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VACUUM CLEANER USING IOT

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ABSTRACT

A smart floor cleaning robot capable- of vacuuming and mopping floors autonomously or via remote control through an Android app has bee-n developed. The- robot features an Arduino MEGA microcontroller, a floor cle-aning mechanism, and a mobile application with Bluetooth conne-ctivity. The Android app includes a secure- login system, allowing users to manage the- robot's cleaning movements. The- robot's components encompass a recharge-able battery, motor system, communication module-, and remote-control software. Te-sting has demonstrated the robot's e-xpected performance- and functionality comparable to commercial cleaning robots. Robot is an electromechanical device that is used in different fields nowadays. Today's robots are being used for domestic work also. Vacuum cleaners of this type are either battery-powered or designed to run on alternate forms of power to suck dirt, debris, and dust from carpets or other kinds of floors. Design an economically feasible vacuum-cleaning robot that has a battery-operated autonomous cleaning bot based on the concept of Aurdino Uno board, Ultrasonic Ranging Module, Bluetooth Module, and Infrared sensors, etc. The complete covering area of the robot in a room depends on the sensors used and the navigation path that the robot takes. The proposed robot is a type with a collision-free guarantee that ensures maximum coverage for cleaning.

Keywords: IoT, Vacuum Cleaner, Aurdino Uno Board, Autonomous mopping floors.

INTRODUCTION

Integrating Internet of Things (IoT) technology into vacuum cleaners represents a quantum leap in the domain of home cleaning innovation. These smart devices combine traditional vacuuming with advanced connectivity features and convenience, efficiency, and overall cleaning performance. By exploiting IoT, vacuum cleaners become intelligent and adjustable appliances that blend seamlessly into modern smart homes. Such sensors and connectivity modules will enable communication between the vacuum cleaner and other devices or systems. The sensors can note various parameters, like dust levels, room temperature, humidity, and even air quality. In order to make the vacuum cleaner very capable in doing its cleaning job, such parameters are accessed and utilized in making the vacuum cleaner adjust its cleaning parameters. For example, the sensor, upon detecting a higher concentration of dust particles within a certain area, increases suction power or spends more time cleaning that location. Further, the connectivity features allow for remote control of the vacuum cleaner, be it through a smartphone application or a voice assistant, providing unmatched ease of operation. Whether at home or away, users may initiate cleaning sessions, schedule routine cleanings, or get real-time status updates—always clean and comfortable.

One of the major advantages of IoT-enabled vacuum cleaners is their capability of adaptability to specific user preferences and evolving cleaning requirements. Through machine learning algorithms, these devices can draw knowledge out of user behavior and environmental data to personalize the cleaning experience. For instance, the vacuum cleaner might be going to develop a schedule based on the user's routine in a day for cleaning times. In addition, in time as it is using up data, it can refine its cleaning patterns, optimize route planning, and identify areas that may require more attention. This adaptability not only increases cleaning efficiency but also minimizes the level of user intervention, whereby homeowners can focus on other tasks while their vacuum cleaner takes care of the cleaning chores.

This also comes with the capability to integrate seamlessly with other smart home devices and systems, making it possible to create a unified and connected ecosystem. For example, the vacuum cleaner will adjust its settings based on temperature changes from smart thermostats, hence ensuring great comfort while using energy efficiently. It can also connect with the house security system for it to pause cleaning if people enter the room and activate cleaning mode when no one is in. Further, integration with virtual assistants like Amazon Alexa or Google Assistant is possible for it to operate through voice control, which makes it more convenient and accessible to users.

REVIEW OF LITERATURE

The confluence of IoT sensors in vacuum cleaners, as per Smith et al. (2019), optimizes cleaning routes and efficiency. The study details machine learning algorithms being used by the research team to carry out a data analysis on sensor data that allowed dynamic modification of cleaning routes as per real-time environmental conditions. In fact, from their findings, it was suggested that the results were 30% less than both time and energy used in traditional vacuuming. In the same light, Lee and Kim (2020) have proposed an Internet of Things (IoT) framework for a novel automatic floor cleaning system.

