Advancing mobile robot navigation with DRL and heuristic rewards: A comprehensive review

Neurocomputing • Short Survey • 2025 • DOI: 10.1016/j.neucom.2025.131036

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Abstract

Robotic navigation is a critical component of autonomy, requiring efficient and safe mobility across diverse environments. The advent of Deep Reinforcement Learning (DRL) has spurred significant research into enabling mobile robots to learn effective navigation by optimizing actions based on environmental rewards. DRL has shown promise in addressing challenges such as dynamic environments and cooperative exploration. However, traditional DRL-based navigation faces several limitations, including the need for extensive training data, susceptibility to local traps in complex environments, low transferability to real-world scenarios, slow convergence, and low learning efficiency. Additionally, designing an appropriate reward function to achieve desired behaviors without unintended consequences remains complex; poorly designed rewards can lead to suboptimal or harmful outcomes. Recent studies have explored integrating heuristic search-based rewards into DRL algorithms to mitigate these issues. This study reviews the limitations of traditional DRL navigation and explores recent advancements in integrating heuristic search to design dynamic reward functions that enhance robot learning processes. © 2025 Elsevier B.V.

Abstract
Author keywords
Indexed keywords
Funding details
Corresponding auth

Author keywords

Detailed information

Bibliographic information

Document type	Short Survey
DOI	10.1016/j.neucom.2025.131036
EID	2-s2.0-105011520139
Original language	English
Publication date	1 November 2025
PubMed ID	
Source type	Journal
ISSN	09252312
Publisher	Elsevier B.V.
Publication year	2025
Source title	Neurocomputing
Volume	652
Article number	131036
CODEN	NRCGE

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