METHODS ARE LABOR-INTENSIVE AND INEFFECTIVE IN SMALL-SCALE APPLICATIONS.
- AUTONOMOUS ADVANCEMENTS: INTEGRATION OF ROBOTICS, ULTRASONIC SENSORS FOR OBSTACLE DETECTION, AND SOLAR PANELS FOR ENERGY EFFICIENCY ENABLE ECO-FRIENDLY AND EFFECTIVE CLEANING SOLUTIONS.
- CHALLENGES IN CURRENT SYSTEMS: HIGH COSTS, LIMITED SCALABILITY, AND ENVIRONMENTAL CONCERNS HINDER WIDESPREAD ADOPTION (GARCÍA ET AL., 2021).

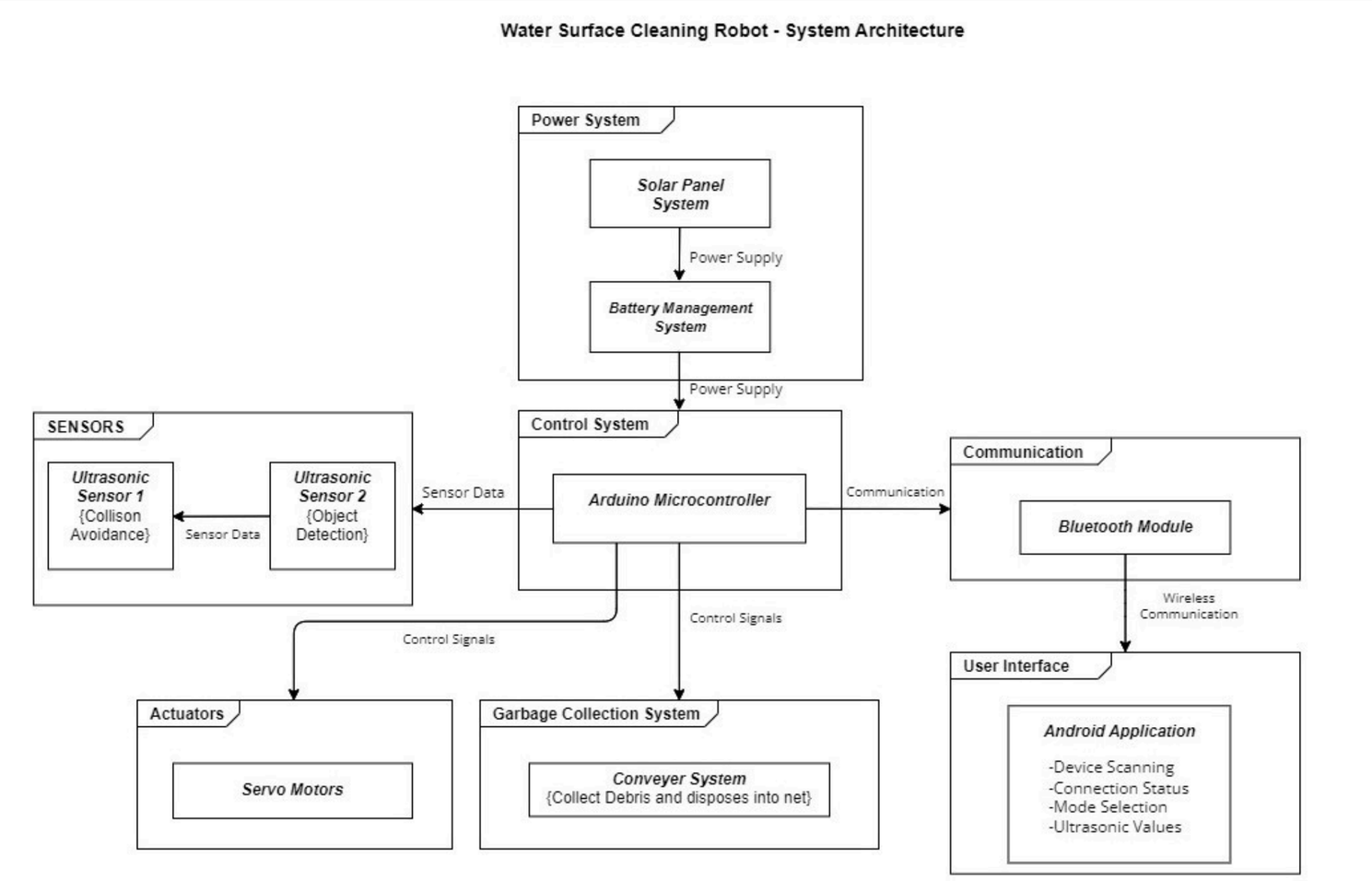
RESEARCH FINDINGS

- COST AND SCALABILITY ISSUES: EXISTING SYSTEMS ARE INACCESSIBLE FOR SMALL-SCALE ENVIRONMENTS DUE TO HIGH COSTS AND MAINTENANCE REQUIREMENTS (GARCÍA ET AL., 2021).
- ENVIRONMENTAL CONSIDERATIONS: NEED FOR NON-TOXIC, CORROSION-RESISTANT MATERIALS TO MINIMIZE ECOLOGICAL IMPACT (SMITH ET AL., 2018).
