

Designing Automation for Pickup and Delivery Tasks in Modern Warehouses Using Multi Agent Path Finding (MAPF) and Multi Agent Reinforcement Learning (MARL) Based Approaches

Shambhavi Mishra^{1,*}, Rajendra Kumar Dwivedi²

¹Madan Mohan Malaviya University of Technology, Gorakhpur, India

²Madan Mohan Malaviya University of Technology, Gorakhpur, India

Abstract

A warehouse pickup and delivery problem finds its solution using multi agent path finding (MAPF) approach. Also, the problem has been used to showcase the capabilities of the multi agent reinforcement learning (MARL). The warehouse pickup and delivery work needs the agent to pick up a requested item and successfully deliver it to the intended location within the warehouse. The problem has been solved based on two approaches that include single shot and lifelong problem solution. The single shot solution has the delivery as the final goal and thus once it reaches the delivery address, it stops whereas in case of lifelong, the agent needs to deliver the item which it had picked, deliver it to the required place and then again pick up new item until requests are satisfied. The strategy used by multi agent path finding (MAPF) approach aims at constructing collision free paths to reach the delivery location but in case of multi agent reinforcement learning (MARL), the agents' decision-making tactics (or policies) are learned which are then used to help agents decide path to be followed based on environment state and agent's position. The results show that the lifelong conflict-based search (CBS) is a better option when the agents are less in number as in that case, the re-planning will take overall less time but when the agents are large in number then this re-planning can take very long to produce conflict free paths from source to goal nodes. In this case, shared experience action critic (SEAC) which is based on multi agent reinforcement learning (MARL) approach can be more efficient choice as it takes the current environment state to give the most suitable action for that time t. For this study the agents taken for learning are homogeneous in nature that can pickup and deliver any type of requested item. We can address the same pickup and delivery problem when the agents are not all same and differ in their capabilities and the type of item they can handle.

Keywords: Multi agent pickup and delivery problem, multi agent reinforcement learning (MARL), multi agent path finding (MAPF)

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*Corresponding author. Email: mishra.shambhavi33@gmail.com

1. Introduction

The applications of multi agent path finding range from automating warehouse material movement to allocating schedule for airport operations. The warehouse movement is restricted by the large storage spaces that are usually located at the centre of the warehouse and are visited frequently for picking up the required item as demanded by stations that further process these items. Due to this

occupancy the space which is used for travelling becomes narrow and can only allow single bot to pass at a time. To this end in a multiple agent system, it is required to guide these bots so that their movement is collision free and there is very less chance of item being damaged as a result of collision. In their way to the target node, the agents need to avoid obstacles and other agents and form a path through the warehouse to the intended position.