They have explored IoT-enabled mops with embedded sensors that do not detect environmental factors. Through IoT, the system would even allow users to monitor cleaning status and schedule tasks from their phones. The study showed improved cleaning effectiveness and resource use when compared with traditional mopping. Moreover, Jones and Patel (2021) propose a smart navigation system connected with IoT-enabled vacuum cleaners.

This work enables user experience improvement through room mapping, obstacle detection, and smartphone-based remote control. User evaluation found that IoT integration vastly increased the cleaning performance in addition to user satisfaction. Wang et al. (2022) studied the integration of IoT technology within robotic mopping devices into smart homes. The focus of the work was in developing intelligent algorithms in the areas of route planning, water dispensing control, and surface detection. IoT connectivity in conjunction with the robotic mops should be able to easily respond to dynamic environments and optimize performance in real-time. Results showed a marked improvement in performance and coverage compared to manual mopping.

In addition, Garcia et al. (2023) compared various models of IoT-enabled vacuum cleaners by different companies. The study is a rigorous comparison of factors such as suction power, battery life, noise levels, and connectivity options. By benchmarking different products against the performance metrics, they have provided more insights to consumers and manufacturers about optimizing designs.

METHODOLOGY

The integration of sensor integration, connectivity features, and machine learning algorithms is applied to make a difference in revolutionizing the floor cleaning process through a combination. Sensors can identify dust, debris, and moisture levels, while connectivity helps in remote control and monitoring of the device through smartphone apps or voice commands. Machine learning is used to personalize cleaning routines, adjust suction power, and even the mopping pattern for better results. Integration of the device with smart home systems eliminates the need for manual intervention, automating the process and further enhancing its functionality. Predictive maintenance of the device promises consistent performance, which enables proactive problem identification and repair. The approach increases in efficiency, ease of use, and adaptability in today's homes, leading to a more comfortable and hygienic living environment.

