SMART AUTONOMOUS SANITIZATION, MOSQUITO-KILLER ROBOT AND UVC DISINFECTION WITH OBSTACLE AVOIDANCE

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PRODUCT PROBLEM

In the past, maintaining hygiene in public and private spaces was largely dependent on manual labor, which posed serious health risks to sanitation workers due to direct exposure to harmful chemicals and infectious pathogens. The sanitization process was often inconsistent, time-consuming, and inefficient in covering all critical areas, especially in high-footfall zones like hospitals, offices, and schools. Moreover, mosquito control was treated as a separate task, requiring additional devices or sprays, which were often forgotten or irregularly used.

SOLUTION

The Smart Autonomous Sanitization and Mosquito-Control Robot is a fully automatic hygiene solution designed for indoor use. It includes a powerful UVC light to kill germs and bacteria, a mosquito-killing module similar to electric mosquito bats, and a sanitizer sprayer with added room fragrance to freshen the environment. With obstacle avoidance and autonomous movement, it operates safely and efficiently without human help, making it ideal for homes, hospitals, offices, and public spaces.

PRODUCT DOMAIN STUDY

Summary

The global Sanitization Robot Market is witnessing significant growth potential, driven by rising hygiene concerns across public and private sectors, especially in high-traffic areas like hospitals, airports, and offices. Key players include Xenex, UVD Robots, Neato, iRobot, Ecovacs, LG Electronics, and others across the US, Europe, and Asia. The market is fueled by innovations in UV-C disinfection, autonomous navigation, and smart sensor integration, offering both fully and semi-autonomous solutions. With increasing demand in sectors such as healthcare, hospitality, and transportation, sanitization robots are becoming vital for public safety. The market is segmented by robot type, technology, sensor and controller type, and geography, and is expected to grow significantly through 2029, driven by technological advancements, health safety demands, and government support during pandemics.

Article Link: https://www.linkedin.com/pulse/sanitization-robot-market-may-see-potential-upside-numwf/

PROBLEM STATEMENT:

In today’s world, maintaining hygiene and controlling disease-carrying mosquitoes in indoor spaces is a growing concern, especially in public and high-traffic areas. Manual disinfection is labor-intensive, inconsistent, and increases human exposure to harmful chemicals. Additionally, common mosquito control methods are either ineffective or pose health hazards when overused. There is a critical need for an automated, safe, and efficient system that can sanitize environments and control mosquitoes simultaneously without human intervention.

Rani, a working mother, needs a safer and automated way to keep her home disinfected and mosquito-free, because manual cleaning and sprays are time-consuming, expose her to chemicals, and don’t offer consistent results. A smart robot that automates sanitization and pest control can help her maintain a healthy environment effortlessly.

MY ROLE:

- Conceptualizing and designing the complete robotic system.
- Integrating multi-functional modules: UVC light, sprayer, and mosquito control unit.
- Developing the automation logic and obstacle avoidance system.
- 3D modeling and assembling the robot’s body and internal components.
- Managing power supply design and battery integration for smooth operation.
- Testing each module for performance and efficiency in real environments.
- Presenting the final prototype and its impact for evaluation and feedback.

MY RESPONSIBILITIES:

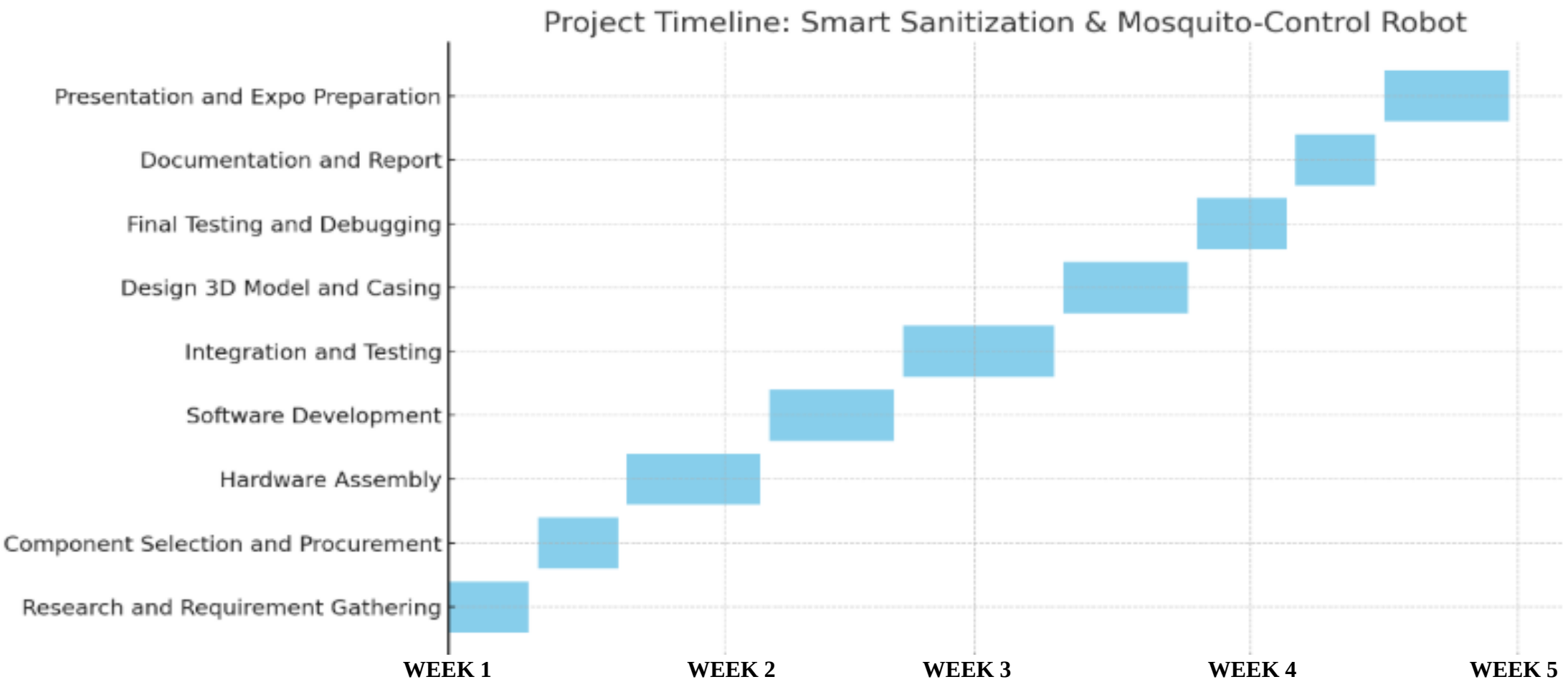
- Selecting appropriate components: sensors, UVC light, motors, and sprayer.
- Wiring and integrating electronic modules with proper safety protocols.
- Programming the robot using Arduino and automation logic.
- Ensuring effective disinfection and mosquito control performance.
- Calibrating obstacle avoidance using ultrasonic sensors.
- Troubleshooting hardware/software issues during development.
- Documenting the build process and maintaining project records for reports.

