Zeco - The Cleanup Bot

Stella J[1], Caleb Felix Kumar[2], Nancy Merciline[3], Berlius Pereira[4]
[1,2,3,4] *Department of Information Technology, Xavier Institute of Engineering, Mahim, Mumbai, India*

***Abstract*: In recent years, people have become more focused on their careers, and because of their unpredictable work hours, it is more difficult for people, especially women, to manage both home and work concurrently. They typically hire cleaners to keep their houses, workplaces, etc. clean, but they don't have much confidence in them. The Smart Vacuum Cleaner is designed to automate the cleansing process and employs more cutting-edge technology to address the problem. The programme is used to launch the automaton. The planned use is the automatic vacuum cleaner for the house. By measuring the distance with this sensor, the vehicle steers to avoid collisions with obstacles by veering in the direction where the distance between the object and the car is higher. This study shows how this approach can produce a variety of intriguing results despite the real limitations of the robot.**

Keywords: IOT, Mobile, Bluetooth, Arduino, Vacuum, RC

I. INTRODUCTION

"Things" alludes to a network of tangible objects with electronics, sensors, software, and network connectivity in the Internet of Things. (IoT). The Internet of Things (IOT) enables seamless merging of computer-based systems with the physical world by allowing remote object sensing and management. Robotics goes into great depth about the design, functionality, building, and applications of robots. It also describes how computers are used for management, data processing, and sensory input. Robotics and the Internet of Things have been working together to encourage and promote personal development.

With their cutting-edge technology, robots are already a crucial part of modern society, enhancing human ease and quality of life. The floor-cleaning robots are useful in a variety of situations, including residences, hotels, eateries, workplaces, hospitals, factories, warehouses, and colleges. As a result, they are receiving more attention in automation study. Fundamentally, what sets robot cleaners apart are their cleaning abilities, which include dry sweeping and floor washing.

While some contemporary devices rely on laser mapping technology, others for straightforward object avoidance rely on infrared or ultrasonic sensing. Cleaning machines can be used in a variety of methods, each with its own benefits and drawbacks. For instance, some robots that use laser imaging are a lot quicker, more expensive, and more energy-efficient. The laser mapping method has some disadvantages, including the need for expensive data processing tools and the purchase of new cloud-based software.

Due to their random cleaning, obstacle avoidance-based cleaning machines require more time and less energy but are less costly. The cost rises because nations that don't produce cleaning machines must acquire them from other nations. By utilising local resources and keeping expenses low, it might be feasible to develop a cleaning robot that could considerably ease industrial problems.

Obstacle avoidance and affordability are the cornerstones on which the creation of the smart hoover cleaning is based. The concept and construction of a clever floor-cleaning robot are presented in this study. The robot can operate in both independent and distant control settings. The robot can regularly clear the floor in both domestic and commercial settings without assistance from a person.

A. Problem Definition

To maintain sanitation, daily domestic tasks like cleaning and dusting are necessary. However, cleaning is a strenuous activity that requires a lot of manual labour. Many people today battle to find the time for these pastimes because of their demanding work schedules. Several technologies have been created in order to resolve these problems and enhance human living by dividing difficult, time-consuming chores into simpler ones.Because of their intricacy, size, and weight, vacuum cleaners are difficult to transport and keep.

Commercially accessible smart vacuum cleaners are pricey and beyond the means of the average individual.
We intend to create a cheap vacuum cleaner using Bluetooth, RC motors, sensors, and Android software. Nowadays, most vacuum machines are either autonomous or operated by a person. Our suggestion is a robotic helper model that will assist people with their housekeeping chores and has the ability to operate in both autonomous and distant control modes. They can be automatically or manually operated. Our initiative aims to provide a low-cost model that serves both functionalities, allowing the customer to use the hoover cleaner however they like. An app that can be obtained and put on any phone will be used to operate the device.

B. Project Scope

The primary objective of the initiative is to benefit the ecosystem. Cleaning is one method to improve the ambiance. Our suggestion is a dual-mode cleaning device that functions intelligently and on its own. The vehicle will help the model move by utilising a variety of methods, and the vacuum will assist by using its suction power. The complete vacuum model can be recharged, and its dust receptacle will hold all of the collected dust. The layout will be cost-effective. They are considerably less costly than pricy housekeepers. The equipment can be programmed to clean exactly as required and needs little upkeep.

You only need to change the bag or periodically empty the receptacle. In addition to keeping your surfaces cleaner and eradicating dust and other allergens in ways that your hand vacuum cleaner could never, they give you a lot more spare time. Even the most powerful conventional vacuums cannot completely reach under beds, in odd spots in the rear, or under cupboard edges.

