A Futuristic Living Room Experience with Robotic Serenity

P. Venkateswara Rao[1], Tigulla Hruthika Goud[2], Bodula Sujitha[3], Kanithi Ravi, Kishore[4]

[1]Assistant Professor, Department of Information Technology, Mahatma Gandhi Institute of Technology
[2,3,4]Student, Department of Information Technology, Mahatma Gandhi Institute of Technology

Abstract
Automation, environmental consciousness, and robots are dancing on our houses more and more. Imagine your living room filled with friendly robots, air-purifying trees that swing to the beat of the sun, and vacuum cleaners that scutter over the floor. The intelligent design of household robots, environmentally conscious marvels like smart trees, and even the robotic makeover of the common vacuum cleaner are shaping this future—it's no longer science fiction. Developing technology that works with us, not against us, is the key. Adopting this human-centered strategy will enable us to build dwellings that are full of life, where technology speaks softly rather than loudly, and where convenience and sustainability go hand in hand. The future house is a symphony just waiting to be created, so let's welcome the robots, make friends with the cleansing trees, and enjoy the dance of the vacuums.

Keywords: Household Robot, Vacuum, Air-purification.

1. Introduction

Technological breakthroughs have been accelerated in recent years by the integration of robots across several industries, solving a range of difficulties from regular jobs to complicated operations in hazardous locations. In-depth discussions of robots' many uses in cleaning, agriculture, disaster relief, and reducing roadside pollution are included in this paper. One important aspect of this research is how important coverage path planning (CPP) algorithms are for maximizing robot operational effectiveness. The paper traverses the changing terrain of coverage route planning research in response to the necessity to improve the performance of these robotic systems. Robots navigate a predetermined operating environment by following carefully planned routes that avoid both stationary and moving obstacles, thanks to the strategic method known as CPP. This report tackles the shortcomings of current robot path planning algorithms. It proposes a new one called SmSTC, which leverages the structure of a spanning tree to find the best routes, dodge obstacles, and avoid unnecessary retracing, ultimately maximizing coverage in any environment. Simulations show Smooth-STC shines in unpredictable and intricate situations. It spotlights the importance of cleaning, both in everyday situations and those posing a danger to humans. Recognizing the limitations of human cleaners, it explores the development of autonomous floor-cleaning robots. It emphasizes the crucial role of ultrasonic sensors, acting as the robot's "eyes" to navigate and avoid obstacles, ensuring efficient cleaning. One of the report's main concerns is the ubiquitous problem of roadside pollution in metropolitan settings. Considering the detrimental effects that particulate matter has on both the environment and human health, the idea of artificial trees strikes us as a creative remedy. These trees provide a sustainable way to combat air pollution since they have solar power production, air purification systems, and energy storage capabilities. This is especially useful in areas where planting regular trees may not be feasible. Finally, the paper turns its attention to the rapidly expanding field of home service robots. Using data from a consumer robotic product, the Roomba Discovery Vacuum, the research emphasizes how important it is to comprehend human-robot interaction in the context of the particular dynamics of the house. The goal of the paper is to make engineers and designers more aware of the various material and social issues involved in implementing robotic technology in homes as these technologies become more and more integrated into daily life. The study will discuss CPP problems in unfamiliar situations, examine environments that support CPP, and provide a detailed presentation of the suggested SmSTC method in the parts that follow. The adventure comes to an end with a discussion of the experimental findings, possible directions moving forward, and closing thoughts.

2. Literature Review

1. Smooth-STC Algorithm for enhanced coverage path planning in Robots: The Smooth-STC algorithm struts its stuff in both simulated and real-world tests, proving itself the king of coverage. In simulated battles against other contenders, it reigns supreme, achieving near-perfect coverage, especially for robots with a larger build. But its prowess doesn't stop there – it's a master of adapting to different environments, like a chameleon in a costume shop, maintaining over 95% coverage even when the terrain gets tricky. Real-world tests in a forest, its natural habitat, further solidify its dominance, with coverage reaching a staggering 98-100%. Smart sensors act as its loyal companions, enhancing its performance in this green arena. But even champions have their kryptonite. Optimizing turning angles and navigating the ever-changing forest environment are like unsolved mysteries for SmSTC. To make it even more unstoppable, future research will focus on updating its knowledge base, like adding new moves to its arsenal, and using real-world data as fuel to power up its performance and reasoning abilities in the robotic world.