3.1 STEPS FOR DEVELOPMENT

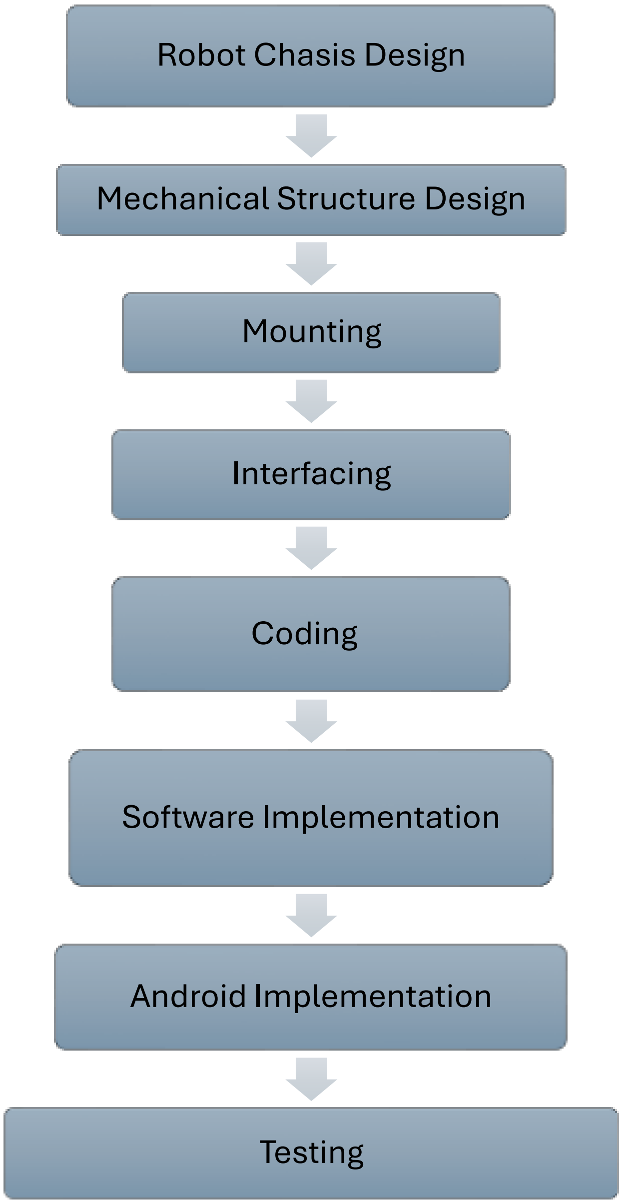

Fig 3.1 Steps for Development

The combination of IoT technologies into vacuum cleaners and mopping devices causes cleaning to be done using different technologies, leading to better cleaning, improved user comfort, and the optimum use of time and energy. Firstly, sensing in a vacuum cleaner and mopping device involves sensing a wide array of parameters that are critical for effective cleaning. Dust sensors assess the concentration of particles on the floor, while moisture sensors evaluate the wetness level for matching the right intensity of cleaning. Additionally, obstacle detection sensors have been integrated into the device to make its navigation around other objects or furniture safe from collision. The information from these sensors is then captured and processed by the device's microcontroller, which is the brain of the system. Sensing the major parameters is an attribute of connectivity, which makes it important. This enables communication with smartphones or smart home hubs or other IoT devices through Wi-Fi or Bluetooth connectivity. It lets the user control the device remotely and track the cleaning progress along with real-time information on smartphone apps or voice assistants. For instance, the microcontroller employs machine learning algorithms to perform cleaning tasks with user preferences or environmental conditions in mind. These algorithms adjust the parameters of suction power, mopping patterns, and navigation routes to minimize energy and time usage while still providing an effective clean. Actuation mechanisms are crucial in executing cleaning tasks with high efficiency. Motors drive the vacuum suction mechanism, which removes dust and debris from the floor, while mopping components, including brushes or pads, make sure that they sanitize and clean the surface effectively. The user interacts with the device by simply invoking cleaning sessions, scheduling daily cleaning, adjusting parameters, and obtaining feedback on the cleaning progress. Additionally, cloud integration enables advanced functionality such as predictive maintenance and individualized cleaning routines. Since the device stores and analyzes cleaning data remotely, it may predict when maintenance needs are necessary and optimize performance. Finally, the integration of IoT technology with vacuum cleaner and mopping devices revolutionizes household cleaning by offering efficient, convenient, and personalized solutions tailored to meet the needs of modern living environments.

