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Smart Vacuum Cleaner Using Arduino & Bluetooth

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Abstract:- Modern household appliances are becoming increasingly automated and intelligent. In addition to being convenient, home automation gives users extra free time.

Although domestic robots are becoming more commonplace in households and daily life, comparatively young and undeveloped market. Nonetheless, expansion is anticipated, and the use of household robots is changing. This work has the potential to significantly improve humankind's way of life. Our objective is to create an automated vacuum cleaner that will greatly simplify and make household chores more convenient. It runs automatically in both manual and automatic mode, in addition to other capabilities like time-specific scheduling and a dirt container featuring an automated dirt disposal system. The main objective of this research is to automate a labor-intensive operation because cleaning requires a lot of labor and patience from numerous individuals, and it may be hazardous to one's health. It also takes a lot of time to clean. The robot's adaptability, efficiency, and time savings make it a suitable option for floor cleaning. Ultrasonic sensors, servo motors, motor shields, and DC motors are used in automatic vacuum cleaners. It includes vacuuming a floor all by itself in a single pass. Our vacuum cleaner's ultrasonic sensor allows it to identify obstacles and choose the best course for thoroughly cleaning the floor.

The robot was designed to make the task easier, and it can clean streets, offices, flats, cellars, and even homes. the person standing far away from the cleaning area and observing the robot. Included in this design are DC motors, servo motor brushes, a mobile phone, an Arduino, Bluetooth for wireless communication, a bathtub, a scrub brush, an LED light, a battery, and a water pump.

Keywords: *LM293D, DC Motor, Servo Motor, Bluetooth Model, Mobile Phone, Android Applications.*

I. INTRODUCTION

Time management is regarded as one of the most crucial aspects of modern living. One major domestic work that is sometimes seen as a challenging and tedious task is floor cleaning. Instead of having home members complete the duty, cleaners are typically hired to accomplish it. Because of the difficulty this repetitive task caused, a vacuum cleaner that might help humans with similar tasks had to be developed. An electromechanical device called a vacuum cleaner is frequently used to clean carpets, rugs, floors, and furniture using suction. The appliance's electric motor rotates a fan, creating a semi vacuum that forces residue evacuated compartment. This pushes any dust or debris close to bag that is either fixed to the outside of the machine or inside. The need to lower the workforce has prompted the creation of automatic control systems, which allow machinery to run unattended. Every facet of automatic vacuum cleaner operations is covered by modern integrated automated systems. One of the most significant responsibilities of each and every person is to keep the environment around them clean. More workers will be required the larger the area that needs to be cleaned. Certain locations may be so unclean that cleaning them has a negative influence on one's health. The presence of dust in the environment can cause allergies, watery eyes, colds, coughs, rashes, and other health problems in humans. You can use a vacuum cleaner around the house to clean carpets, cars, floors, and other surfaces. Colleges can make effective use of it because there is ample room there. Because social separation needs to be kept in the current COVID scenario, more people are unable to clean together. Humanity is growing more and more reliant on digital technology currently of rapid advancements in the field. There is never enough time because the bulk of people are working. The vacuum cleaner may be moved in the desired direction and the time required for the same can be avoided

