exponentially when more agents come into the same environment (more realistic for construction tasks). Using a decentralized learning algorithm is feasible to train multi-agents in those cases. The only problem is efficiency, as it takes a long training time. Still, the results are robust because this method provides a suitable evolving environment without too many changes to deal with, unlike centralized training. Therefore, it can be said that for the case study investigated, the decentralized learning approach could be better suited for complex construction task simulations.

Ongoing work by the authors includes the investigation of other RL algorithms for single task manipulation and execution, such as bricklaying, painting, door installation, etc., to prove the eligibility of such a combination of construction robot applications with RL. Our future goals include: 1) Adopting and developing current DRL and MARL algorithms for construction robot applications. 2) Adopting the multi-robot framework to solve complex tasks (e.g., laying bricks to build up a user-defined structure) through the cooperation of individual agents. 3) Assign different characters that allow different robots to work in different roles, such as manipulator, inspector, material delivery, etc. 4) Conducting the simulation in game engines such as Gazebo, Unreal, or Unity, and setting up communication among different platforms by using BIM models, this set up a great foundation for future verification in a real environment. 5) Benchmarking for efficiency of other algorithms to see which one is the best fit for the construction robot applications.

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