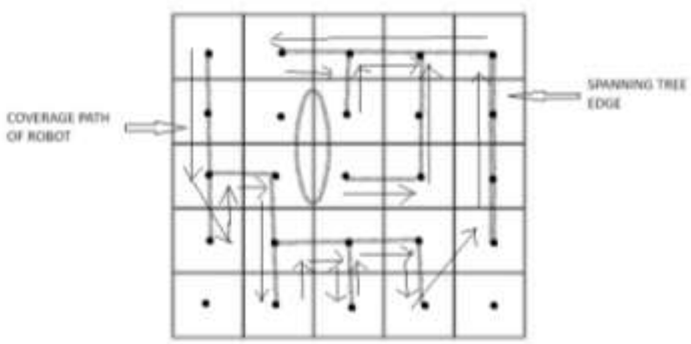

Fig.1 Smooth SMT Algorithm

2. Service Robots performing Vacuum in domestic environment: This dive headfirst into the fascinating world of home ecology, specifically exploring how individuals, routines, and products interact within this dynamic ecosystem. The spotlight shines brightly on cleaning and cleanliness, examining the intricate dance between humans and technology, particularly the humble Roomba.

- Home as an Ecology: The study embraces a holistic view, considering the home as a web of interconnected elements: physical space, social norms, individual roles, cleaning goals, utilized products, and performed activities. This multi-faceted approach reflects the study's ambition to understand the broader implications of robots like Roomba in our domestic landscapes.

- Domestic Service Robots: Existing research on these robotic companions is dissected, emphasizing the crucial need to understand their seamless integration into daily routines and the unique nuances of human-robot interaction.
- Sociocultural and Psychological Dimensions: The review delves into the broader tapestry of technology adoption within homes, exploring the sociocultural and psychological factors that influence acceptance and usage. This lays the groundwork for investigating how Roomba reshapes housekeeping habits and practices.
- Ecological Perspectives: Relevant literature on ecological approaches in domestic settings is unearthed, illuminating the interconnectedness of various elements within the home ecology. This provides valuable insights into the intricate interplay between humans, technology, and the environment.
- The review champions the merits of ethnographic research in capturing the subtle nuances of daily life and the organic integration of technology. This approach sheds light on aspects often missed by traditional methods, allowing for a deeper understanding of the social and ecological dimensions of domestic robots.
- Gaps and Contributions: The review identifies gaps in existing literature that the current study aims to address. By focusing on the social and ecological dimensions of domestic robots, this study seeks to enrich our understanding of their impact on household dynamics and contribute to a more comprehensive picture of human-robot cohabitation.

3. Purification of Particulate Matters: This delves deep into the critical realm of air quality, exploring the dangers of particulate matter (PM), innovative solutions for pollution reduction, and the potential of smart technology to monitor and mitigate the issue.

Pollution's Peril: The literature sets the stage by highlighting the detrimental effects of PM and black smoke on public health, particularly for elderly populations in European cities (Lai et al., Yu et al.). This underscores the urgent need for effective control measures, with photocatalytic oxidation emerging as a promising approach (Yu et al.).

Purification Powerhouses: HEPA filters are lauded for their exceptional ability to remove pollutants (Ao et al.). Additionally, Ao et al. highlight the enhanced adsorption potential of Activated Carbon Filters when combined with TiO_2, making them even more effective at tackling indoor air contaminants. For vehicle environments, Kim et al. propose a modified Electrostatic Precipitator (ESP) with improved efficiency in capturing PM. Subrahmanyam et al. further broaden the scope by exploring alternative techniques like passing polluted air through water for purification.

Smart Sensing and Monitoring: The literature recognizes the importance of accurate and accessible monitoring of PM and pollutants in smart city settings. Low-cost, reliable sensors are identified as key players in this endeavor. Lanjewar et al. propose remote air quality monitoring using data mining analysis, emphasizing the power of advanced analytics in providing actionable insights.

Harnessing the Sun's Power: Diantari et al. shift the focus to solar energy production, exploring optimal solar panel positioning and associated costs. Tiberiu et al. introduce intelligent solar panel tracking using light sensors, maximizing efficiency and harnessing the sun's potential to the fullest.

The Four-Stage Filtration Champion:

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The proposed air purification system in the literature takes center stage with its four-stage filtration process:

1. Pre-filters: These capture large particles, ensuring the system runs smoothly.
2. UVC lamps: Ultraviolet light from these lamps disinfects the air, eliminating harmful microorganisms.
3. Electrostatic Precipitators: These magnets for PM effectively remove tiny pollutant particles from the air.
4. Carbon filters: These final guardians tackle volatile organic compounds (VOCs), leaving the air fresh and clean.