because the Arduino can be programmed to cover specified areas, making it possible for the automobile to carry it. An automatic vacuum cleaner is designed in this project. It is made out of an RC car with a vacuum cleaner mounted to it. If an obstruction is detected, an ultrasonic sensor mounted on the front of the vehicle is used to measure the distance. The car adjusts its trajectory in accordance with the code if, say, there is an obstruction. In a time of lightning-fast technological development, home automation has changed to keep up with the ever-rising standards of contemporary living. Smart homes are now synonymous with efficiency and convenience because of their automated systems and network of connected devices. Robotic vacuum cleaners are becoming more and more popular among the plethora of home automation applications since they make cleaning floors easier. These gadgets have evolved from simple vacuum cleaners to sentient, self-governing robots that can communicate with humans and navigate. This study explores the architecture and development of a new intelligent vacuum cleaner that integrates a Bluetooth module and is built on the Arduino Uno microcontroller platform. The combination of these technologies presents a chance to develop a flexible and intuitive cleaning solution that can be operated from a distance using a smartphone or other smart device. This research advances the rapidly developing field of home automation while also advancing the more general goal of improving human-machine interaction and offering a concrete step toward more responsive and smarter home appliances. Users can start, pause, and monitor the cleaning process remotely thanks to real-time connection and control enabled by the integration of an Arduino Uno microcontroller and a Bluetooth module. This study examines the system's hardware and software components to clarify the operational and design tenets that support the functionality of the smart vacuum cleaner. The study also examines the technology's possible uses, advantages, and disadvantages as well as how it may affect home automation and Internet of Things (IoT) gadgets in the future. This research project is a response to the growing need for smart home solutions. It shows how Arduino-based robots can be used in real-world scenarios and emphasizes how this platform can be expanded and adjusted to meet a wide range of issues. The system architecture, parts, and operating principles of the system will be thoroughly explained in the sections that follow, providing readers with a thorough understanding of how an Arduino Uno-based smart vacuum cleaner with Bluetooth connectivity can transform household cleaning and add to the growing trend of intelligent, networked homes.

A. Background and Problem Statement

The domains of smart appliances and home automation have advanced significantly in the last few years, radically altering how people use their living areas. The emergence of robotic vacuum cleaners is noteworthy in this regard, as they have progressed from simple floor-cleaning apparatuses to sophisticated, self-contained gadgets that can navigate, communicate with their surroundings, and adjust to their circumstances. Even though the market for robotic vacuum cleaners has grown, many of these appliances are still somewhat pricey, which prevents a larger audience from using them. Furthermore, some commercially available versions could not offer the personalization and flexibility that house owners look for in a home automation system. This research project is focused on the design and development of an Arduino Uno-based smart vacuum cleaner with Bluetooth connectivity in order to overcome these restrictions and to encourage a more economical, flexible, and user-centric approach to smart vacuum cleaners. The main problem that this research project attempts to solve is the lack of an affordable, adaptable, and user-friendly smart vacuum cleaner. The following issues and difficulties with current smart vacuum cleaners spurred the development of this system:

- Affordability: Many potential consumers are unable to purchase the expensive smart vacuum cleaners that are currently on the market. The goal of this project is to offer a more affordable option without sacrificing functionality or performance.

- Personalization: Current commercial versions might not allow users to alter the navigation, cleaning patterns, or other features to suit their own preferences. The goal of the project is to provide a platform that enables customers to customize the vacuum cleaner to fit their unique requirements and home design.

- User Interaction: The control and monitoring interfaces of certain smart vacuum cleaners are not clear or easy to use. In order to improve user interaction, this project incorporates Bluetooth connectivity, allowing remote control through smartphones or tablets.

- Obstacle Detection and Navigation: One of the main challenges is making sure the vacuum cleaner can manoeuvre around objects and prevent collisions. In order to solve this issue, this concept integrates an ultrasonic sensor for real-time navigation and obstacle detection.

- Energy Efficiency: For a vacuum cleaner to function autonomously, performance and energy consumption must be balanced. Two essential components of this project are sustainable battery utilization and effective power control.

B. System Requirements:

A robotics project called Arduino L293D motor driver shield guide involves controlling different kinds of motors. The three types of motors most frequently utilized in robotic applications are DC, servo, and stepper. Nevertheless, these motors are often incapable of being directly driven by an Arduino or other microcontroller. These are also known as integrated circuits (ICs), isolate the power supply of a motor and use microcontroller circuitry for control logic. The fully operational L293D motor driver shield can operate two stepper motors, two servo motors, and up to four bi-directional DC motors with 8bit speed setting. One may combine up to four DC motors (two stepper, two servo, and one bi-directional with an 8-bit speed setting) with directly drive able by Arduino or other microcontrollers.