- TECHNOLOGICAL LIMITATIONS: INEFFECTIVE NAVIGATION IN CONFINED SPACES AND POOR ADAPTABILITY TO DYNAMIC CONDITIONS REDUCE EFFICIENCY.

PROBLEM IDENTIFIED

- COST: CURRENT SYSTEMS ARE EXPENSIVE AND OVERLY COMPLEX FOR SMALL-SCALE ENVIRONMENTS.
- ENVIRONMENTAL CONCERNS: MANY SOLUTIONS STILL USE MATERIALS HARMFUL TO AQUATIC HABITATS.
- INEFFICIENCY: DESIGNS FOR LARGER APPLICATIONS ARE UNSUITABLE FOR SMALL, STABLE WATER BODIES.
- MAINTENANCE: HIGH MAINTENANCE DEMANDS LIMIT USABILITY IN NON-INDUSTRIAL SETTINGS.

Architecture of the project



Techniques and Tools used

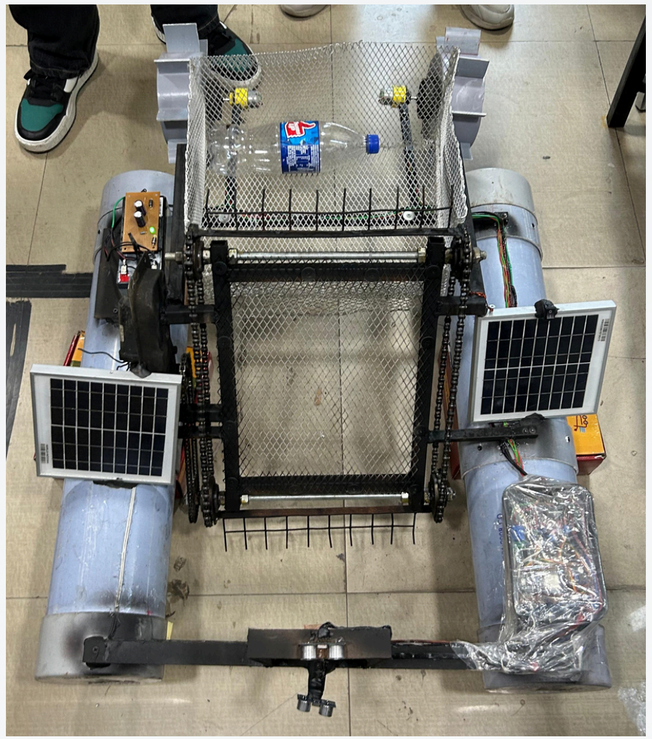
TECHNOLOGIES AND TOOLS:

