Arduino Based Smart Vacuum Cleaner Robot

Dr. V. Ramesh[1], M.P. Bhargavi[2], B. Akhila[3], P. Tejaswini[4], K. Gurudev Varma[5]
Associate Professor[1], UG Student[2, 3, 4, 5], Department of Electronics & Communication Engineering,
Sai Rajeswari Institute of Technology, Proddatur, Andra Pradesh,516360.
ramesh719@gmail.com[1], syamalareddy63@gmail.com[2],
akhilaakhila7868@gmail.com[3],paduchuritejaswini@gmail.com[4],gurudavavarma@gmail.com[5]

ABSTRACT

Arduino based Smart Vacuum Cleaner Robot designed for autonomous [1] floor cleaning. The system is implemented using an Arduino Uno microcontroller, integrating infrared (IR) sensors [2] and an ultrasonic sensor mounted on a servo motor for obstacle detection. The motor driver and DC motors facilitate smooth mobility within an indoor environment, ensuring efficient coverage. The cleaning mechanism employs a vacuum pump, which is activated via a relay module upon detecting dust [6] or debris. This autonomous cleaning system enhances efficiency by combining automated navigation and real-time dust collection, making it a cost-effective and practical solution for smart home applications. [3]

KEYWORDS-

Arduino Uno Microcontroller, Servo Motor, Ultrasonic Sensor, Motorized wheels, Vacuum Pump.

I. INTRODUCTION

With the rapid advancements in automation and smart home technology, autonomous cleaning systems have gained significant attention. Traditional vacuum cleaners require manual operation, which can be time-consuming and inefficient.

To address these challenges, this paper presents the design and development of a Smart Vacuum Cleaner Robot, which operates autonomously [1] to enhance cleaning efficiency in indoor environments.

The proposed system utilizes an Arduino Uno microcontroller as its core processing unit, integrating infrared (IR) sensors [2] and an ultrasonic sensor mounted on a servo motor to detect obstacles and measure distances. The robot's movement is controlled using DC motors and a motor driver, enabling smooth navigation. The cleaning mechanism consists of a vacuum pump, which is activated via a relay module upon detecting dust or debris. [6]

By combining automated navigation, real-time dust collection, and smart obstacle avoidance, the system provides an efficient and cost-effective solution for autonomous [4] cleaning. The integration of IoT and robotics in household applications not only enhances convenience but also optimizes energy consumption and labour effort. This study focuses on the hardware implementation, working principles, and performance evaluation of the smart vacuum cleaner, demonstrating its potential for smart home automation. [3]

II. PROBLEM STATEMENT

Maintaining clean floors in homes and commercial spaces can be tedious and time-consuming, especially in the absence of automated solutions. While robotic vacuum cleaners exist, their high cost and complexity often make them inaccessible to a large segment of users. Additionally, traditional cleaning methods rely heavily on manual effort and lack efficiency. This project proposes the development of a smart vacuum cleaner robot using Arduino,

designed to provide an affordable, efficient, and user-friendly cleaning solution. Equipped with sensors for obstacle detection [5], automated navigation, and a vacuuming mechanism, the robot will operate autonomously, reducing human effort and ensuring cleaner environments. The goal is to offer a practical and cost-effective alternative for maintaining cleanliness in various indoor settings.

III. METHODOLOGY

The methodology for creating an Arduino-based smart Vacuum cleaner entails defining the cleaning requirements, selecting the necessary hardware

components, such as motors, sensors [2], and batteries, writing the software code using the Arduino IDE, assembling the components in accordance with the design, testing and debugging the system to ensure it satisfies the requirements, improving the design to add features, and documenting the design and code for later use. To produce a practical and effective tool that can carry out particular cleaning activities automatically or manually, this requires a mix of hardware and software design and testing.

IV. BLOCK DIAGRAM

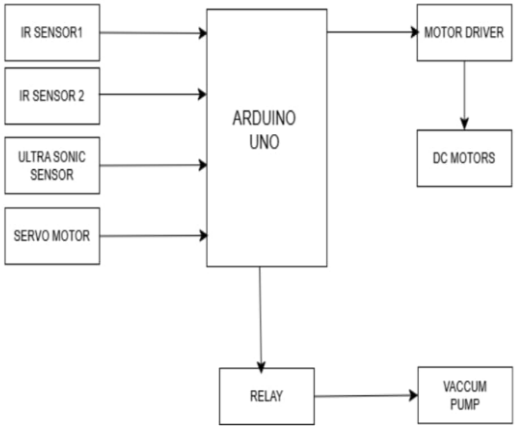


Fig: Block Diagram

V. COMPONENTS USED

1. ARDUINO UNO

The Arduino UNO is a widely used open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