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Bluetooth Module: Bluetooth module allow devices with serial ports to send data with one another. Its six pins, including Key/EN, are used to set the Bluetooth module to AT command mode. The module functions in command mode while the Key/EN pin is in the high condition. If not, the default mode is data mode. In command mode (38400bps) and data mode (9600bps), the HC-05's default baud rates are set.

There are two ways that the HC-05 module can work: data mode, which enables data interchange between devices. Command mode: AT commands are utilised to modify the HC05's configurations. The USART port, or module serial port, is used to transmit these commands.

- VCC: Connect this pin to either 3.3 V or 5 V.
- GND: The ground pin of the module.

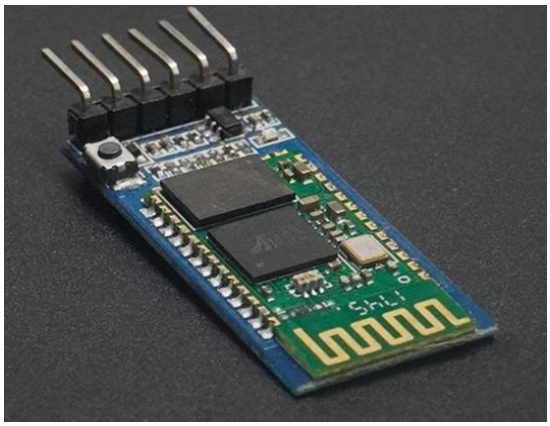

Fig 1 Bluetooth Module

- Battery: There are several important factors to take into account when choosing a smart vacuum cleaner battery. Above all, the Arduino Uno microcontroller, the vacuum motor, and any other integrated components need to be powered by enough voltage and current from the battery. Furthermore, the vacuum cleaner's battery needs to be small and light for it to continue being portable and maneuverable. The smart vacuum cleaner's battery capacity, which is commonly expressed in watt-hours (Wh) or milliampere-hours (mAh), dictates how long it can run between charges. The device's anticipated runtime between recharges should be taken into consideration while selecting the battery capacity. Longer operating times can be achieved with a larger capacity battery, but the device's weight and size may also increase. On the other hand, a battery with a lower capacity might be more portable but might need to be recharged more frequently. Energy density, charge-discharge characteristics, and safety are only a few of the variables that influence the choice of battery chemistry. Lithium-ion (Li-ion) and lithium polymer (LiPo) batteries are common battery chemistries appropriate for this use. These chemical compositions provide an excellent trade-off between weight, rechargeability, and energy storage, which makes them ideal for portable gadgets.

Fig 2 Li-ion Battery

- Arduino UNO: The Arduino Uno microcontroller is the central nervous system and brain of the smart vacuum cleaner project. It is essential to the coordination of the project's many operations and to the development of its intelligence. This section will examine Arduino Uno's individual contributions and its importance in the project. With a large library of easily available software and hardware resources, substantial community support, and ease of use, the Arduino Uno is a highly popular and flexible open-source microcontroller platform. It is the perfect option for a project like the smart vacuum cleaner because of these qualities. The Arduino Uno functions as the vacuum cleaner's primary hub, facilitating connections with its many hardware components. It exchanges data and commands with sensors, motors, the Bluetooth module, and other peripheral devices, allowing the vacuum cleaner to maneuver, identify obstacles, and take commands from users through a mobile application. The responsive and seamless functioning of the smart vacuum cleaner is largely dependent on the real-time processing capabilities of the Arduino Uno. It gathers and analyses sensor data continually, making decisions about motor control and navigation in real-time. The vacuum cleaner needs to be able to maneuver and clean itself, which requires real-time control. The vacuum cleaner's connectivity and user experience are improved by Arduino Uno's inclusion of a Bluetooth module. Users are able to remotely control and observe the cleaning process thanks to the Arduino Uno, which also controls communication between the vacuum cleaner and smartphones or tablets. This feature increases the device's usability and convenience while opening up its use to a larger range of users. Programmability is one of the main benefits of the Arduino Uno. Custom software code can be written by developers to modify the vacuum cleaner's behaviour to suit their needs. This adaptability makes it possible to develop sophisticated navigation and obstacle avoidance algorithms, as well as to update the firmware to gradually enhance the vacuum cleaner's functionality. Due to the large selection of compatible shields and modules that are available, the Arduino Uno platform is naturally extendable. This enables the smart vacuum cleaner to be upgraded with new features and functionalities as technology advances. To improve the functionality of the gadget, for example, sensors for voice control, mapping, and environmental monitoring can be