PRODUCT DEVELOPMENT CYCLE

GNATT CHART

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Problem Identification	✅	✅				
Market & User Research	✅	✅	✅			
Ideation & Concept Design		✅	✅	✅		
Hardware Component Selection		✅	✅	✅		
Prototype Development			✅	✅	✅	
Testing & Iteration				✅	✅	✅
Final Assembly & Integration					✅	✅
Report Documentation & Presentation					✅	✅

PROJECT TIMELINE



USER PERSONA

Name: Stephan
Age: 50 Years
Education: B.E Literature
Hometown: Chennai
Occupation: School Principal

PROBLEM STATEMENT

Mr. Stephan, a 50-year-old school principal, is facing challenges in maintaining a hygienic and mosquito-free environment in classrooms and common areas, especially during the monsoon season. With limited cleaning staff and growing concerns over student health and safety, he is seeking an affordable and automated solution that can efficiently sanitize school premises and mitigate mosquito-related issues to ensure a safe learning environment.

GOALS

- Keep classrooms and common areas clean and mosquito-free
- Ensure students' safety and well-being
- Implement affordable automation solutions

FRUSTRATION

- Limited cleaning staff
- Mosquito issues during monsoon
- Difficulty in maintaining hygiene in large campuses

USER JOURNEY MAP

AWARENESS	CONSIDERATION	PURCHASE	USAGE	FEEDBACK
The user becomes aware of increasing hygiene concerns and mosquito-related health risks in their environment.	The user starts looking for effective, automated solutions that can reduce human effort and exposure to chemicals.	The user evaluates product options and chooses the smart autonomous robot for its multifunctionality and modern features.	The user deploys the robot in their space; it operates automatically, disinfects with UVC, sprays fragrance-based sanitizer, and controls mosquitoes.	The user experiences satisfaction and shares positive feedback due to improved hygiene, convenience, and time-saving benefits.

COMPETITION ANALYSIS:

Product/Competitor	Features	Limitations
Manual Sanitizer Sprayers	Inexpensive, easily available	Requires human operation, no automation, no mosquito control
UVC Handheld Devices	Uses UV light to kill bacteria and viruses	Small coverage area, needs manual use, no obstacle avoidance
Automatic Room Fresheners with Disinfectant	Spray-based sanitization and fragrance	No UVC light, not mobile, lacks mosquito repellent
Electric Mosquito Bats	Effective for killing mosquitoes manually	Manual use, no disinfection, limited coverage
Commercial Disinfection Robots (high-end)	Autonomous, UVC-based, sometimes AI-enabled	Very expensive, no mosquito control, not suitable for homes

BUSINESS POTENTIAL

Gap Analysis

- Lack of a single device that performs sanitization, mosquito control, and autonomous navigation.
- Most available products either disinfect or repel mosquitoes very few do both, and fewer are autonomous.
- A smart robot that combines UVC, sanitizer spraying, mosquito repellent, and obstacle avoidance for all-in-one automated hygiene.

