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TY Mini Project
Review- I

Design & Development of Arduino based Smart Vacuum Cleaner Robot

Academic Year: 2024-25

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Content

1. Introduction

- The **Arduino-based Smart Vacuum Cleaner Robot** is an autonomous cleaning system designed to efficiently clean floors using automation and sensor technology.
- It uses an **Arduino microcontroller** as the main controller, along with **ultrasonic sensors for obstacle detection, IR sensors for navigation, a motor driver for movement, and a vacuum motor for dust collection**.
- This project aims to develop a **cost-effective and intelligent vacuum cleaner** that can navigate autonomously, avoid obstacles, and ensure efficient cleaning.
- It can also be enhanced with **IoT features for remote control** via a smartphone.
- This mini-project is a great way to explore **robotics, automation, and embedded systems** while applying smart technology to simplify daily tasks.

2. Problem Statement

➢ **Manual cleaning challenges:**

•Traditional vacuum cleaners require **constant human effort**.
•Cleaning is **time-consuming and labor-intensive**.

➢ **Need for automation:**

•A **cost-effective and intelligent solution** is needed.
•The system should **operate independently without human intervention**.

➢ **Proposed Solution – Arduino-Based Smart Vacuum Cleaner Robot:**

•Uses **automation and sensor technology** for efficient cleaning.
•**Ultrasonic sensors** for obstacle detection.
•**IR sensors** for navigation and path-following.
•**Motor driver** for movement control.
•**Vacuum motor** for dust collection

OBJECTIVES

✓ **Automation & Efficiency:**

•Develop a fully **autonomous vacuum cleaner** that can operate without human intervention.
•Improve **cleaning efficiency** by integrating smart navigation and obstacle avoidance.

✓ **Cost-Effective Solution:**
•Create a **low-cost and energy-efficient** cleaning robot using Arduino and readily available components.

✓ **Obstacle Detection & Navigation:**
•Use **ultrasonic sensors** to detect and avoid obstacles.
•Implement **IR sensors** for path tracking and better movement control.

✓ **Effective Dust Collection:**
•Integrate a **small vacuum motor** to efficiently collect dust and debris from the floor.

✓ **Enhancements & Future Scope:**
•Enable **IoT-based remote control** for operation via a smartphone.
•Improve **path-planning algorithms** for better coverage and efficiency.

✓ **Learning & Practical Application:**
•Provide hands-on experience in **robotics, automation, and embedded systems**.
•Demonstrate the **integration of sensors, motors, and controllers** in a real-world application.

Scope

- **Automated Cleaning:** Reduces human effort, ideal for homes and offices.
- **Cost-Effective:** Affordable alternative to expensive robotic vacuum cleaners.
- **Smart Navigation:** Uses ultrasonic and IR sensors for obstacle detection and movement.
- **IoT & AI Integration (Future Scope):** Can be upgraded for remote control and smart path planning.
- **Scalability:** Customizable for larger areas with improved battery and motor power.
- **Educational Value:** Useful for learning robotics, automation, and embedded systems.

Literature Review

❖ **Evolution of Robotic Vacuum Cleaners:**

•Early models like **Roomba (2002)** introduced autonomous cleaning.
•Modern systems use **AI, LiDAR, and IoT** for better performance.

❖ **Arduino in Robotics:**
•**Arduino is widely used** in automation due to its affordability and open-source nature.
•Effective for **motor control, sensor integration, and wireless communication**.

❖ **Obstacle Detection & Navigation:**
•**Ultrasonic & IR sensors** improve real-time obstacle detection.
•**Sensor fusion** enhances navigation accuracy.

❖ **Vacuum Suction Mechanism:**
•Uses **low-power DC fans** for dust collection.
•Brush-assisted suction improves **cleaning efficiency**.

❖ **IoT & Smart Features:**
•**Wi-Fi/Bluetooth** enables smartphone-based remote control.
•**AI-driven path planning** optimizes cleaning patterns.

❖ **Applications & Future Trends:**
•Growing demand for **smart home automation**.
•Future focus on **AI, LiDAR navigation, and machine learning** for better autonomy.

Methodology

➢ **Problem Identification:**

•Manual vacuum cleaning is **time-consuming and inefficient**.
•Need for an **automated, cost-effective, and intelligent cleaning solution**.

➢ **System Design & Component Selection:**

•**Microcontroller:** Arduino Uno for system control.
•**Sensors:**
    •**Ultrasonic Sensor** – Detects obstacles and prevents collisions.
    •**IR Sensors** – Helps in line tracking and navigation.
•**Motor Driver (L298N):** Controls **DC motors** for movement.
•**Vacuum Motor/Fan:** Provides **suction power** for dust collection.
•**Power Supply:** Rechargeable **battery** for continuous operation.

➢ **Circuit Design & Hardware Assembly:**

•Connect components to **Arduino** and test functionality.
•Assemble the **chassis, wheels, and vacuum system**.