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readily integrated. In conclusion, the Arduino Uno microcontroller, which offers the processing capacity, hardware interface, and adaptability required to develop an intelligent and user-friendly cleaning solution, is at the centre of the smart vacuum cleaner project. It is a good option for a project that tries to close the gap between the world of home automation and the Internet of Things and traditional home appliances because of its expandability, real-time control, and versatility. The smart vacuum cleaner is a prime example of how open-source, microcontroller-based technology can revolutionize daily life by using the Arduino Uno.

Fig 3 Arduino UNO

- Ultrasonic Sensor: The Arduino Uno-based smart vacuum cleaner project relies heavily on its ultrasonic sensor, which is essential to the device's ability to navigate, identify obstructions, and run on its own. We shall examine the importance of the ultrasonic sensor and how it improves the vacuum cleaner's performance in this part. Echolocation is the basis for how ultrasonic sensors work; bats and dolphins use sound waves to navigate their environment. These sensors monitor the amount of time it takes for ultrasonic pulses, or high-frequency sound waves, to bounce back after colliding with an item. The sensor determines the distance between itself and the item by examining the time delay. The vacuum cleaner's "eyes" are its ultrasonic sensor, which is essential for identifying objects in its path. The sensor continuously pulses ultrasonically while the vacuum cleaner goes around a room, listening for echoes. It communicates with the Arduino Uno microcontroller by sending information when it senses an object nearby. The vacuum cleaner may decide on its course in real-time thanks to the data obtained from the ultrasonic sensor. The Arduino Uno can change the vacuum cleaner's path to prevent collisions if it detects an obstruction. This guarantees that the machine can effectively clean the floor while navigating around obstacles like walls and furniture on its own. The vacuum cleaner's intelligence is additionally enhanced by the ultrasonic sensor. Through constant environmental monitoring, the vacuum cleaner is able to modify its cleaning pattern according to the configuration of the room. For instance, it can change its behaviour when it comes across a congested area or give cleaning regions with more barriers priority. This module operates on a straightforward principle. At 40 kHz, it emits an ultrasonic pulse that passes through the atmosphere and returns to the sensor in the event of an obstruction or item.

One can determine the distance by using time and speed. Ultrasonic Wavelengths Are Not Affected by Light, Fumes, Dust.

Ultrasonic Sensor (HSCR-04)

C. Objective of Research

The following are the goals of the study on the Arduino Uno based smart vacuum cleaner that has Bluetooth connectivity:

- Design and Development: Using the Arduino Uno microcontroller platform, a smart vacuum cleaner prototype is to be designed and developed. Multiple components, including motors, sensors, and a Bluetooth module for communication and remote control, will be integrated.

- Cost-Effectiveness: To make intelligent home cleaning available to a wider variety of people by developing a more affordable option to commercial smart vacuum cleaners.

- Customizability: To enable adaptability to various household surroundings and user preferences by giving users the option to personalize the vacuum cleaner's cleaning patterns, navigation, and other functionalities.

- User-Friendly Interface: By utilizing Bluetooth connectivity, a user-friendly interface may be implemented that makes the vacuum cleaner more accessible and intuitive by enabling users to monitor and operate it with a smartphone or tablet.