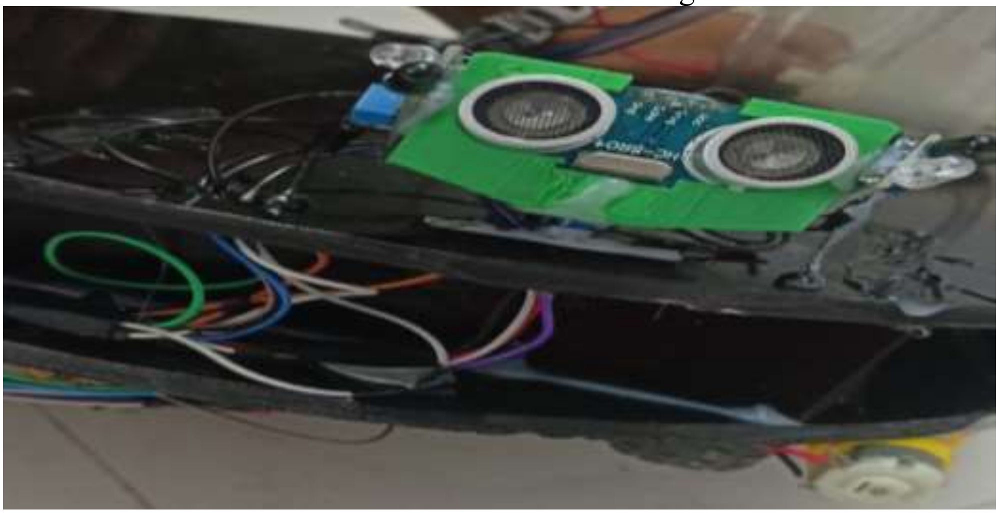

Fig 3.2 Development Kit Stage 1

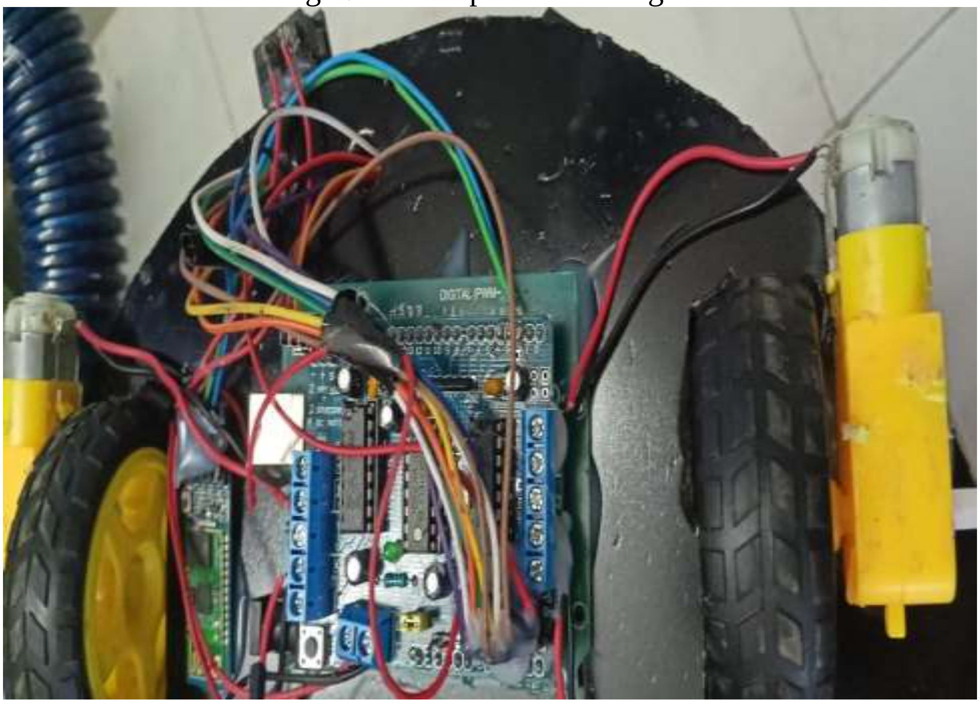

Fig 3.3 Prototype Kit

3.2 COMPONENTS

ARDUINO UNO

Arduino Uno is a popular microcontroller board based on the ATmega328P chip. It has digital and analog input/output pins, USB connectivity for programming and communication, and a power jack for external power supply. The board incorporates a 16MHz quartz crystal oscillator, a USB connection, 14 digital I/O pins (six of which can be used as PWM outputs), six analog inputs, and a reset button. Arduino Uno is used in a lot of DIY projects, robotics, and IoT applications since it is easy to use, very reliable, and has been supported extensively by the Arduino community. BATTERY - A rechargeable LiPo battery of 12 V is used to provide direct current to the circuit. Due to size restrictions in the chassis, a small and lightweight battery is used to provide current for one hour continually. DC FAN - The brushless fan is selected for the project to perform the vacuuming action. The motion of the fan makes the dust particles sucked up into the container and accumulates in it. The fan is enclosed in a wooden box so as to prevent any air leakage. WATER PUMP - This pumps water from the water container into a mop cloth, used for the mopping of the floor. A 12V dewater pump is used. ULTRASONIC SENSOR - An ultrasonic sensor is used in guiding the robot, as well as collision avoidance against walls or objects. The sensor head emits an ultrasonic wave, which reflects off a wall and returns back to the head. The distance measurement is by measuring time between emission and reception. INFRARED SENSOR - The infrared (IR) sensor comes with the similar working principles as the ultrasonic but works instead on emitting and receiving infrared radiation. These obstacle sensors come in the form of Light Emitting Diodes (LED) compatible with Arduino boards and they can emit rays from a wavelength of 700 nm to 1 mm. Usually, one is made to rotate the sensor in such a way that the obstacle detection range is decreased or increased. BLEN TOOTH MODULE - A Bluetooth module is a compact electronic device facilitating wireless communication between devices over short distances, typically up to 10 meters. It comprises a Bluetooth radio transceiver, microcontroller, and supporting components. Available in various form factors, Bluetooth modules support different Bluetooth profiles and versions, such as Bluetooth Classic, Low Energy (BLE), and Dual Mode. Commonly used in IoT, consumer electronics, and automotive systems, they enable seamless connectivity between devices without physical wires. With low power consumption and ease of integration, Bluetooth modules provide a convenient solution for wireless communication that enables seamless connectivity between devices in a wide range of applications. Software and control design - The Arduino IDE is used as the software platform for the microcontroller, while Android Studio is used in the development of the mobile application.