- ARDUINO MICROCONTROLLERS: CENTRAL CONTROL FOR MOTORS, SENSORS, AND OVERALL OPERATION.
- ULTRASONIC SENSORS: ENABLES OBJECT DETECTION AND COLLISION AVOIDANCE.
- SERVO MOTORS: ENSURES PRECISION IN THE DEBRIS COLLECTION MECHANISM.
- SOLAR PANELS: POWERS THE ROBOT SUSTAINABLY USING RENEWABLE ENERGY.
- ANDROID APP: PROVIDES USER-FRIENDLY MANUAL AND AUTOMATIC CONTROL MODES.

KEY FEATURES:

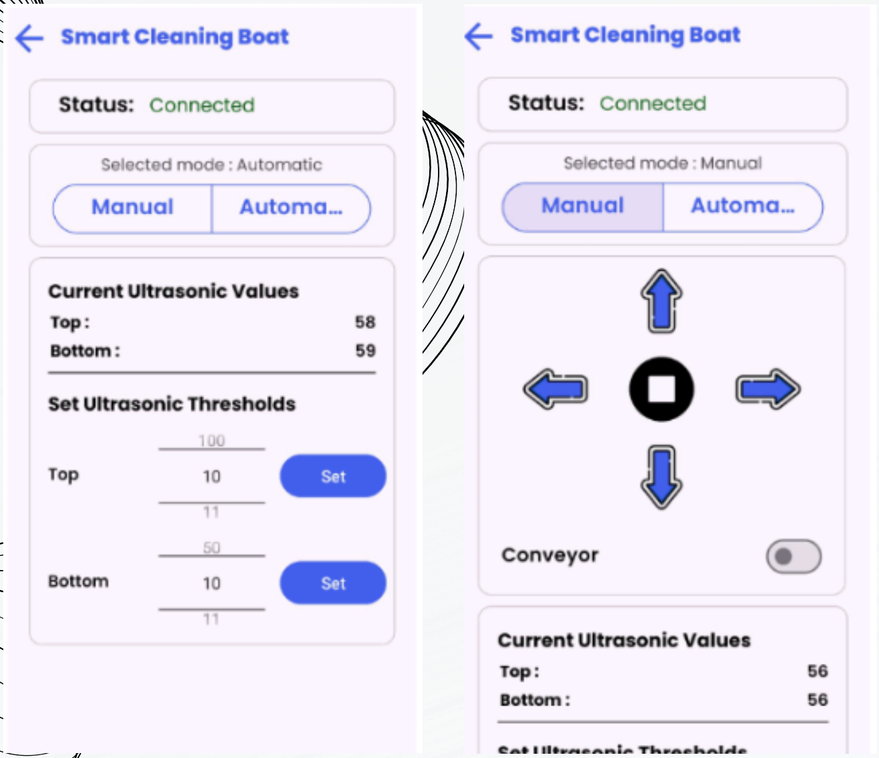
- INTEGRATION OF ROBOTICS, AUTOMATION, AND ENERGY EFFICIENCY.
- DESIGNED FOR ECO-FRIENDLINESS AND EASY USABILITY IN SMALL WATER BODIES

PROJECT DESGIN



HARDWARE SETUP

ROBOT IN ACTION DURING TESTING



ANDROID APPLICATION INTERFACE

Methodology – Overview

Design and Prototyping

- Created AutoCAD models and assembled the prototype with reliable components (Arduino, sensors, motors, solar panels).

Environmental Compatibility

- Used eco-friendly materials and tested in controlled environments for aquatic safety.

Optimization and Scalability

- Improved navigation with ultrasonic sensors, extended runtime with solar power, and ensured cost-effectiveness.