Target Audience

- Hospitals and clinics seeking regular surface and air disinfection
- Offices, co-working spaces, and IT companies prioritizing employee health
- Schools and colleges needing frequent sanitization in shared spaces

Market Size

- Global Cleaning Robot Market is expected to reach USD 24.3 Billion by 2028
- UVC Disinfection Robot Market alone projected to grow at over 30% CAGR post-COVID
- Rising demand in India’s smart hygiene segment due to increased awareness of health and automation

USER PAIN POINTS

1. Manual sanitization is time-consuming and exposes workers to harmful chemicals.
2. Ineffective mosquito control in large or open indoor spaces.
3. Lack of consistent hygiene in shared public and private environments.
4. No automation in traditional cleaning systems — requires human monitoring.
5. Limited coverage of UVC devices, often requiring stationary placement.
6. High labor costs and dependency on housekeeping staff.
7. Disinfectants with strong odors or unsafe chemical usage in closed rooms.

GPCU

G-GAP ANALYSIS

Existing Market Gaps:

- No single device currently combines UVC disinfection, mosquito control, and sanitizer spraying in a fully autonomous robot.
- Manual disinfection and mosquito control are labor-intensive and inconsistent in coverage.
- Existing solutions are either costly or limited to specific environments.

Identified User Needs:

- A hands-free, all-in-one solution for sanitization and mosquito control.
- Reliable operation in both indoor and semi-outdoor settings (e.g., hospitals, hostels, balconies, waiting areas).
- Affordable, easy-to-use technology that reduces human effort and enhances hygiene.

P-PRODUCT DESIGN

Key Features:

- UVC Disinfection Lamp to kill bacteria and germs.
- Mosquito-killer unit for vector control.
- Automatic Sprayer with room freshener-infused sanitizer.
- Obstacle Avoidance using ultrasonic sensors.
- Fully autonomous and battery-powered operation.

Design Elements:

- Compact rectangular body with four – wheel base for easy mobility.
- Vertical UVC tower with protective grill
- Internal Sanitizer storage with spray nozzle mechanism
- Mounted ultrasonic sensor on front for smooth navigation

Prototype Stages:

- Concept Design: Sketch and identify components.
- Hardware Assembly: Structure building with 3D casing, wheels, sensors.
- System Integration: Combine UVC lamp, sprayer, and mosquito-killer.
- Testing: Validate obstacle avoidance and sanitization efficiency.
- Final Prototype: Fully assembled and functional demo-ready model.

C-COMPARE

Feature	Traditional Methods	Your Product
Sanitization Process	Manual cleaning with disinfectants or fogging machines	UVC disinfection + automatic sprayer with room fragrance
Mosquito Control	Coils, sprays, or handheld electric mosquito bats	Inbuilt electric mosquito-killing system (like mosquito bat)
Mobility	Stationary or manually operated devices	Autonomous movement with obstacle avoidance
Coverage Efficiency	Inconsistent, dependent on human effort and visibility	Smart navigation ensures thorough, consistent surface coverage
Human Involvement	Requires full-time human operation	Fully automatic operation, reducing human exposure to chemicals

U-UNIQUENESS

Innovative Features

- Integrated UVC disinfection and fragrance sprayer system
- Built-in mosquito killer (electric mesh-based)
- Fully autonomous navigation with obstacle avoidance
- Rechargeable and eco-friendly operation

User Benefits

- Minimizes human contact with chemicals and reduces manual labour
- Ensures 360° surface and air sanitization along with mosquito control
- Enhances hygiene and health in homes, hospitals, offices, and public spaces
- Smart automation saves time and ensures reliability

Market Differentiator

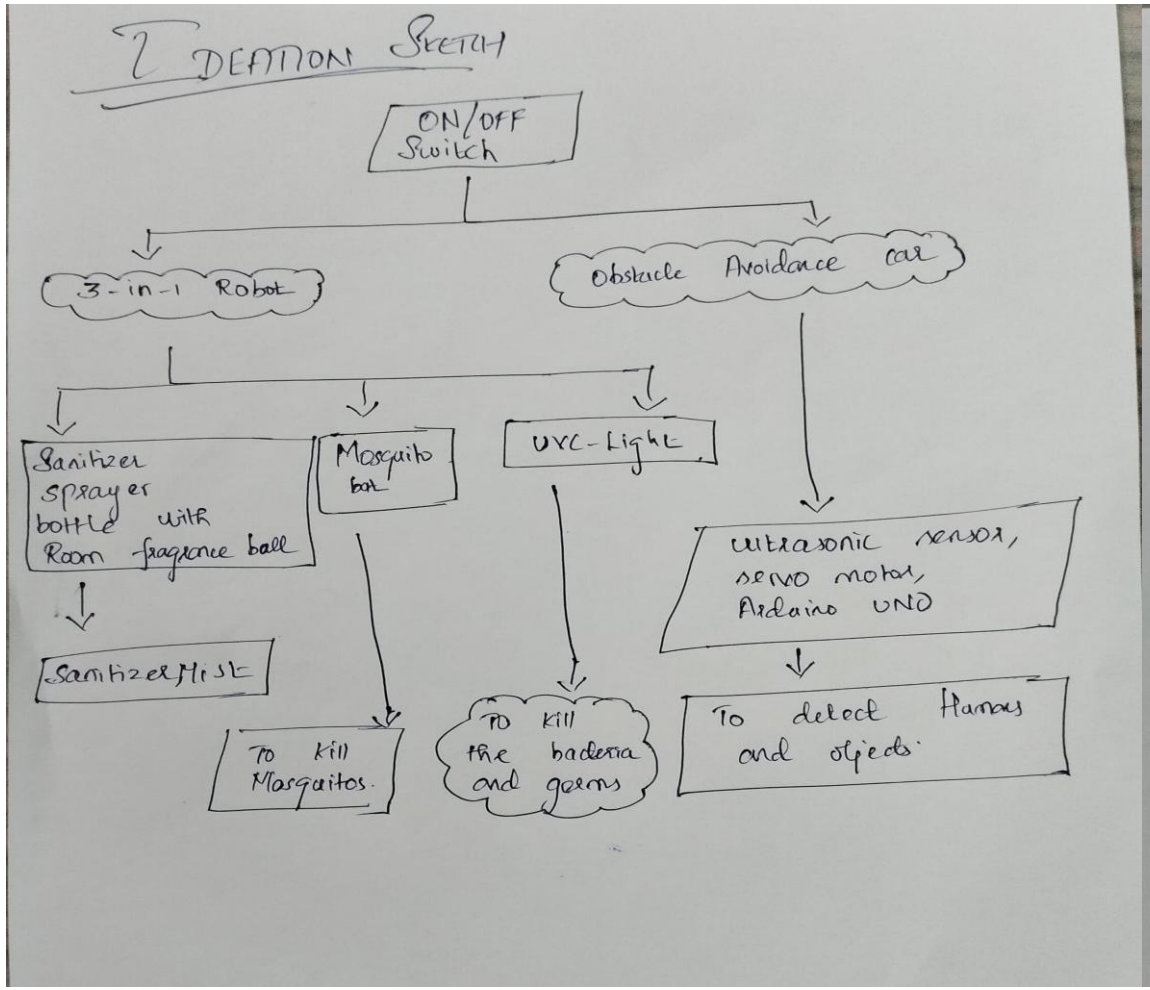
- Combines three critical hygiene functions (disinfection, fragrance spray, mosquito control) in one mobile robotic unit
- Targets both health (virus/bacteria) and comfort (mosquito-free & fresh environment) needs
- More cost-effective and intelligent than existing single-function devices

