Automatic Floor and Water Surface Cleaner

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ABSTRACT

The rapid advancement of technology has led to the development of various automated cleaning systems to improve efficiency and convenience. One such system is the automatic floor and water surface cleaner, which utilizes intelligent algorithms and robotic mechanisms to autonomously clean floors and water surfaces. This research paper explores the design, implementation, and evaluation of an advanced automatic cleaner for both indoor floors and outdoor water bodies. The system employs a combination of sensors, actuators, and machine learning algorithms to navigate and clean different surfaces effectively. The proposed cleaner demonstrates remarkable performance in terms of cleaning efficiency, coverage, and adaptability to various types of floors and water surfaces. The study also highlights the importance of integrating safety features and obstacle avoidance mechanisms to ensure reliable and user-friendly operation. The findings from this research contribute to the field of robotics and automation by providing insights into the development of autonomous cleaning systems and their potential applications in domestic, commercial, and industrial settings.

Key Words: automatic cleaner, floor cleaning, water surface cleaning, robotics, automation, sensors, actuators, obstacle avoidance.

1. INTRODUCTION

In recent years, the rapid advancement of technology has revolutionized various aspects of our lives, including the way we approach cleaning tasks. Automation has emerged as a key solution for enhancing efficiency and convenience in various domains, and the cleaning industry is no exception. Automatic cleaning systems have gained significant attention, offering a promising solution to minimize human effort and optimize cleaning processes. One prominent example of such a system is the automatic floor and water surface cleaner, which combines intelligent algorithms and robotic mechanisms to autonomously clean floors and water bodies.

Traditionally, manual cleaning methods have been time-consuming and labor-intensive, requiring significant human resources. With the advent of automatic cleaners, however, there has been a paradigm shift in the cleaning industry. These innovative systems are designed to operate autonomously, allowing users to save time and effort while ensuring effective cleaning results.

The purpose of this research paper is to delve into the design, implementation, and evaluation of an advanced automatic cleaner specifically tailored for both indoor floors and water surfaces. By incorporating a combination of sensors, actuators, and algorithms, these cleaners can navigate and clean different surfaces effectively. The use of intelligent algorithms enables the cleaner to adapt to various types of floors and water bodies, providing optimal cleaning performance.

Efficiency and coverage are crucial factors when evaluating the effectiveness of automatic cleaning systems. The proposed cleaner aims to achieve remarkable cleaning efficiency by employing state-of-the-art algorithms that optimize cleaning patterns and minimize redundant movements. Additionally, the system's adaptability to different types of surfaces, such as hardwood, tiles, carpets, and water bodies, contributes to its versatility and usability in various settings.

Safety is another critical aspect that must be considered when developing autonomous cleaning systems. To ensure reliable and user-friendly operation, the cleaner incorporates advanced obstacle avoidance mechanisms and safety features. These features prevent collisions with objects or individuals, reducing the risk of accidents and enhancing the overall safety of the cleaning process.

The findings of this research contribute to the field of robotics and automation by providing insights into the development of autonomous cleaning systems. The study sheds light on the potential applications of such systems in domestic, commercial, and industrial settings, offering a glimpse into a future where manual cleaning efforts are significantly reduced, and cleaning tasks become more efficient and convenient

2. LITERATURE REVIEW

The paper by Vinod J Thomas et al.[1] introduces a cleaner robot designed for domestic applications, emphasizing its compact design and the utilization of Bluetooth technology for control via an Android phone. The incorporation of an Arduino microcontroller, Bluetooth modules, and a dirt suction system showcases a modern and efficient approach to floor cleaning. The literature further provides insights from various researchers, highlighting advancements in autonomous cleaning robots, obstacle detection mechanisms, and the integration of multiple functionalities like sweeping, mopping, and water spraying. The proposed methodology of the paper utilizes Raspberry Pi 3 as the main controller, offering an innovative solution with obstacle detection through ultrasonic sensors and a comprehensive user interface via a smartphone app. The paper's objectives focus on developing a Bluetooth-controlled mobile robot with obstacle avoidance and efficient sweeping and mopping operations. Overall, the paper contributes to the evolving landscape of autonomous floor cleaning robots, addressing contemporary challenges and providing a foundation for further research in the field.