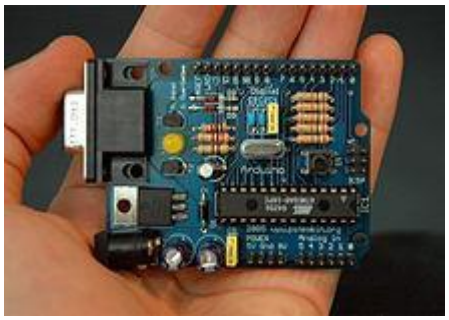


Fig: ARDUINO UNO

2. ULTRASONIC SENSOR

Ultrasonic sensors [2] are widely used in robotics, automation, and security systems for distance measurement. They use sound waves to determine the distance between the sensor and an object. The most common ultrasonic sensor used with Arduino is the **HC-SR04.**

Fig: ULTRASONIC SENSOR

3. SERVO MOTOR

The SG90 is a small, lightweight, and cost-effective servo motor widely used in robotics, automation [1], and hobby projects. It is a 9g micro servo motor that provides precise angular movement within a limited range

Fig: SERVO MOTOR

4. MOTOR DRIVER

Motor drivers are devices that act as an interface between a motor and a control system, such as a microcontroller or a computer. Motor drivers are crucial for precise control over the speed, direction, and torque of motors. They are widely used in applications ranging

from small DIY projects to industrial automation systems. The basic functionality of a motor driver include voltage & current control, direction control, speed control and torque control.

Fig: MOTOR DRIVER

In voltage and current control drivers regulate the amount of voltage and current supplied to the motor, in direction control the driver changes the motor's rotation direction as most DC motors changes direction by reversing the polarity of the voltage.

5. DC MOTOR

The DC motor automates the forward movement of the smart trolley. It delivers electrical energy through motion, so the trolley follows the customer without the operator's intervention. The motor works with a motor driver, where the Raspberry Pi microcontroller sends commands to it. Based on user motion detected by Bluetooth.

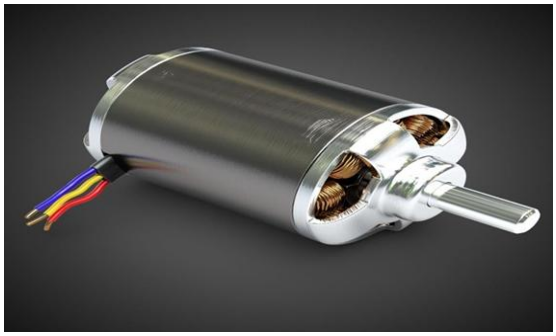


Fig: DC MOTOR

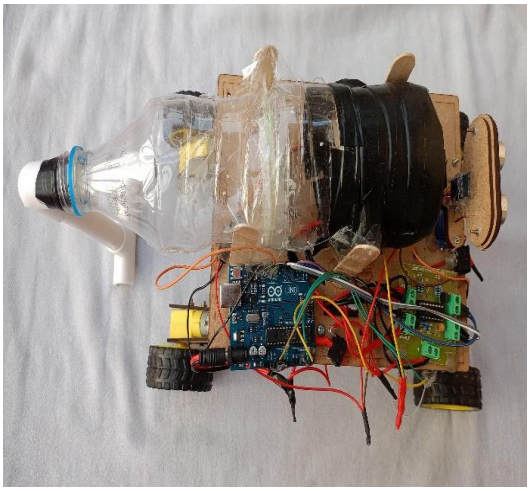
It also changes speed and direction. Compactness, ease of use, and efficiency drive it to make it the proper choice for use here, thereby providing a relaxed and hassle-free shopping experience.

6. VACUUM PUMP

The vacuum pump [2],[4],[5] is a critical component of the Smart Vacuum Cleaner Robot, responsible for dust and debris collection. It ensures efficient suction and cleaning performance while operating in synchronization with the robot's movement.

Fig: VACUUM PUMP

RESULT: -



CONCLUSION:

The Smart Vacuum Cleaner Robot presented in this work successfully integrates autonomous navigation, real-time obstacle detection, and efficient cleaning mechanisms to provide a cost-effective and practical solution for modern cleaning applications. The system is built around an Arduino Uno microcontroller, utilizing infrared (IR) sensors for line following, an ultrasonic sensor with a servo motor for obstacle detection, and a vacuum pump for dust collection.

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