Methodology

- **Programming & Algorithm Development:**

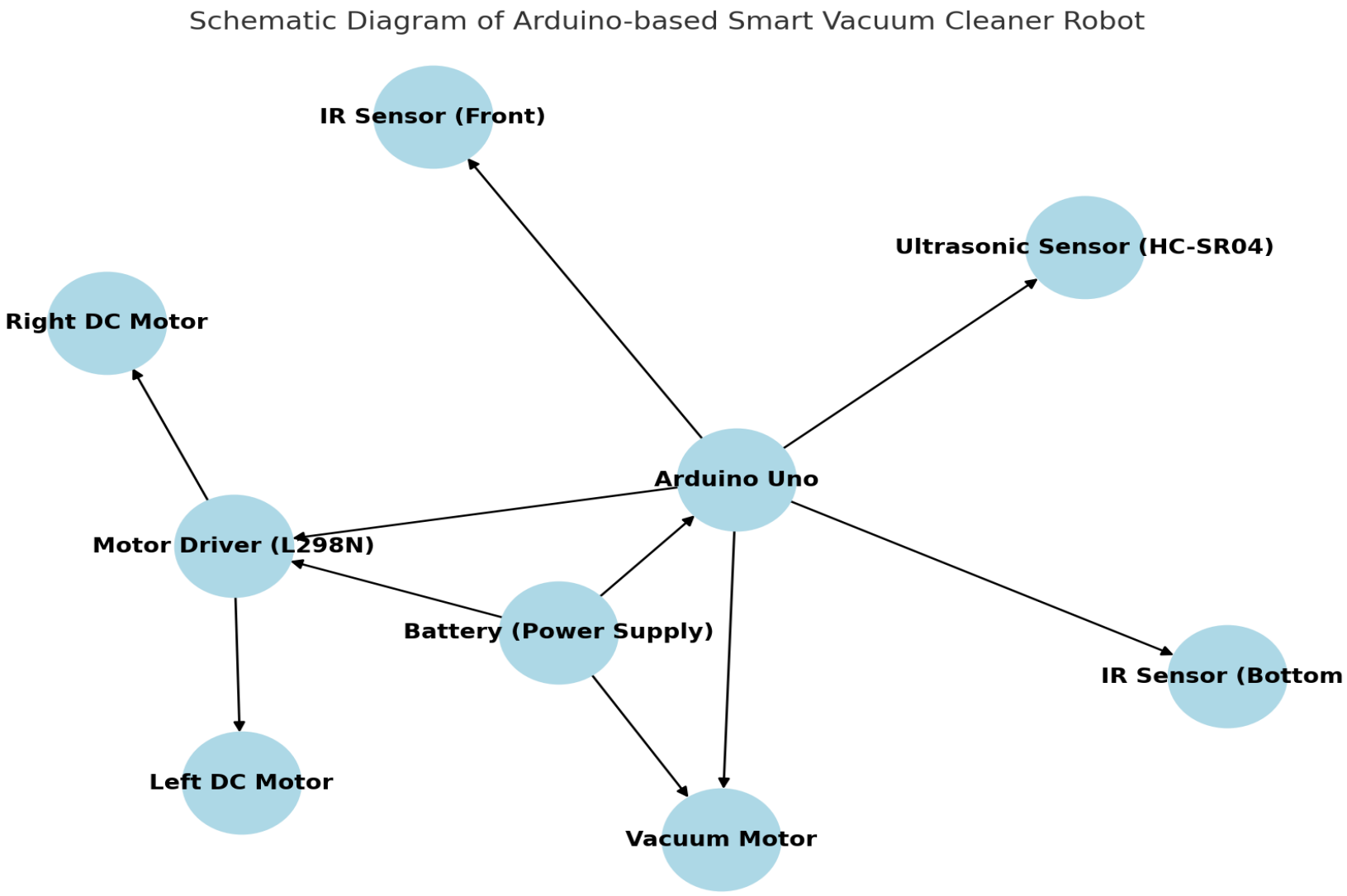
- **Sensor data processing** for navigation and obstacle avoidance.
- **Motor control algorithms** for movement in different directions.
- **Path optimization** to improve cleaning efficiency.