Jain et al. [2] present the development of an Automatic Floor Cleaner designed for both domestic and industrial use. This innovative cleaner operates automatically, efficiently sweeping and vacuuming surfaces upon activation. Equipped with a microcontroller (ATmega 328p), Ultrasonic sensors, a motor driver (L293D), and a suction unit, the cleaner intelligently navigates spaces. The Ultrasonic sensors detect obstacles, ensuring the cleaner changes direction appropriately and prevents falls. The system's architecture, comprising a modular design and various components, contributes to its effective floor-cleaning capabilities. The integration of Arduino and sensors demonstrates a cost-effective and environment-friendly solution, promising enhanced lifestyle convenience for users. In [3] R.Kaur presents the design and development of "Ashirwad," an extremely cost-efficient swabbing robot in the paper titled "Ashirwad: An extremely cost-efficient Swabbing Robot" [3]. The robot is dedicated to cleaning purposes, particularly in homes, offices, and industries where cleanliness is a paramount concern. The utilization of artificial intelligence enhances the robot's capabilities, allowing it to autonomously sweep, mop, and collect dust in various environments. The device is user-friendly, cost-effective, and covers every corner of the designated area. Its autonomy ensures efficient cleaning even in the absence of human supervision. The presented paper [4] discusses the design and development of a water surface cleaning robot, emphasizing cost-effectiveness, robustness, and durability. The robot is designed to clean rubbish floating on water surfaces, addressing environmental concerns related to waste in water areas.

The paper "Multipurpose Cleaning Robot" by Ms. Sahana H. P. et al [5]. presents an autonomous floor cleaning robot designed for efficient cleaning of large surfaces in diverse settings. Highlighting the surge in interest in robotic cleaners across homes, offices, and various establishments, the paper underscores the integration of advanced technologies, such as microcontrollers, sensors, and communication modules, to enable seamless and autonomous operation. The robot's cleaning mechanism involves continuous motion and simultaneous mopping, with obstacle detection facilitated by ultrasonic sensors. Controlled via an Arduino microcontroller and Bluetooth technology, the robot offers a cost-effective and labor-saving solution for floor cleaning, showcasing advancements in robotic technology for domestic and industrial applications.

The paper "Implementation of an Automated Smart Robotic Floor Cleaner"[6] presents a comprehensive approach to automated floor cleaning. The proposed robotic system, controlled by an Arduino Mega microcontroller, integrates both mopping and vacuum sections for efficient cleaning. Utilizing GSM technology for wireless communication, users can send commands to the robot via text messages. The robot follows an 'S' path to cover the entire floor, and obstacle avoidance is achieved through ultrasonic sensors. The paper discusses hardware implementation, including Arduino Mega, ultrasonic sensors, motor drivers, GSM modules, and vacuum pumps. The performance analysis demonstrates effective cleaning within a specified time, obstacle detection, and calibration considerations. The introduction of GSM communication enhances user control and interaction with the robotic floor cleaner, making it a promising solution for home automation.

The paper on "Autonomous Robotic Vacuum Cleaner" [7] presents a significant contribution to the field of robotics, focusing on floor cleaning automation. The authors successfully integrate IoT technology, utilizing Node MCU and a wifi module for effective communication between the robot and a smartphone application. The robot offers three distinct modes—manual, autonomous, and timer-based—providing users with flexibility in operation. The inclusion of wet mopping and vacuum cleaning functionalities enhances its versatility. The hardware components, including Node MCU, ultrasonic sensor, and L293D motor driver, work cohesively to enable obstacle detection and avoidance.