Robotic vacuums are silent as they glide under the furnishings and up against the wall in quest of dust mites. The problem with corded vacuum cleaners is that moving them from one location to another can be very challenging. Most importantly, when the wires get tangled, accidents can occur when people misstep and tumble over them. If you use a robot vacuum, none of the present issues will concern you. You won't have to keep plugging and unplugging the machine to clear all of your surfaces.

Even lightweight contemporary vacuums might be difficult to use for someone who is injured or has a handicap. You've undoubtedly noticed that vacuuming requires much more bodily effort than you might anticipate. Robotic vacuums work entirely on their own, without the need for any pulling, hauling, or stooping. They are also wonderful for aged people.

II. CURRENT ASSUMPTIONS

The utility is presently made with development and design teams in mind, but it was created as a general-purpose answer for use by anyone. Any user who decides to use a vacuum cleaner should not be needed to possess any technical expertise. Future modifications can be made to the device.

III. PRIMITIVES/GLOSSARY

A. *Obstacle Identification*

When it discovers obstacles, the robot makes an effort to loosely categorise them. Thanks to the categorization of barriers, the robot can create a representation that is more helpful than one that only contains the information "empty" or "occupied" on the map. [9] The identification also allows the robot to use these obstacles at natural locations. For seemingly immovable obstacles like walls as opposed to mobile obstructions like chairs, for example, the trust in such a landmark is greater. [2]

The robot can then determine its position by using the obstacles it ran into while investigating the previously unexplored area. Obstructions because the legs are completely round and less than 15 centimetres in circumference. Whether the impediment is a chair, a table, or any other object has no bearing on the automaton.

B. Using Hypotheses

Knowing an obstruction's identity enables the computer to make several assertions that significantly help in creating a cohesive plan. [15] The theories are tested as they are put to use to avoid problems brought on by incorrect recognition. When the robot identifies an obstacle as such, it can presume that the wall is straight. The robot can track the wall with great accuracy and consistency and determine its length using odometry. [12]

Once you are conscious that the obstacle is a wall and know how long it is, drawing a straight line into the bitmap depiction is easy. The odometry can be adjusted even at the very conclusion.

C. Map Creation

The only method to guarantee complete cleaning is to use a plan that the robot can use to designate cleaned areas. The creation of maps is a well-researched subject in mobile robotics. The primary difficulty in creating a plan is keeping it coherent. The position is less crucial than the requirement that it contain all obstacles. [11] More important are the barriers' proper relative locations.

The quickest method to create a coherent plan is to contour the area first, then look at its contents. Any extra obstacles discovered inside the area can be navigated using the contour map. The robot will always be able to find itself when provided a border map, even if it gets completely disoriented. Consequently, the main problem of a mobile robot getting misplaced will be addressed.

D. Bitmap Representation

Unquestionably, the easiest method for remembering cleaned areas is a bitmap strategy. utilised in unknown settings. Bitmaps are also more likely to yield outcomes right away. A bitmap depiction also allows us to remember the form of the unknown obstacle by integrating the local picture created by contouring it with the arm into the overall map. [20]

This method is much faster and simpler than learning a challenging barrier with a polynomial representation. [16] The bitmap method also enables some fascinating navigational algorithms, especially for clearing the exposed surface.

IV. METHODOLOGY

Determine the requirements: Define the specifications for the vacuum cleaner, such as the size of the area to be cleaned, the type of flooring, and the level of dust and debris. Determine the range and accuracy required for the ultrasonic sensors. In addition to the materials listed above, you'll need a Bluetooth module, cliff sensor, and a microcontroller compatible with both the ultrasonic and cliff sensor.

Design the hardware: Select the appropriate ultrasonic sensors and microcontroller. Connect the sensors to the microcontroller and design the circuitry required to operate them.

Gather Materials: You'll need an Arduino microcontroller, ultrasonic sensors, a motor, a battery, a dustbin, and other necessary materials.

Assemble the Vacuum Cleaner: First, assemble the basic structure of the vacuum cleaner using a plastic container or other suitable material. Then attach the motor and the dustbin to the structure. Make sure to connect the motor to the power source.

Integrate Bluetooth Control: Add a Bluetooth module to the microcontroller, and program the microcontroller to accept commands via Bluetooth. For example, you could program the vacuum cleaner to start or stop when a certain button is pressed on a smartphone app.

Write the software code: Write the code required to control the vacuum cleaner. This will involve programming the microcontroller to read data from the ultrasonic sensors and control the motor and other components of the vacuum cleaner.

Test the prototype: Build a prototype of the vacuum cleaner and test it in a controlled environment. Verify that the ultrasonic sensors accurately detect obstacles and adjust the vacuum cleaner's movement accordingly.

Iterate and refine: Analyse the test results and make any necessary adjustments to the design. Refine the software and hardware until the vacuum cleaner performs as desired.