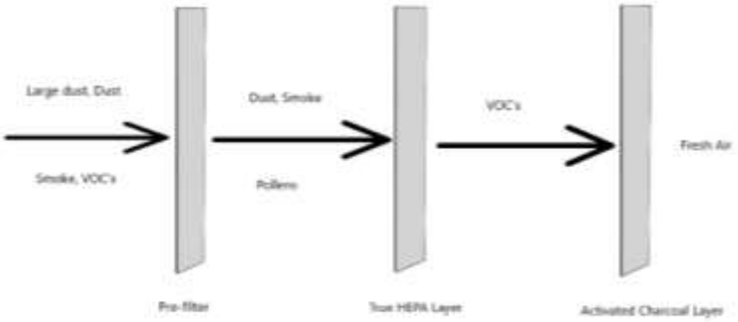

Fig 2. HEPA architecture

This multi-pronged approach ensures clean outflow air, reducing PM2.5, PM10, smoke, and VOC levels significantly.

Solar Power (Fuelling the System): Solar power generation and tracking are crucial components of the proposed system. The UAE's favourable climate for solar energy production is leveraged, with dual-axis solar tracking maximizing energy generation. Charge controllers and inverters play their part by stabilizing battery charging and converting DC to AC, ensuring continuous system operation.

Mathematical muscle: The literature delves into the calculations behind the chosen 2*285 Wpeak solar panels, demonstrating their ability to produce 1184.6367 KWhr annually.

Sustainability Champion: The environmental impact of this solar setup is meticulously assessed, showcasing its positive contribution to sustainability through a carbon emission trade-off calculation.

Intelligent Monitoring: A particulate matter and power monitoring system is integrated, measuring PM2.5, PM10, power, and energy consumption. This valuable data is transmitted through a Raspberry Pi processor, enabling real-time remote monitoring via a 4G network.

Real-World Results:

The results and analysis section puts the proposed system to the test in scenarios like bus stations and smokers' rooms. The artificial tree effectively reduces particulate matter, demonstrating its potential for deployment in diverse environments.

This paints a clear picture of the air quality challenge, highlighting the importance of air purification, solar power generation, and intelligent monitoring systems. The proposed artificial tree emerges as a promising solution, offering a sustainable approach to reducing harmful PM and aligning with clean energy, climate action, and sustainability goals. By combining advanced filtration technology with the power of the sun and smart monitoring, this innovative system has the potential to make a significant impact on air quality in various settings. As research and development continue, we can expect even more effective solutions to emerge, paving the way for a cleaner and healthier future for all.

4. Solar Floor Cleaner Components: These are the essential building blocks that power the proposed system. Each component plays a vital role in its smooth operation, making it a true team effort in the fight for efficiency.

OLED Display: A Feast for the Eyes

The OLED display takes center stage, boasting high contrast and crystal-clear readability thanks to its cutting-edge OLED technology. With a resolution of 128x64, it provides ample space for information display. Each pixel is meticulously controlled by the SSD1306BZ controller, ensuring a smooth and vibrant visual experience.

L298N Motor Driver Module: The L298N motor driver module flexes its muscles, handling high-voltage and high-current applications with ease. Its dual full-bridge drivers are perfect for controlling inductive loads, like the trusty motors that power the system.

60 RPM 12V DC Gear Motors: These 60 RPM 12V DC gear motors are the workhorses of the system. Delivering a perfect blend of precision and power, they tackle diverse tasks with confidence. Their versatility makes them an invaluable asset.

12V-1.3Ah AGM Battery: The 12V-1.3Ah AGM battery, fueled by AGM technology, keeps the system humming along. Its maintenance-free design makes it ideal for applications like alarm systems and backup power, ensuring uninterrupted operation.

Solar Panels: Sustainability takes center stage with the inclusion of solar panels. These energy-harvesting heroes convert sunlight into electricity, powering the system and contributing to a greener future.

Software Tools: The Arduino IDE and Proteus Design Suite play crucial roles in the system's development and simulation. The Arduino IDE provides the platform for programming the microcontroller, while the Proteus Design Suite allows for virtual testing and refinement of the PCB design.

3. Conclusion

To summarize, the SmSTC method is a significant advancement in coverage route planning, demonstrating exceptional pathfinding performance, little backtracking, and maximum coverage in real-world operating settings. Its usefulness is demonstrated by experimental findings, especially while crossing dangerous locations with obstructions. By integrating the algorithm into an autonomous floor cleaning robot, it is possible to improve operating efficiency, save personnel costs, provide automated path modification and hurdle detection, and guarantee comprehensive cleaning. The suggested method nearly completely covers the area, recognizing the necessity for frequent cleaning around obstructions. The paper expands on this by introducing fake trees as a sustainable way to reduce particulate matter pollution in places like bus terminals. These trees support climate action and promote health in line with clean energy and environmental aims. Furthermore, the research on household service robots offers insightful information on how they might be incorporated into family environments. Future studies on the ecological adaptation of robotic devices in households might build on the insights provided by the ecological method, which reveals social dynamics and adaptation processes. All in all, this thorough investigation is a step toward a future in which cutting-edge algorithms, self-driving cars, and environmentally friendly solutions are smoothly incorporated into day-to-day living, providing effective solutions that both promote sustainability and adjust to changing home circumstances.

