Integrating Big Data and Machine Learning to Improve the Decision-Making Processes of Autonomous Robotic Cleaners

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Abstract

The advent of autonomous robotic cleaners has significantly enhanced operational efficiency in various cleaning domains, from household environments to industrial settings. However, their decision-making processes often lack the adaptability and intelligence required for dynamic and complex environments. This paper explores the integration of big data analytics and machine learning (ML) techniques to improve the decision-making capabilities of autonomous robotic cleaners. By analyzing vast datasets collected from sensors and external sources, and applying machine learning algorithms, these robots can learn from their environment, predict potential obstacles, and optimize cleaning routes in real-time. The study demonstrates how such integration can lead to more efficient, effective, and intelligent cleaning solutions, significantly reducing human intervention while adapting to changing environmental conditions. Through experimental setups and simulations, we validate the proposed approach, showcasing notable improvements in decision-making accuracy, cleaning efficiency, and adaptability to unforeseen situations.

Background

Autonomous robotic cleaners have become increasingly prevalent, offering promising solutions to automate tedious and repetitive cleaning tasks. Despite their advancements, the decision-making processes in these robots often rely on pre-defined algorithms that struggle with unpredictability and complexity. The integration of big data and machine learning offers a groundbreaking approach to enhancing these processes. Big data analytics allows for the processing of extensive sensor data and environmental information, while machine learning algorithms enable robots to learn from past experiences, improving their performance over time.

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Main Findings

1. **Data Collection and Analysis**: Autonomous cleaners equipped with sensors generate a vast amount of data, including spatial information, obstacle encounters, and efficiency metrics. By integrating big data analytics, this information is processed and analyzed to identify patterns and insights, which inform the decision-making process.
2. **Machine Learning Models for Decision Making**: We implemented various machine learning models, including decision trees, neural networks, and reinforcement learning algorithms, to enable autonomous cleaners to make informed decisions. These models allow robots to predict obstacles, optimize cleaning paths, and adapt strategies based on environmental changes.
3. **Enhanced Cleaning Efficiency**: The integration of ML algorithms led to a significant improvement in cleaning efficiency. Robots were able to reduce cleaning time by optimizing their paths and automatically adjusting to different surface types, leading to a more thorough cleaning process.
4. **Adaptability and Learning from the Environment**: Through continuous learning, autonomous cleaners demonstrated improved adaptability to new or changing environments. The robots learned from each cleaning session, enhancing their ability to navigate and clean effectively over time.
5. **Reduced Human Intervention**: The improved decision-making capabilities of the robots minimized the need for human intervention, allowing for fully autonomous operation even in complex and dynamic environments.

Conclusion

The integration of big data and machine learning into the decision-making processes of autonomous robotic cleaners represents a significant advancement in the field. This approach not only enhances the efficiency and effectiveness of cleaning tasks but also increases the autonomy and adaptability of robotic cleaners to diverse environments. The findings of this study highlight the potential of combining these technologies to revolutionize the capabilities of autonomous cleaning systems,

paving the way for more intelligent and self-sufficient robots. Future research will focus on exploring more advanced machine learning models and expanding the application of these technologies to other domains within autonomous systems [1]

References

[1] S. Khanna and S. Srivastava, “The Emergence of AI based Autonomous UV Disinfection Robots in Pandemic Response and Hygiene Maintenance,” *International Journal of Applied Health Care Analytics*, vol. 7, no. 11, pp. 1–19, Nov. 2022.