Manufacture the final product: Once the prototype has been optimised, manufacture the final product. Conduct quality control checks to ensure that each unit meets the required specifications.

Finalise and Use: Once you're satisfied with the performance of the vacuum cleaner, finalise the design and use it to clean your home or office.

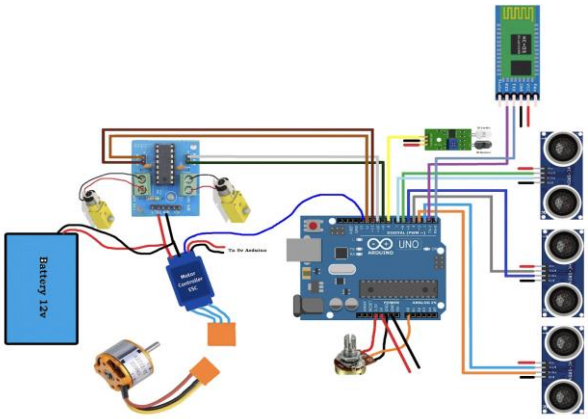

Fig 1: Circuit Diagram

V. IMPLEMENTATION

The Arduino module is connected to all of the sensors. The motor driver is instructed by the Arduino module to rotate the wheels in accordance with the parameters set by the sensors. The Arduino, which serves as the system's brain, is also directly connected to the Bluetooth module.

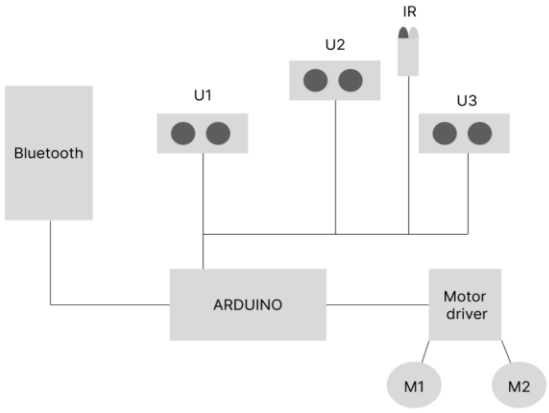

Fig 2: Implementation of Components

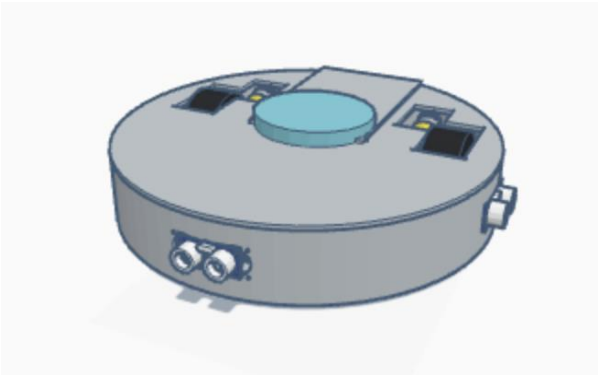

Fig 3: Proposed Model Diagram

Fig 4: Final Prototype

VI. CONCLUSION

The Vacuum Cleaner is a tiny, lightweight gadget that is easy to use, carry and it does not require any technical knowledge to operate it. The vacuum functionality performs admirably and the battery efficiency is satisfactory.

The cliff sensing, vacuum suction and item detection mechanisms all work flawlessly. Battery life is respectable. Both the manual and smart modes' features function well.

VII. FUTURE SCOPE

The battery life of this project will be extended in the future. LIDAR sensors will replace the ultrasonic sensors now employed for object detection. The vacuum will be made to learn a certain route. The positioning of the charging ports will also be improved for ease.

Additionally, a device to locate the vacuum cleaner will be added. The strength of the vacuum suction will be greatly increased. The user will receive a warning when a low battery is detected.

REFERENCES

[1] Vijayalakshmi, M. & Baljoshi, Bhargavi & Lavanya, G. & Master, Gouri & Sushil, Gurav. (2020). Smart Vacuum Robot. 10.1201/9781003052098-10.

[2] Ulrich, Iwan & Mondada, Francesco & Nicoud, J.d. (1997). Autonomous Vacuum Cleaner. Robotics and Autonomous Systems. 19. 10.1016/S0921-8890(96)00053-X.

[3] Manasa M, Vidyashree T S, Bindushree V, Sanjana Rao, Gowra P S, Smart vacuum cleaner, Global Transitions Proceedings, Volume 2, Issue 2, ISSN 2666-285X, 2021,

[4] Sutendra Subash Mahale, Aparna Rane, Vaishnavi Malvanker. IOT Based Vacuum Cleaner Robot International Journal of Computer Trends and Technology, 67(8),18-19.