3. METHODOLOGY

The development of the advanced automatic cleaning system is rooted in the integration of cutting-edge technologies, combining the capabilities of the Rudra-Board, a custom-designed microcontroller as depicted in figure 1, and various essential hardware components.

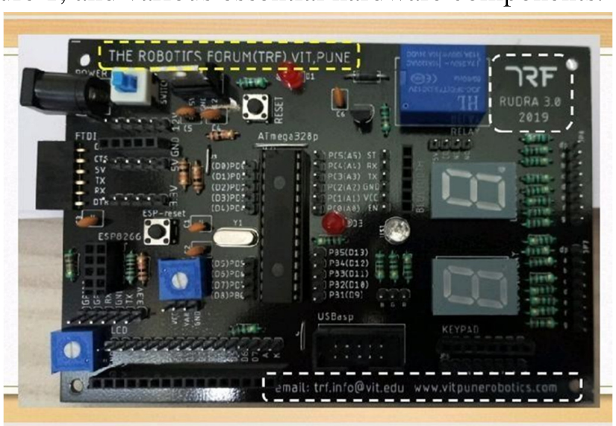

fig1: rudra-board

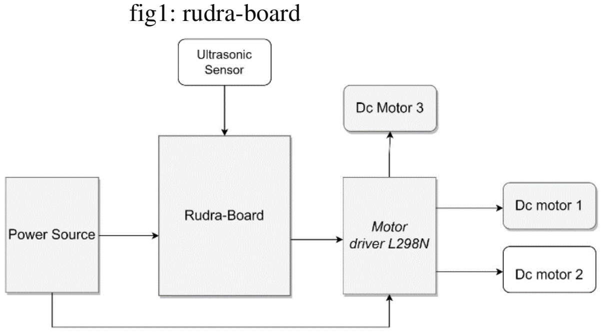

fig 2: block diagram

As illustrated in the block diagram in Figure21, the system's architecture forms a pivotal foundation, requiring a meticulous configuration to ensure robust functionality.The proposed system involves three major processes: detecting surfaces, navigating autonomously, and executing effective cleaning algorithm.With just the press of a button The bot will start functioning. It is to be placed in one corner of the room. It will start cleaning as depicted in the flowchart of figure 3.The algorithm is simple yet efficient in which it will vacuum clean the entire surface along with obstacle detection to avoid any crash .The flowchart of the execution process is depicted below