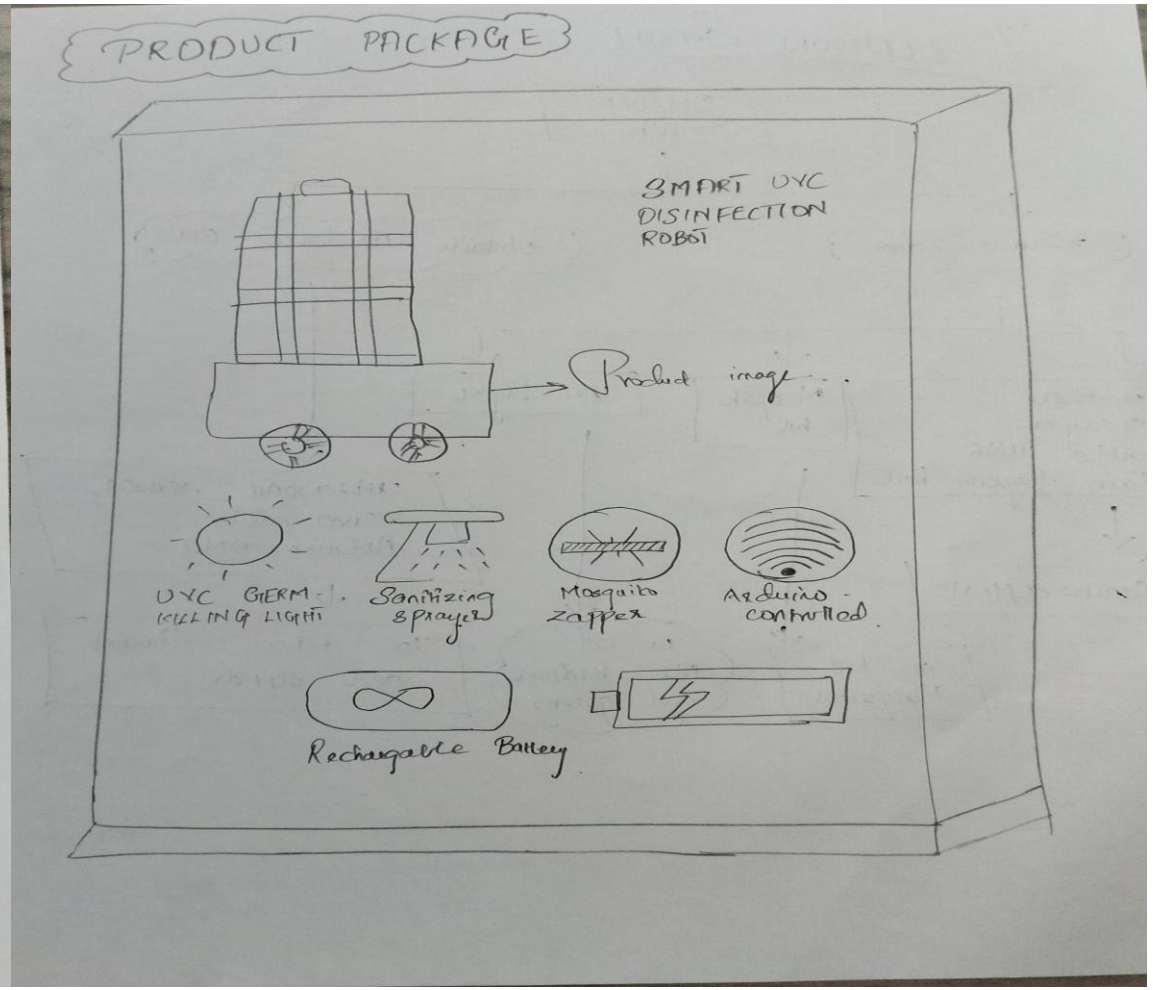
UNDERSTANDING THE USER

- ✓ Requires a hands-free, automated hygiene solution for daily use
- ✓ Prefers a compact device with multi-functionality (disinfection + mosquito control)
- ✓ Expects chemical-free, safe operation for health and environmental safety