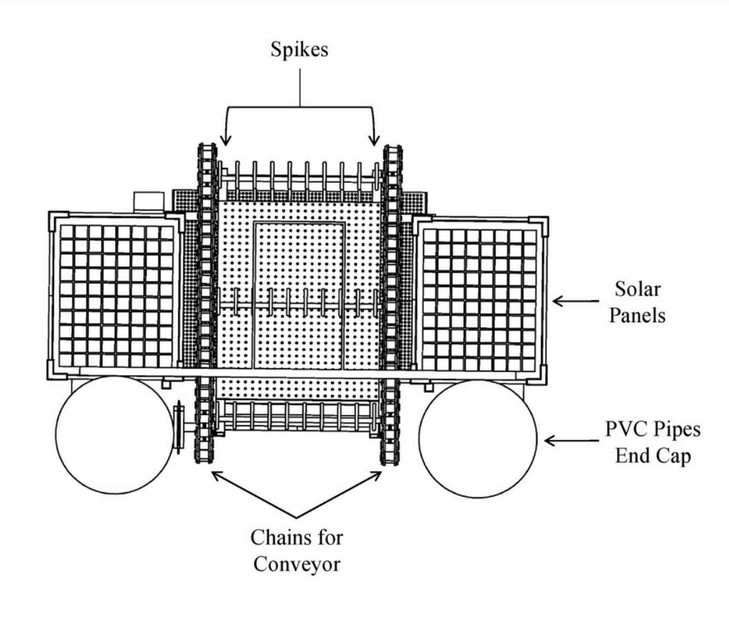
Android Application

- Developed a Bluetooth-enabled app for manual and automatic control.

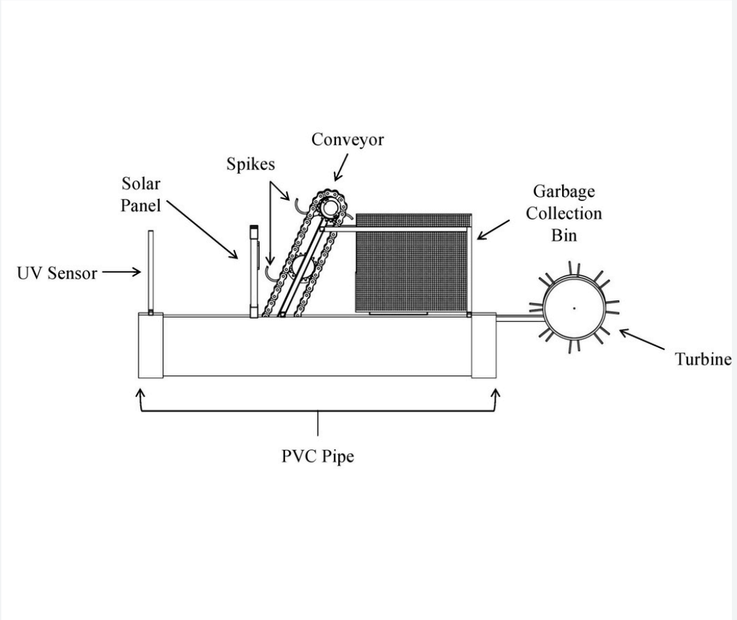
Testing and Validation

- Tested in various water bodies, optimized for efficient coverage and debris collection.