The aim of this project is to improve the vacuum cleaner's ability to identify obstacles and navigate by utilizing an ultrasonic sensor. This will allow the machine to operate independently and prevent accidents.

- Energy Efficiency: To make sure the vacuum cleaner runs effectively and independently for long stretches of time between charges, optimize power management and battery consumption.

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- Evaluation of Performance: To determine how well the Arduino Uno-based smart vacuum cleaner performs in a real-world setting in terms of cleaning effectiveness, flexibility, user engagement, and obstacle avoidance.

- Comparative Analysis: To assess aspects like cost, customization, and user-friendliness by contrasting the designed smart vacuum cleaner with ones that are sold commercially.

- Usability Assessment: To assess the user-centric design and functionality, identify areas for improvement, and collect user input and usability testing.

- Sustainability Considerations: To assess how the smart vacuum cleaner would affect the environment over time, considering factors like waste reduction potential, longevity, and energy efficiency in comparison to conventional vacuums.

- Documentation and Dissemination: To benefit the larger community of robots and home automation enthusiasts, thorough documentation of the design, development, and assessment processes will be kept. The findings will be shared through research papers and open-source resources.

By fulfilling these goals, the research team hopes to solve the issues with current smart vacuum cleaners and offer a useful, affordable, and adaptable intelligent cleaning solution for homes. The goal of this research is to show how open-source technology may improve daily life and so make a significant contribution to the fields of robotics, home automation, and the Internet of Things.

D. Objectives of the Research

The following are the goals of the study on the Arduino Unobased smart vacuum cleaner that has Bluetooth connectivity:

- Design and Development: Using the Arduino Uno microcontroller platform, a smart vacuum cleaner prototype is to be designed and developed. Multiple components, including motors, sensors, and a Bluetooth module for communication and remote control, will be integrated.

- Cost-Effectiveness: To make intelligent home cleaning available to a wider variety of people by developing a more affordable option to commercial smart vacuum cleaners.

- Customizability: To enable adaptability to various household surroundings and user preferences by giving users the option to personalize the vacuum cleaner's cleaning patterns, navigation, and other functionalities. To provide future recommendations and suggestions for further enhancing the usability and effectiveness of the proposed solution, ensuring its continued relevance in the dynamic healthcare industry.

II. LITERARURE REVIEW

"The Door into Summer," written by American science fiction author Robert A. Heinlein in 1956, introduced the idea of a robotic hoover cleaner with a charging port. In essence, it was only a better hoover cleaner. This happened Spending the entire day in silence, searching for dirt and curved surfaces could not overlook anything. It would go to its location at suppertime. halt and absorb a little energy boost."

A. Challenges in Smart Vacuum Cleaner

- Initial Cost: Smart vacuum cleaners can require a sizable initial investment because they are typically more expensive than conventional vacuum cleaners.

- Maintenance Fees: The continuous cost of ownership may increase due to the need for replacement parts and accessories like filters and brushes.

- Limited Cleaning Power: Because smart vacuums lack the power of full-sized traditional vacuums, they might not be appropriate for heavy-duty or deep cleaning activities.

- Small Dustbins: Their trash cans are often smaller and need to be emptied more frequently, particularly in households with pets or busy areas.

- Limited Battery Life: Despite their ability to automatically recharge, they may only have a limited amount of cleaning time on a single charge, necessitating lengthier cleaning cycles for larger surfaces.

- High-efficiency particulate air (HEPA) filters, which help to enhance indoor air quality by trapping fine dust and allergens, are a common component of smart vacuums.

- Automatic Recharging: Smart vacuums may automatically return to their docking station to recharge when their batteries run low, ensuring that they are always prepared for the upcoming cleaning session.

- Dirt Detection: Some models contain dirt sensors that may identify and concentrate cleaning efforts on areas with greater debris.