- ✓ Looks for devices that can navigate and function independently in complex spaces
- ✓ Values affordability, ease of use, and minimal maintenance in hygiene solutions

RAPID PROTOTYPING – IDEATION

Ideation Sketches





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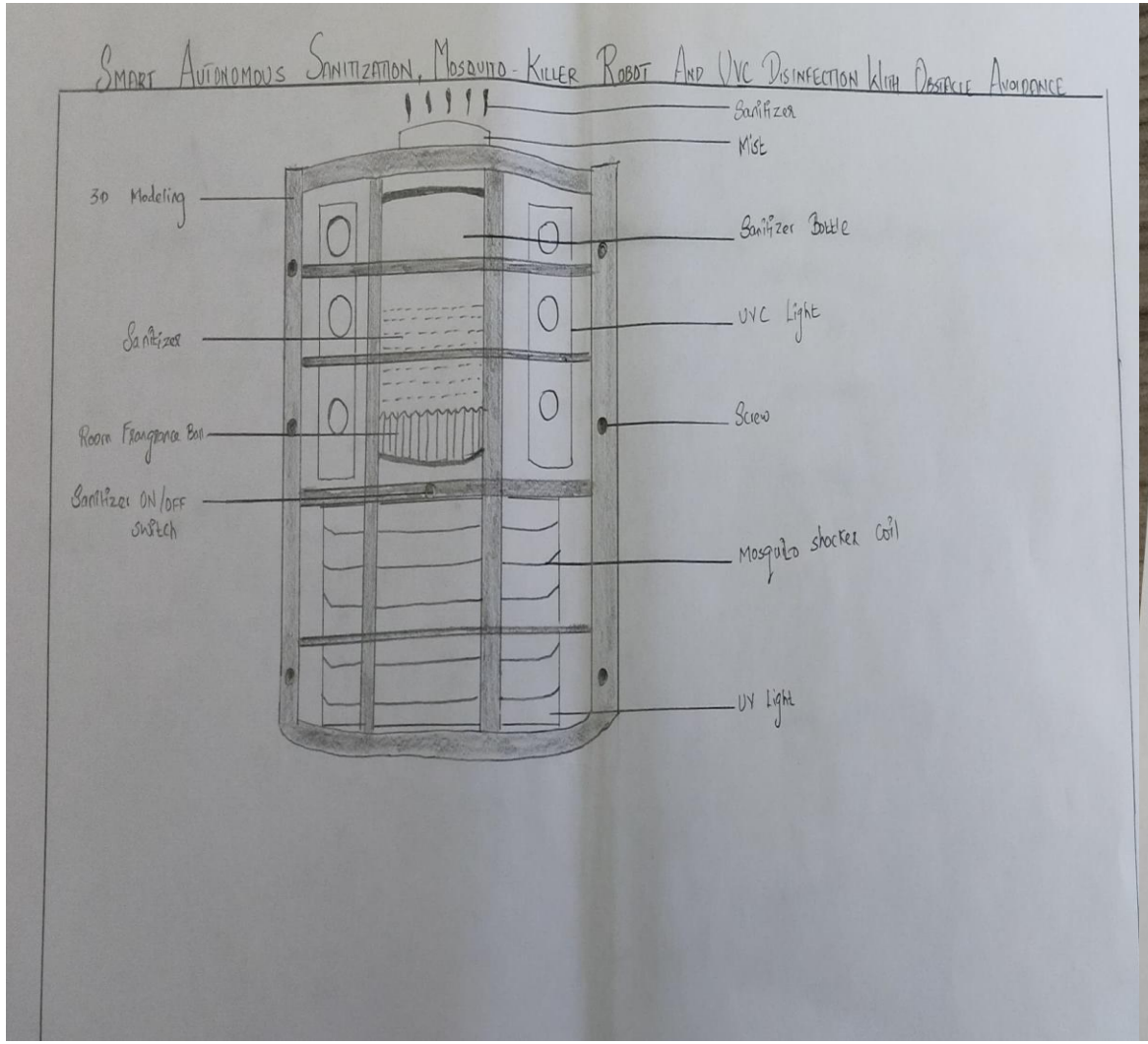