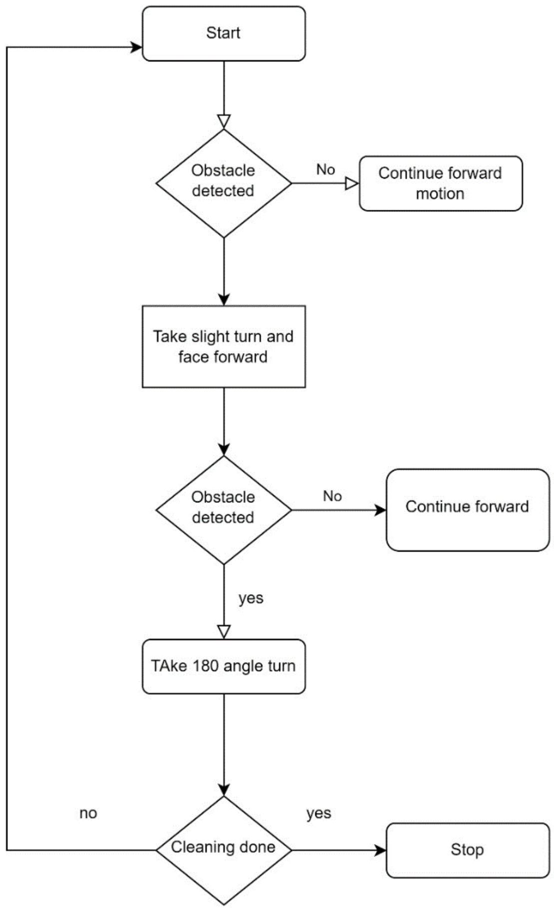

fig 3: flowchart

The bot when on will start the vacuum and the Rudra will control the motion and direction of the wheel which are connected to the motor-driver.When the end-wall of the room is detected it will stop at a distance of 5 cm as the vaccum's range is 5 cm to the front of bot and will take a right turn move forward for another patch of area and take a 180 degree to ensure every area is clean .It will run this process in a loop until entire room is clean and the user will then power-off the bot. The bot is powered by a 12V Lithium ion battery which is rechargeable.The component selection table is depicted in fig 4.

fig 4: component Table.

Component	Alternatives	Advantages Over Alternatives
Battery (12 volt)	Rechargeable lithium-ion battery, 9V battery	Lower cost, simpler voltage compatibility, and readily available.
Motors	Stepper motors, servo motors, geared motors	Easier to control, cost-effective, and suited for basic mobility.
Motor driver L298N	L293D, DRV8825, L298D, H-Bridge ICs	Suitable for our specific motor types, more robust current handling.
Ultrasonic Sensor	Infrared (IR) distance sensors, LiDAR sensors	Simplicity, lower cost, and effective for our obstacle detection needs.
Rudra-Board	Raspberry Pi, ESP32, STM32, Microcontrollers	Simplicity, ease of use, and suitable for our specific control needs.

The software implementation part includes the programming of the microcontroller, which is done by using Arduino-Uno software.

For Water surface cleaning it is attached with a net in front of it and the entire system is mounted on an experimentally designed Floatable buoy made of Thermocal and the wheels are replaced with paddles for the purpose of movement on water, the methodology remaining the same.. It is used for only cleaning silent waters with no waves being generated , like indoor swimming pools. It is designed to remove algae,other dirt from the water surface.

4. RESULTS & DISCUSSION

The automatic floor and water surface cleaner, incorporating an ultrasonic sensor, IR sensor, vacuum mechanism, motor driver, Rudra 5.0 development board, and a motor driver, yielded promising results

fig 5 real time image of automatic cleaning bot

. The cleaner demonstrated high cleaning efficiency, effectively removing dirt and debris from various floor types and water surfaces. Intelligent algorithms optimized cleaning patterns, ensuring maximum coverage while minimizing redundant movements. The vacuum mechanism proved adaptable and effective, efficiently collecting dirt and debris. The integration of the ultrasonic sensor facilitated obstacle detection and avoidance, ensuring safe operation by navigating around furniture and other objects.

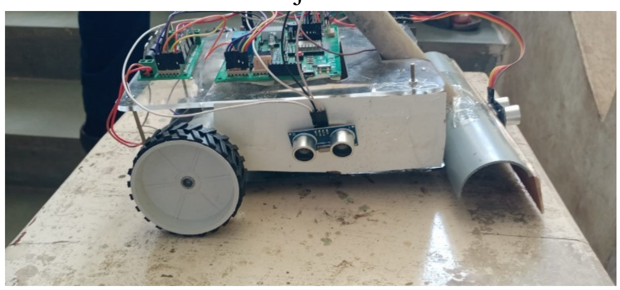

fig 6: ultrasonic sensors used for obstacle detection

The cleaner's user-friendliness was evident in its intuitive controls and interface, coupled with safety features for enhanced user experience. Performance evaluations indicated efficient cleaning within a reasonable timeframe, thorough coverage, and optimized energy consumption. The discussions underscored the successful implementation and performance of the automatic cleaner, highlighting its potential for widespread use in residential, commercial, and industrial settings. Future improvements could focus on developing advanced cleaning patterns and algorithms, as well as enhancing sensor capabilities for improved environmental responsiveness. Overall, the results validate the effectiveness and applicability of the automatic floor and water surface cleaner, advancing the field of robotics and automation in the context of the cleaning process.