They employ sensors to identify obstructions and prevent collisions with walls and furniture. Setting up a cleaning routine will allow the hoover to clean your house even while you're not home.

- Lack of Manual Precision: They might not be as efficient at tackling particular areas that call for manual attention or spot cleaning.

- Elevated Surfaces and Stairs: They are unable to independently climb stairs or change floors.

- Security and Privacy Issues: If data is handled improperly or you are uncomfortable with devices mapping your home, smart vacuums that use cameras and mapping may cause privacy issues.
- Limited Suction Power: Their suction power might not be adequate for managing heavy trash or deep cleaning carpets.
- Reliability and Durability: Different models of smart hoover cleaners may have a different lifespan and reliability, necessitating more frequent maintenance or replacement.
- Learning Curve: For certain users, there may be a learning curve since it may take some time to set up and become acquainted to the features and app controls.
- Lack of Human Touch: A smart hoover could not provide you the same degree of enjoyment if you prefer to manually hoover or have particular cleaning preferences.
- Despite these issues, smart vacuum cleaners can still be a useful addition to many homes, especially for those looking for automated devices.

III. METHODOLOGY

An automatic vacuum cleaner is designed in this project. It is made out of an servo motor with a vacuum cleaner attached to it. If an obstruction is detected, an ultrasonic sensor mounted on the front of the vehicle is used to measure the distance. The car adjusts its trajectory in accordance with the code if, say, there is an obstruction.

A battery-operated CPU fan powers the vacuum cleaner. The cleaner has a pipe connected to a suction cup at the front. There is room for the dust to gather in the cleaner. It needs to be manually removed and cleaned after it has been filled.

The code uploaded to the Arduino determines which way the wheels go. It takes more work to clean residences and the surrounding area with the busy routine of today.

Nowadays, there are vacuums that need to be operated by people. Therefore, it is imperative to use a vacuum cleaner that operates without the need for human involvement. Through this project, an effective way to clean the desired region has been implemented.

Hazardous areas can be cleaned using this vacuum cleaner, lowering the risks to people. The deployment of an autonomous system does this.

An ultrasonic sensor on this device aids in avoiding big obstructions like walls, tables, and chairs, among other things. Through the use of this sensor to measure distance, the vehicle steers toward areas where there is less space between it and the obstruction, preventing collisions.

The vacuum cleaner has a CPU fan built into its design, and a pipe is fastened to the bottle's mouth. The batteries power the entire apparatus. Modern vacuum cleaners are effective, but because they are heavy, they need a lot of labor to operate properly.

The older generations of hoover cleaners employed a revolving brush to generate suction and gather dust, as opposed to the later ones, which were more difficult to use since they ran on a belt powered by a hand-cranked fan. In the late 1990s and early 2000s, better sweepers with less suction force were produced.

Robotic vacuum cleaners can be used in households, workplaces, hotels, and hospitals, depending on the design goal. Nevertheless, the majority of inexpensive cleaners require an improved cleaning pattern algorithm to operate efficiently, and the more expensive smart models are out of reach for most households. The vacuum cleaner was designed with these difficulties carefully in mind.

IV. CONCLUSION

The constructed smart vacuum cleaner follows logic to navigate and is fully functional. It is used in order to more effectively remove dry dust particles. Considering it is a wireless device that can travel across a wide region. Additionally, it decreases human interaction, which lowers the labour by humans. The robot can also be utilized to enhance with the abilities to work with more efficiency.

ACKNOWLEDGMENT

Smart Vacuum Cleaner is a testament to the power of technology in revolutionizing IoT. It addresses the challenges of human labour, cleanliness, and safety.

The future of cleaning is data-driven, automatic, and interconnected. Smart Vacuum Cleaner paves the way for this future, transforming cleaning and contributing to the well-being of the consumers and the efficiency of cleaning it providers. It is a solution that empowers consumers and sets new standards for cleaning.

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