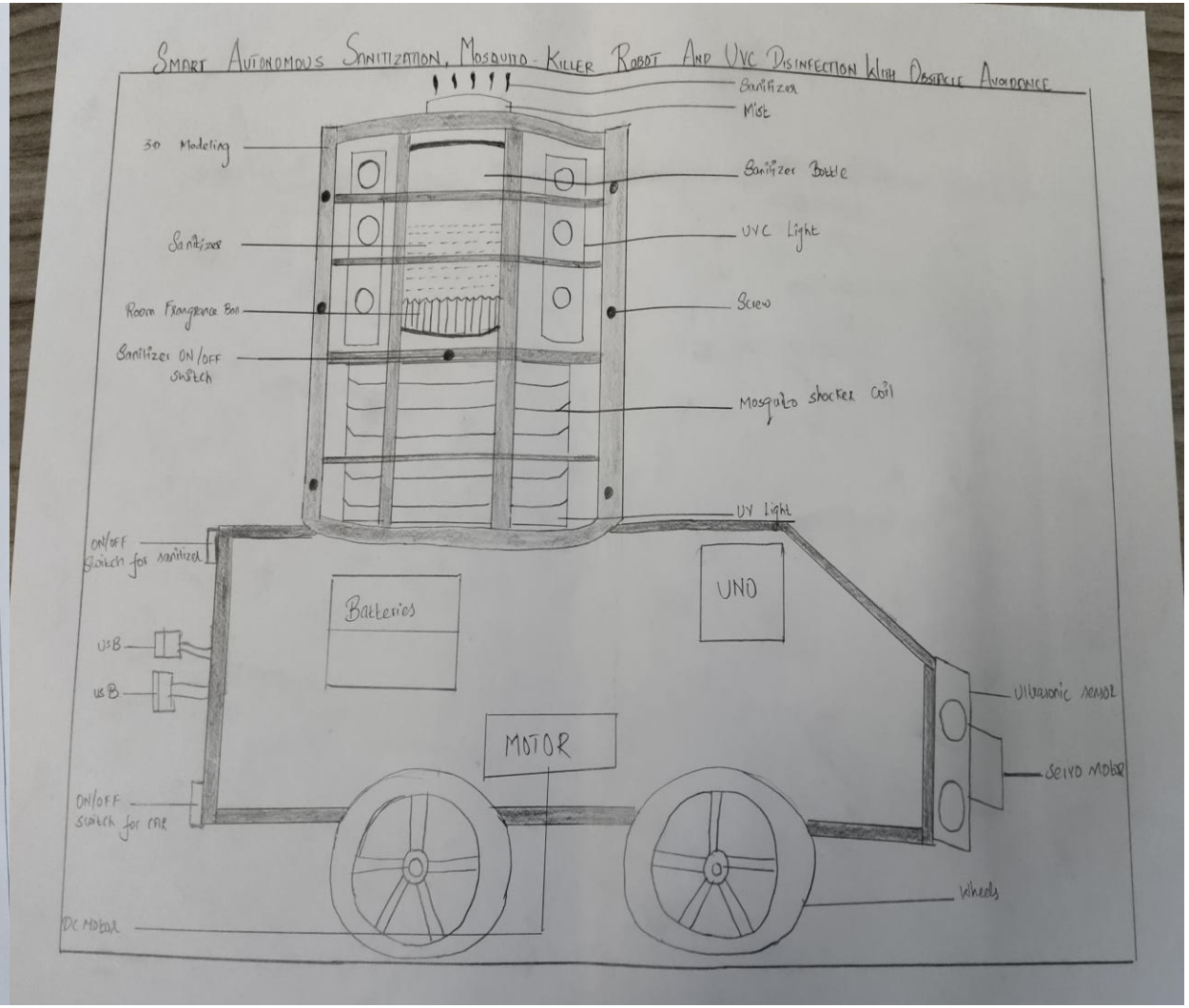

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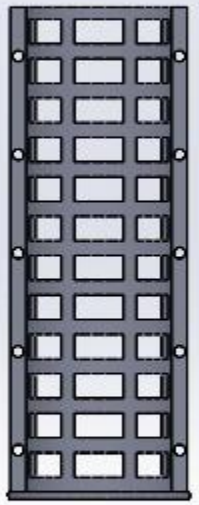
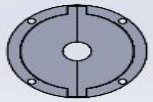
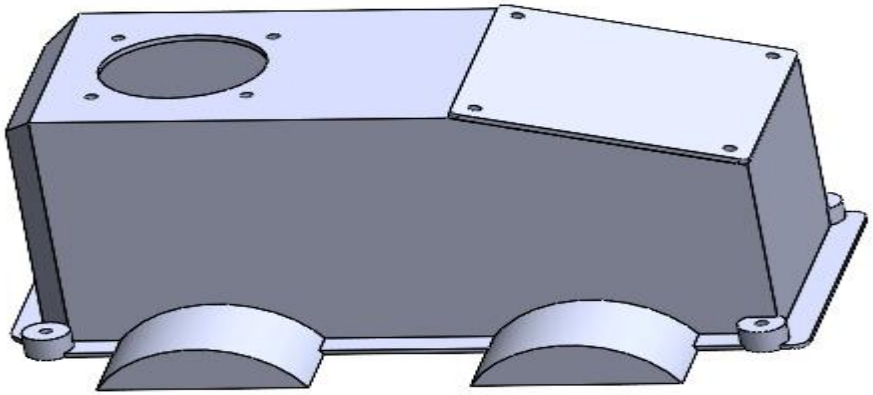






FUTURE WORKS:

- **Mobile App Integration:**
  Develop a companion app to control, monitor, and schedule sanitization and mosquito control tasks remotely.
- **Real-Time Monitoring System:**
  Add sensors for detecting air quality, humidity, and mosquito presence to trigger actions intelligently.
- **Voice Assistant Compatibility:**
  Integrate with Alexa or Google Assistant for voice-controlled operation.
- **Solar Charging Option:**
  Introduce solar panels for eco-friendly, off-grid recharging.
- **Compact & Modular Design:**
  Refine the physical design to be sleeker and modular for easier maintenance and upgrades.
- **AI-Based Navigation:**
  Implement AI for smarter path planning, room mapping, and adaptive obstacle avoidance.