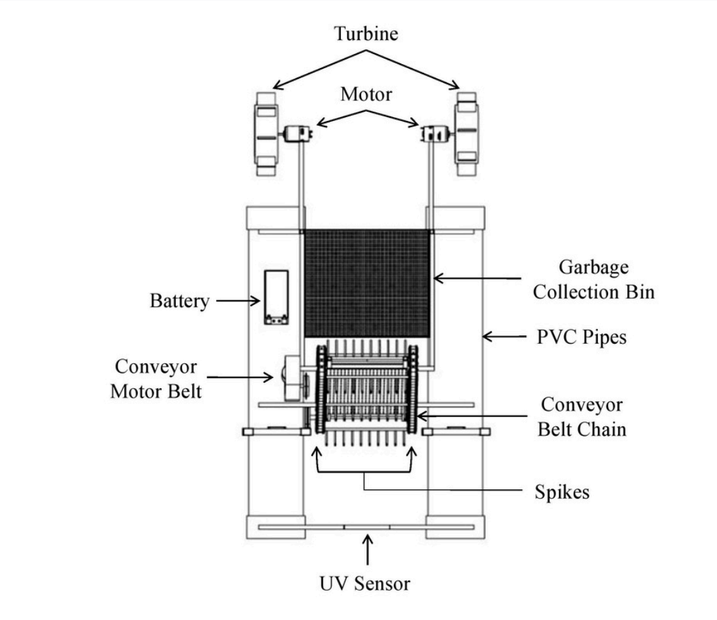
Design Diagrams



FRONT VIEW



SIDE VIEW



TOP VIEW

TEST CASES:

5.4.2 Test Cases

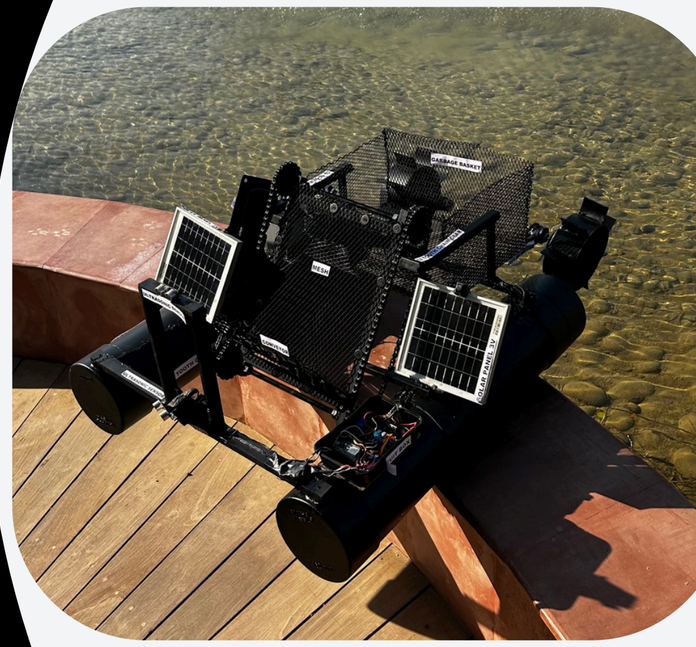
Test Case ID	Description	Expected Outcome	Status
TC-01	Obstacle detection and avoidance	Robot successfully avoids obstacles.	Passed
TC-02	Debris collection mechanism	Conveyor collects and deposits all types of debris.	Passed
TC-03	Manual mode operation	Smooth manual control via Android app.	Passed
TC-04	Autonomous navigation efficiency	Robot covers entire water surface without manual intervention.	Passed
TC-05	Solar charging and power management	Solar panels sustain operation for at least 6 hours.	Passed
TC-06	Bluetooth connectivity	Stable connection within a 10-meter range.	Passed
TC-07	Waterproofing	Components remain dry and functional in water.	Passed

Results and Performance:

- Cleaning Efficiency: Successfully collected floating debris in small water bodies (ponds, pools) with over 90% accuracy.
- Navigation Performance: Ultrasonic sensors ensured smooth obstacle avoidance and precise debris detection.
- Energy Efficiency: Solar panels extended operational runtime by 40%, reducing reliance on external charging.
- Coverage: The robot covered up to 10 square meters in a single cleaning cycle efficiently.
- User Experience: Android app provided seamless control and real-time feedback in both manual and autonomous modes.
- Environmental Impact: Operated without harming aquatic ecosystems, using eco-friendly materials and renewable energy.