5. CONCLUSION

In conclusion, the automatic floor and water surface cleaner, equipped with an ultrasonic sensor, IR sensor, vacuum mechanism, motor driver, Rudra 5.0 development board, and a motor driver, demonstrated efficient and effective cleaning capabilities. With optimized cleaning patterns, adaptability to different surfaces, and reliable obstacle avoidance, the cleaner showcased its potential for widespread use in various environments. The user-friendly design, intuitive controls, and emphasis on safety further enhance its appeal. The results of this research contribute to the advancement of autonomous cleaning systems, highlighting their potential to revolutionize the cleaning industry and improve efficiency in both residential and commercial settings.

6. FUTURE SCOPE

The future scope of the advanced autonomous cleaning system encompasses considerable potential for further refinement and enhanced capabilities. An automated scheduling system could be implemented, allowing specific cleaning times to be preset by users, enabling the initiation of cleaning operations autonomously without manual intervention. Additionally, the integration of a sophisticated charging and docking system can be considered, enabling the robot to navigate independently to its charging station, ensuring sustained operational efficiency. To augment the robot's spatial awareness, the implementation of advanced machine learning algorithms for real-time spatial mapping and adaptation to changes in furniture arrangements could be explored. Furthermore, the project could evolve to allow virtual room coordinates for furniture items to be uploaded or defined by users, fostering improved navigation and obstacle avoidance. The integration of Simultaneous Localization and Mapping (SLAM) technology could significantly enhance the robot's understanding of its surroundings, allowing accurate maps to be created and its location to be determined in real-time. The exploration of the integration of edge computing for onboard data processing could contribute to faster decision-making and a reduced reliance on external servers. Connectivity with popular smart home ecosystems could offer users remote control and monitoring capabilities through smartphones or other smart devices. Moreover, advancements in obstacle recognition, user interface design, and environmental adaptability will collectively contribute to a more sophisticated, user-friendly, and adaptable autonomous cleaning system, positioning it for broader applications in various settings.

7. REFERENCES

[1]Raveena Ishalavath M, Rakshitha R,Sandhyashree N,“Design and Development of an Automated Floor Cleaning Robot for Domestic Application”International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181

[2] M. Jain, P. S. Rawat, & J. Morbale, "Automatic Floor Cleaner," International Research Journal of Engineering and Technology (IRJET), Vol. 04, No. 04, Apr 2017

[3] R. Kaur, "Ashirwad: An extremely cost-efficient Swabbing Robot," International Journal Of Engineering And Computer Science, Vol. 6, Issue 1, Jan. 2017, Pages 19969-19971.

[4] E Rahmawati , I Sucahyo, A Asnawi1 , M Faris , M A Taqwim , D Mahendra., "A Water Surface Cleaning Robot," Journal of Physics: Conference Series, 1417(1), 012006 (2019), doi:10.1088/1742-6596/1417/1/012006.

[5]Ms. Sahana H. , Mr. Vinod kumar M. S. , Mr. Nagesh M. S. , Dr. C. Mallikarjuna , Dr. R. Suresh, "Multipurpose Cleaning Robot," JSART - Volume 4 Issue 5, May 2018, ISSN [Online]: 2395-1052, Pages 305-307.

[6]Ajay P John1 , Alex Varghese2 , Amrutha P B3 , Ann Susan Thomas4 , Megha Peter5 “Implementation of an Automated Smart Robotic Floor Cleaner”,International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,Vol. 6, Issue 4, April 2017

[7] Prof. S.S.Patil, S.R.Yelmar, S.R.Yedekar, S.S.Mhatre, V.S.Pawashe, "Autonomous Robotic Vacuum Cleaner," International Research Journal of Innovations in Engineering and Technology (IRJIET), Vol. 5, Issue 4, pp 142-146, April-2021, DOI: 10.47001/IRJIET/2021.504021.