[5] T.B. Asafa, T.M. Afonja, E.A. Olaniyan, H.O. Alade. Development of a vacuum cleaner robot, Alexandria Engineering Journal, Volume 57, Issue 4, 2018,

[6] H. Zhou, L. Deng, W. Xu, W. Yu, J. Dehlinger and S. Chakraborty, "Towards Internet of Things (IoT) Forensics Analysis on Intelligent Robot Vacuum Systems," 2022 IEEE/ACIS 20th International Conference on Software Engineering Research, Management and Applications (SERA), 2022, pp. 91-98, doi: 10.1109/ SERA54885.2022.9806735.

[7] K. Tanaka, T. Morimoto, K. Yano, T. Arima and S. Fukui, "Suction-port Position Control for Vacuum Working Robot to Improve Working Efficiency," 2020 IEEE REGION 10 CONFERENCE (TENCON), 2020, pp. 1046-1051, doi: 10.1109/ TENCON 50793. 2020.9293703.

[8] W. H. C. Wickramaarachchi, M. A. P. Chamikara and R. A. C. H. Ratnayake, "Towards implementing efficient autonomous vacuum cleaning systems," 2017 IEEE International Conference on Industrial and Information Systems (ICIIS), 2017, pp. 1-6, doi: 10.1109/ICIINFS.2017.8300385.

[9] A. Saleem, A. Iqbal, A. Sabir and A. hussain, "Design and Implementation of an Intelligent Dust Cleaner Robot for Uneven and Nonstructural Environment," 2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), 2019, pp. 1-6, doi: 10.1109/ICOMET.2019.8673450.

[10] Y. Li, W. Luo, L. Wang and L. Sun, "Design and Control Research of Vacuuming Robot Cleaning Mechanism," 2015 International Conference on Computer Science and Mechanical Automation (CSMA), 2015, pp. 258-262, doi: 10.1109/CSMA.2015.58.

[11] J. Hess, M. Beinhofer, D. Kuhner, P. Ruchti and W. Burgard, "Poisson-driven dirt maps for efficient robot cleaning," 2013 IEEE International Conference on Robotics and Automation, 2013, pp. 2245-2250, doi: 10.1109/ICRA.2013.6630880.

[12] T. Takeshita, T. Tomizawa and A. Ohya, "A House Cleaning Robot System -Path indication and Position estimation using ceiling camera," 2006 SICE-ICASE International Joint Conference, 2006, pp. 2653-2656, doi: 10.1109/SICE.2006.315049.

[13] M. Muthiah, K. Nirmal and R. Sathiendran, "Low cost radio frequency controlled robot for environmental cleaning," 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015], 2015, pp. 1-5, doi: 10.1109/ICCPCT.2015.7159519.

[14] Xueshan Gao and K. Kikuchi, "Study on a Kind of Wall Cleaning Robot," 2004 IEEE International Conference on Robotics and Biomimetics, 2004, pp. 391-394, doi: 10.1109/ROBIO.2004.1521810.

[15] S. Jeon, M. Jang, D. Lee, Y. -J. Cho and J. Lee, "Multiple robots task allocation for cleaning a large public space," 2015 SAI Intelligent Systems Conference (IntelliSys), 2015, pp. 315-319, doi: 10.1109/IntelliSys.2015.7361161.

[16] S. Liu, L. Zheng, S. Wang, R. Li and Y. Zhao, "Cognitive abilities of indoor cleaning robots," 2016 12th World Congress on Intelligent Control and Automation (WCICA), 2016, pp. 1508-1513, doi: 10.1109/WCICA.2016.7578317.

[17] Sewan Kim, "Autonomous cleaning robot: Roboking system integration and overview," IEEE International Conference on Robotics and Automation, 2004. Proceedings. ICRA '04. 2004, 2004, pp. 4437-4441 Vol.5, doi: 10.1109/ROBOT.2004.1302416.

[18] N. Alexandrescu, T. C. Apostolescu, C. Udrea, D. Duminică and L. A. Cartal, "Autonomous mobile robot with displacements in a vertical plane and applications in cleaning services," 2010 IEEE International Conference on Automation, Quality and Testing, Robotics (AQTR), 2010, pp. 1-6, doi: 10.1109/AQTR.2010.5520876.

[19] L. Guangling and P. Yonghui, "System Design and Obstacle Avoidance Algorithm Research of Vacuum Cleaning Robot," 2015 14th International Symposium on Distributed Computing and Applications for Business Engineering and Science (DCABES), 2015, pp. 171-175, doi: 10.1109/DCABES.2015.50.

[20] Sang-Hyuk Park, Young-Ho Choi, Sang-Hoon Baek, Tae-Kyung Lee and Se-Young Oh, "Feature localization using neural networks for cleaning robots with ultrasonic sensors," 2007 International Conference on Control, Automation and Systems, 2007, pp. 449-453, doi: 10.1109/ICCAS.2007.4406949.