KEY HIGHLIGHTS/DELIVERABLES

- Fully Functional Robot:
- Designed for autonomous and manual water surface cleaning.
- Solar-Powered System:
- Sustainable operation using renewable energy.
- Conveyor-Based Garbage Collection:
- Efficiently collects and stores floating debris.
- Bluetooth-Enabled Controls:
- User-friendly Android app for manual and automatic modes.
- Commercial Potential:
- Scalable, eco-friendly, and cost-effective solution for various water bodies.



PROFESSIONAL AND TECHNICAL LEARNING

Mission

		2024	2024	2024	2024	2024	2024	2024	2024	2024	2024	2024
1	Research and Planning											
2	Conceptual Design &Prototyping											
3	Software Development & integration											
4	Mechanical assembly											
5	Testing and validation											
6	Optimization &Documentation											

- Professional Learning:
- Team Collaboration: Enhanced coordination and task delegation among team members.
- Project Management: Learned to manage timelines, resources, and testing phases effectively.
- Problem-Solving Skills: Addressed design, integration, and operational challenges systematically.

- Technical Learning:
- Embedded Systems: Gained expertise in Arduino programming and sensor integration.
- Renewable Energy: Understood solar panel implementation for energy-efficient robotics.
- Mobile Application Development: Developed a user-friendly Android app with Bluetooth control.

Vision

COMPLETED TASKS:

- Create a Functional Prototype
- Ensure Environmental Compatibility
- Optimize Efficiency and Effectiveness
- Assure Affordability and Scalability
- Developed an Android Application for Dual-Mode Control

INDIVIDUAL ROLES AND LEARNING OUTCOMES

Anurag Pannu

Group Leader
Electronics Engineer

Ashish Bhardwaj

Research and Market Analyst

Khushdeep Mukhija

Budget and Procurement Manager

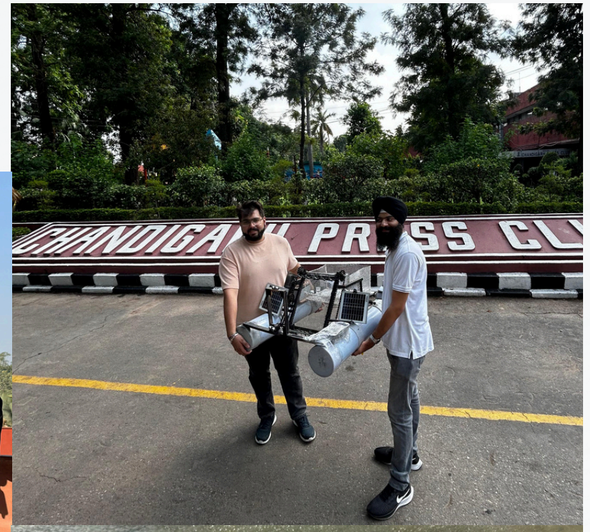
Nishchey Khajuria

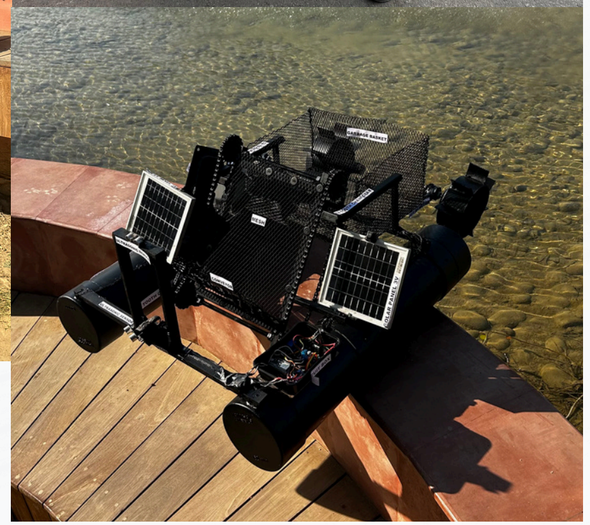
Software Engineer

Parneet Singh Sahni

Mechanical Engineer

PROJECT OUTCOMES





THANK YOU