USABILITY STUDIES

Round 1: Initial Study
Participants: 6 users (homeowners, office staff, cleaning personnel)
Findings:
1.Confusion in Setup: Users found it difficult to understand how to start the robot.
2.Mode Selection Issues: Switching between disinfectant and mosquito control wasn't intuitive.
3.Limited Feedback: No indication if tasks were completed.
4.Battery Uncertainty: Users were unsure about remaining power levels.
Improvements:
•Added a simplified instruction sticker on the body.
•Introduced a one-touch mode button with icons.
•Added LED indicators for task completion.
•Integrated a battery-level display.

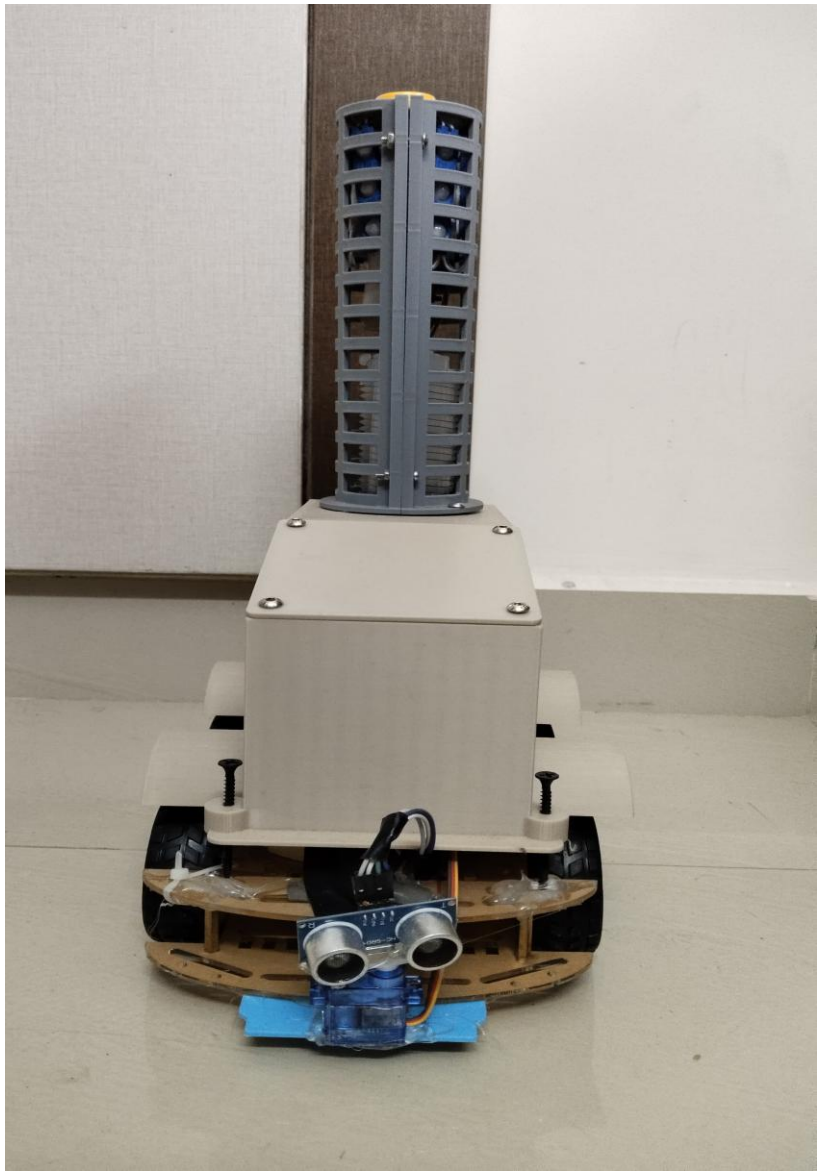
Round 2: Refined Study
Participants: 5 new users (parents, security staff, hostel wardens)
Findings:
1.Smooth Operation: One-touch functionality was appreciated.
2.Task Awareness: LED indicators improved confidence.
3.Improved Safety: Users felt safer with automatic obstacle detection.
4.Noise Concern: Minor noise from fan during mosquito control was noted.
Final Recommendations:
•Add sound insulation near fan if possible.
•Include audio alerts for operation status.
•Provide a mobile-based control/app in future version.
•Offer easy-to-refill sanitizer bottles with indicators.