4. References

1. Atkar, P.N.; Greenfield, A.; Conner, D.C.; Choset, H.; Rizzi, A.A. Hierarchical segmentation of surface

embedded in R3 for auto-body painting. In Proceedings of the 2005 IEEE International Conference on Robotics and Automation, Barcelona, Spain, 18–22 April 2005; pp. 572–577. [CrossRef]
2. Najjaran, H.; Kircanski, N. Path planning for a terrain scanner robot. In Proceedings of the International Symposium on Robotics. International Foundation for Robotics Research, Snowbird, UT, USA, 9–12 October 2000; Volume 31, pp. 132–137.
3. Galceran, E.; Carreras, M. A survey on coverage path planning for robotics. Robot. Auton. Syst. 2013, 61, 1258–1276. [CrossRef]
4. Abukhalil, T.M.; Patil, S.P.; Sobh, T. Coordinating a heterogeneous robot swarm using Robot Utility-based Task Assignment (RUTA). In Proceedings of the 2016 IEEE 14th International Workshop on Advanced Motion Control (AMC), Auckland, New Zealand, 22–24 April 2016; pp. 57–62.
5. Horváth, E.; Pozna, C.; Precup, R.E. Robot coverage path planning based on iterative structured orientation. Acta Polytech. Hung. 2018, 15, 231–249. [CrossRef]
6. C. Alex and A. Moscaritolo, “The Best Robot Vacuums for 2020,”PCMag, 2020. [Online]. Available: https://www.pcmag.com/picks/the-best-robot-vacuuiiLS?test uuid—0 I j rZgWN XhmA1 ocC i7Zl IXevj&test variant-b.
7. A. K. Bordoloi, F. Islam, J. Zaman, N. Phukan, and N. M. Kakoty,“A floor cleaning robot for domestic environments,” in ACM International Conference Proceeding Series, 2017, vol. Part F132085, pp. 1-5.
8. H. Rashid, A. Mahmood, S. Shekha, S. M. T. Reza, and M.Rasheduzzaman, “Design and development of a DTMF controlled room cleaner robot with two path-following method,” in 201619th International Conference on Computer and Information Technology (ICCIT), 2016, pp. 484—489.
9. Arduino.cc, “Arduino UNO Rev3.” [Online]. Available: https://store.arduino.cc/arduino-uno-rev3.
10. J. Forlizzi and C. DiSalvo, “Service robots in the domestic environment: a study of the roomba vacuum in the home,” in Proceeding o f the 1st ACM SIGCH1/SIGART conference on Human-robot interaction - HRI •06,2006, pp. 258-265.
11. WHO (2009) Global health risks: Mortality and burden of diseases attributable to selected major risks. Geneva, World Health Organization. Available online http://www.who.int/healthinfo/global_burden_disease/ GlobalHealthRisks_report_full.pdf.
12. EPA, “Particular matter,” http://www.epa.gov/pm/. View at: Google Scholar Lai, HK, Bayer-Oglesby, L, Colvile, R, Götschi, T, Jantunen, MJ, Künzli, N, Kulinskaya, E, Schweizer, C, Nieuwenhuijsen, MJ. “Determinants of indoor air concentrations of PM2.5, black smoke and NO2 in six European cities”, Atmos Environ 2006; 40: 1299–1313.
13. Yu, J.C., Yu, J.G., Zhao, J.C., 2002. Enhanced photocatalytic activity of mesoporous and ordinary TiO2 thin films by sulfuric acid treatment., Journal of Applied Catalysis B: Environmental, volume 36, Issue 1,2002, pp. 31-43.
14. C.H.Ao, S.C.Lee, “Indoor air purification by photocatalyst TiO2 immobilized on an activated carbon filter installed in an air cleaner”, Journal of Chemical Engineering Science 60(2005), 103-109.
15. Aaker, D.A., and Myers, J.G. (1987). Advertising Management. New York: Prentice Hall.
16. Bell, G., Blythe, M., Sengers, P. (2005). “Making by making strange: Defamiliarization and the design of domestic technologies.” ACM Transactions on Human-Computer Interaction. New York: ACM Press, 149-173.
17. Bell, G., Blythe, M., Sengers, P. , Wright, P. (2003). “Designing culturally situated technologies for the home.” CHI 2003 Extended Conference Abstracts. New York: ACM Press, 1062-1063.

18. Brush, A., Palen, L., Swann, L., Taylor, A. (2005). Special Interest Groups (SIGs): Design for Home Life." CHI 2005 Extended Conference Abstracts. New York: ACM Press, 2035-2036.
19. Cowan, R.S. (1983). More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave. New York: Basic Books.