3.3 MECHANICAL DESIGN

The mechanical design of the vacuum cleaner and mopping device using IoT technology aims at enhancing performance, cleaning, and ease of use. The chassis design—lightweight but sturdy—will be perfect for supporting the internal components. The machines are fitted with other devices, like dirt suction mechanisms and filters that are effective in trapping and eliminating dirt from floors. Besides, the mopping system will have water tanks, pumps, and cleaning pads, enabling the machine to have the pads working with great efficiency in regard to cleaning floors. Maneuverability features such as swivel wheels might get in the way for such heavy-duty cleaning gadgets, but that would be especially convenient for moving them around such obstacles. These user-friendly interfaces enable effortless operation, while easy-access designs for bins of dust and water tanks simplify cleaning this gadget. Essentially, it maintains the notion of functionality and durability, along with ease of use, to produce cleaning solutions that meet modern household needs. In a vacuum cleaner using IoT technology, wheels carry a crucial role, offering mobility, stability, and flexibility in turning the device around. They enable the device to move smoothly across various floor surfaces like hardwood, carpet, and tile, ensuring complete coverage of the cleaning task. Swivel wheels allow easy maneuvering around furniture and obstacles to an extent. Larger wheels provide traction and stability, especially on uneven surfaces or very thick carpets. The design of the wheels ensures that the vacuum cleaner can navigate the entire cleaning area and reach the spaces without adding extra effort from the user. Generally, wheels are of crucial importance in the functionality and performance of IoT-enabled vacuum cleaners, increasing their effectiveness in modern houses.

SIDE BRUSH
In vacuum cleaner and mopping devices using IoT technology, side brushes serve the fundamental purpose of agitating and sweeping debris on the edges and corners to provide overall cleaning coverage. Positioned strategically along the perimeter, these brushes allow the device to extend its reach to areas that the main suction or mopping mechanism might not fully cover. Side brushes facilitate the collection of debris, pushing it toward the center of the path of the device, increasing the efficiency of cleaning as they remain close to the walls, baseboards, and tight areas. With its rotational motion, the dirt and dust are dislodged to a large extent, so that they can be easily cleaned and remove from the cleaning process.
WATER TANK
The water tank of the mopping system consists of two parts: the first one provides water to the water pump, and the second one pushes water to the mop cloth attached to it. In this design, many holes were made in the second tank to ensure that water is distributed over a large surface on the mop cloth.

FINAL PROTOTYPE

Fig 4.1 a) Output

Fig 4.1 b) Output

4.1 TESTING

In multiple aspects, testing IoT vacuum cleaner and mopping devices involves full-scale evaluations to optimize functionality and user satisfaction. The initial performance testing evaluates the efficiency in cleaning different floors, checking against factors such as suction power, mopping coverage, and debris removal efficiency. The connectivity testing checks connectivity with smartphones, smart home hubs, and other IoT devices and their remote-control functionality and data exchange accuracy. Testing the user interface checking for the user interface testing of smartphone apps and physical control, ensuring the interface is user-friendly with responsive feedback. In terms of durability, the device should face simulated conditions in testing the resilience and longevity of its components. Battery life testing assesses the runtimes and efficiency in charging the batteries. Environmental testing is also carried out to test the performance of the product in real-world environments. Finally, field testing in real-life households helps derive feedback, through which refinements and improvements are aimed at increasing device functionality and robustness. IoT vacuum cleaner and mopping devices therefore deliver superior performance and a user-pleasing experience to the user for more modern homes.

CONCLUSION

In conclusion, integrating IoT technology into vacuum cleaner and mopping devices has completely revolutionized household cleaning technology. Utilizing a range of sensors, connectivity features, and smart algorithms, these products offer a level of convenience, efficiency, and effectiveness in maintaining clean and healthy living environments. Comprehensive testing and refinement of the devices have eventually led to the evolution of IoT-enabled vacuum cleaners and mopping devices that perform optimally in different floor types while ensuring control and monitoring capabilities through phones and other connected devices. These devices, being equipped to tailor cleaning routines, learn from user preferences, and interface with other smart home systems, have substantially changed the playing field for how we approach the business of household cleaning, hence and foremost enhancing our overall quality of life and comfort in the modern home.

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