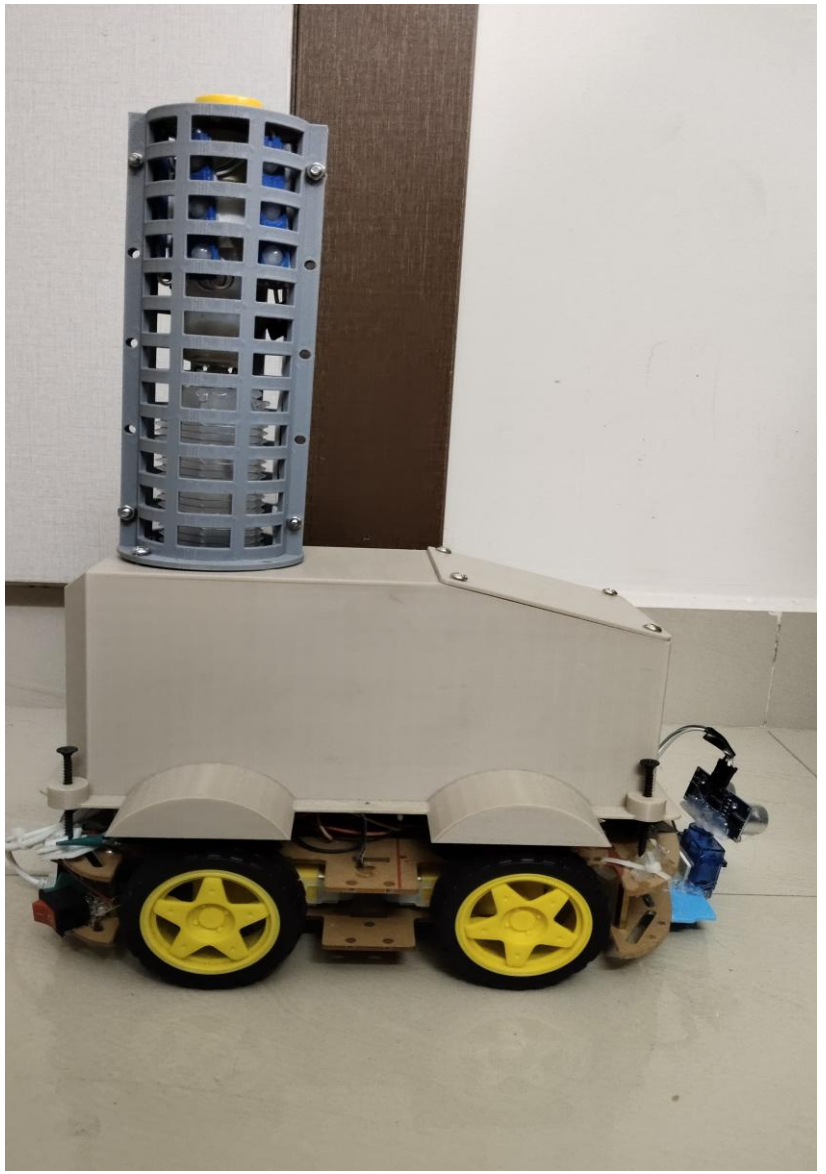
LIST OF COMPONENTS

LIST OF ALL ITEMS:

1. Arduino UNO – Microcontroller Board
2. Ultrasonic Sensor
3. Servo Motor
4. Wheels – 4 pcs
5. DC Motors
6. Batteries
7. Mist Sprayer
8. Sanitizer with Room Fragrance Ball
9. UVC Light
10. Mosquito Shocker Coil with UV Lamp – High Voltage
11. ON/ OFF Switch

PRODUCT DESIGN MOCKUPS





PROJECT LEARNING

Project Impact

•Improved hygiene in daily spaces with minimal human effort.
•Enabled safer environments through automation.
•Combined disinfection and mosquito control in one device.
•Reduced chemical exposure and manual labor.
•Brought smart tech to non-tech-savvy users.
•Enhanced environmental health awareness.

What I Learnt

•Importance of user-centric design in hardware projects.
•Practical application of automation and UVC technology.
•Real-world testing helps identify critical flaws early.
•Simplicity in design can boost usability and adoption.
•Time and resource management throughout prototyping.
•Team collaboration and communication are key for hardware success.

PRODUCT DESIGN PATENT

1. **Claim:** An autonomous sanitization and mosquito-control robot comprising a mobile platform equipped with a UVC disinfection module, a sprayer system, and a mosquito repellent mechanism for dual-function hygiene maintenance.

2. **Claim:** The UVC disinfection module as claimed in claim 1, wherein the module includes UV-C lamps enclosed in a cylindrical protective casing designed to emit germicidal ultraviolet light for killing bacteria, viruses, and pathogens on surfaces and in the air.

3. **Claim:** The sprayer system as claimed in claim 1, which is configured to dispense disinfectant or mosquito-repellent liquids through a nozzle controlled by a servo motor for targeted and uniform spraying.

4. **Claim:** The mosquito repellent mechanism as claimed in claim 1, which includes either an ultrasonic Repeller or mist-based repelling system to reduce mosquito presence and prevent the spread of mosquito-borne diseases.

5. **Claim:** An obstacle avoidance system as claimed in claim 1, comprising ultrasonic or infrared sensors that detect nearby objects and autonomously redirect the robot’s movement to avoid collisions.

Thank You
Let's connect

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