

Efficient Integration of Deep Reinforcement Learning in Robotic Systems through Simplified Real-Time Command Processing

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Abstract:

Deep Reinforcement Learning (DRL) has been proved to solve the complex decision-making problem even in the dynamic environment for robotic and automation systems. However, the computational complexity of DRL models makes direct integration into hardware systems like Unmanned Aerial Vehicles (UAVs), Unmanned Ground Vehicles (UGVs) and intelligent manufacturing systems a significant challenge. Traditional approaches require high-performance computing resources, which is impractical for real-time, low-latency applications on resource-constrained robotic platforms.

This paper addresses this challenge by proposing a novel framework for simplifying the implementation of DRL in robotic systems. The proposed approach offloads the computationally intensive training process to high-performance desktops or cloud-based systems. During real-time operation, sensory data from the robot is transmitted to the computing end via high-speed internet, where DRL models process the data to generate control commands. To ensure real-time reaction, these commands are evaluated and simplified by a lightweight evaluation system to complete the feature extraction via either well trained Neural Networks (NN) or k-Nearest Neighbors (KNN). The final command sent to the robotic hardware is optimized for minimal complexity, facilitating seamless and efficient execution.

This method significantly reduces the computational burden on robotic systems, enabling the integration of sophisticated DRL capabilities without compromising latency or performance. This work provides a pathway for deploying intelligent robotic systems in real-world applications.