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Multi-Agent Path Finding with Human Presence

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Field of study: Cybernetics and Robotics
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Declaration

I declare that this work is all my own work and I have cited all sources I have used in the bibliography.

Prague, November , 2025

Prohlašuji, že jsem předloženou práci vypracovala samostatně, a že jsem uvedla veškerou použitou literaturu.

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Abstract

In process to the end of semester
2025/2026 ...

Keywords: Multi-Agent Path Finding

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Abstrakt

V procesu do konce semestru 2025/2026
...

Klíčová slova: Multiagentní plánování
cest

Překlad názvu: Multiagentní plánování
cest za přítomnosti člověka

Contents

1 Introduction	1
1.1 Contributions	2
2 Related Works	3
3 Problem Formulation	5
4 Theoretical Part	7
5 My Solver	9
6 Experiments	11
7 Conclusion	13
Bibliography	15

Figures

- 1.1 A visualization of a modern
warehouse with fleet of autonomous
robots. 1

Tables



Chapter 1

Introduction

Multi-Agent Path Finding (MAPF) is a fundamental problem in robotics that focuses on computing paths for a group of agents moving from their origins to goal destinations without collisions. However, simply planning a path for each agent individually is often insufficient because they might block each other's way. As the number of agents grows, coordinating their movements becomes increasingly difficult. Consequently, efficient software is essential for running autonomous robot fleets in places like factories, airports, or computer games.

While current studies offer a wide array of solutions focusing on efficiency, optimality, and robustness of robot-to-robot coordination, less attention has been paid to the interaction between autonomous fleets and human workers sharing the same workspace. Based on the review of existing studies, most algorithms represent dynamic obstacles primarily as other predictable agents or static barriers. However, human unpredictability presents a significant challenge and a mandatory safety boundary that current solvers are simply not designed to guarantee.

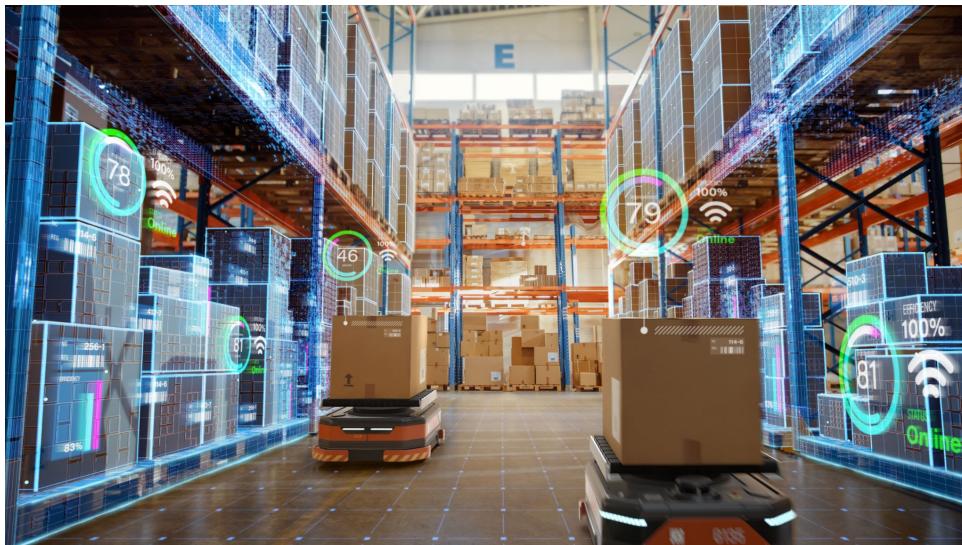


Figure 1.1: A visualization of a modern warehouse with fleet of autonomous robots.

This thesis focuses on the problem of integrating human maintenance workers or service technicians into a warehouse full of autonomous robots managed by optimal MAPF solvers. The primary goal is to extend current planners to strictly guarantee that the human worker always has a clear trajectory to the safety zone. While it is understood that this mechanism reduces optimality, guaranteeing human survival is the highest priority. The work considers both the optimality of different solutions and the practical implementations.

1.1 Contributions

The main contributions of this thesis are as follows:

- **Design of an Evacuation Assurance Mechanism:** The thesis introduces a mechanism designed to strictly guarantee an escape trajectory for the human worker, overriding robot optimality when necessary.
- **Implementation:** I developed a simulation scenario representing a mixed warehouse environment where autonomous agents interact with a human maintenance worker, modeling the specific challenges of dynamic obstacle avoidance.
- **Analysis of the safety efficiency of algorithm:** I performed an experimental evaluation to quantify the cost of safety. The thesis analyzes how the human escape route impacts the overall system compared to standard, non-safe MAPF solvers.



Chapter 2

Related Works



Chapter 3

Problem Formulation



Chapter 4

Theoretical Part



Chapter 5

My Solver



Chapter 6

Experiments

Chapter 7

Conclusion

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Bibliography

- [1] J. Doe. *Book on foobar*. Publisher X, 2300.