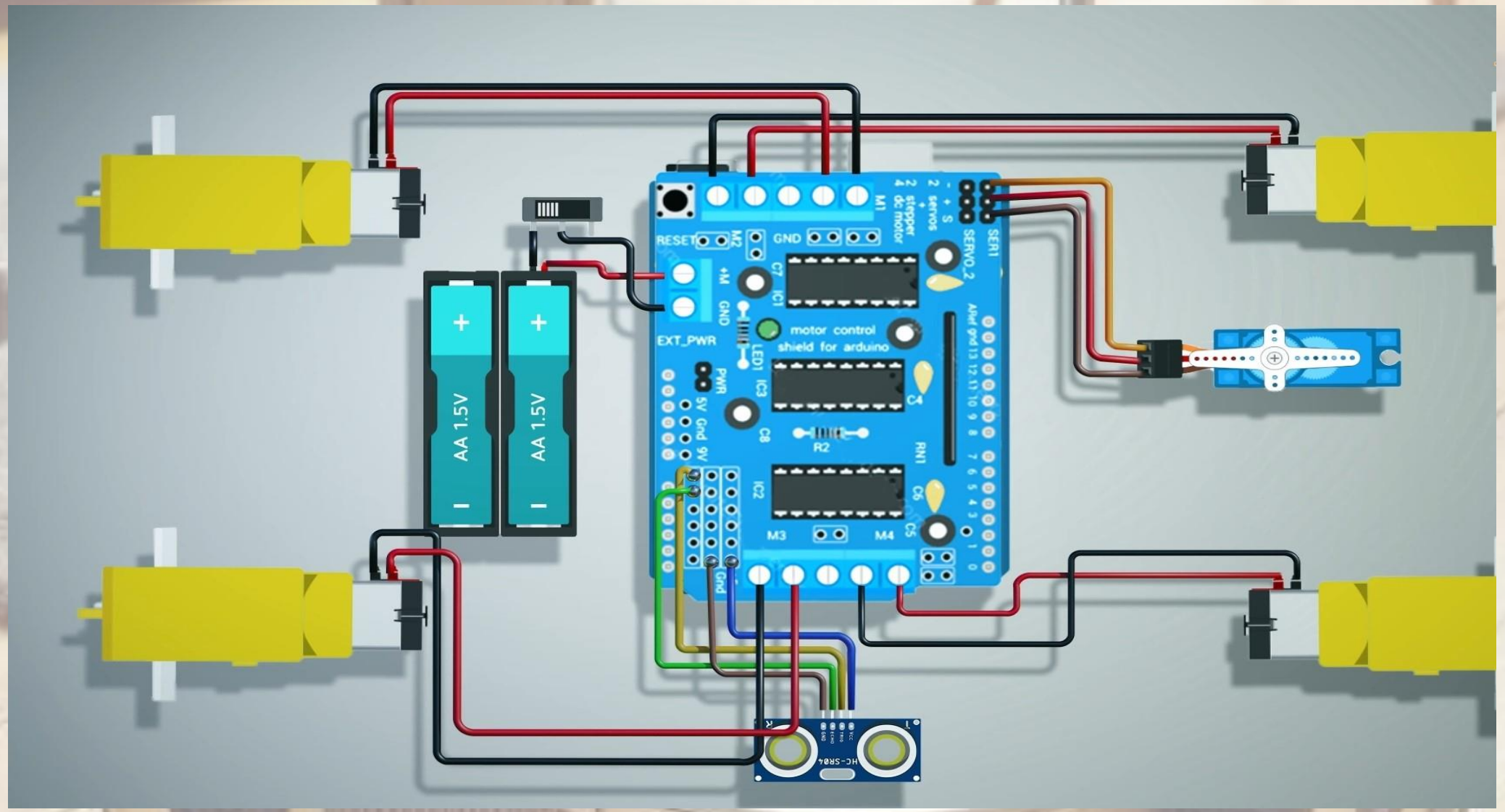
Testing & Troubleshooting:

- Check **sensor accuracy** for obstacle detection and movement.
- Ensure **proper vacuum suction** and dust collection.
- Debug and refine **navigation and obstacle avoidance algorithms**.

- **Enhancements & Future Scope:**
- Add **IoT features** for smartphone control.
- Improve path-planning using **AI and machine learning**.

7. Schematic Diagram of Prototype (Sample)




AA 1.5V
AA 1.5V
motor control
shield for arduino
EXT_PWR
RESET
GND
HC-SR04

8. ACTION PLAN

Activity Plan	January 2023	February 2023	March 2023	April 2023
Literature Survey	Research on vacuum robots, Arduino, sensors, and AI-based path planning	Finalizing research and defining objectives.	-	-
Mathematical Model	Understanding robot movement and suction force calculations.	Developing movement algorithms.	Testing mathematical models.	
Software Analysis	Selecting programming tools (Arduino IDE, libraries)	Writing basic code for motor and sensor control.	Optimizing path planning and obstacle avoidance.	Debugging and final improvements.
Prototype Manufacturing	Component selection and initial assembly.	Circuit design and hardware connections.	Testing movement, suction, and navigation.	Finalizing prototype.
Result Analysis	-	Initial testing of hardware components.	Software and hardware integration testing.	Evaluating cleaning performance and making adjustments.
Report Writing	Collecting initial data and documentation.	Writing draft sections on methodology and design.	Adding test results and analysis.	Finalizing and formatting the report.

References

Papers from Journal:

- **"Arduino Based Smart Vacuum Cleaner Robot"** – International Journal of Novel Research and Development (IJNRD)
- **A Review Paper on 'Smart Vacuum Cleaner'"** – International Journal for Research Trends and Innovation (IJRTI)

- **References Books:**

- **"Arduino Robotics"** by John-David Warren, Josh Adams, and Harald Molle.

- **Web Links:**

- **Link:** https://www.ijnrd.org/papers/IJNRD2305718.pdf
- **Link:** https://ijrti.org/papers/IJRTI2304047.pdf


THANK
YOU !