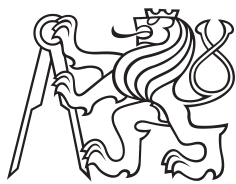


Bachelor Project



**Czech
Technical
University
in Prague**

F3

**Faculty of Electrical Engineering
Department of Cybernetics**

Multi-Agent Path Finding with Human Presence

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**Supervisor: Ing. David Zahrádka
Field of study: Cybernetics and Robotics
November 2025**

Acknowledgements

We thank the CTU in Prague for being a very good *alma mater*.

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.

V Praze, . listopadu 2025

Abstract

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

Keywords: Multi-Agent Path Finding

Supervisor: Ing. David Zahrádka

Abstrakt

V procesu do konce semestru 2025/2026 ...

Klíčová slova: Multiagentní plánování cest

Překlad názvu: Multiagentní plánování cest za přítomnosti člověka

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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 offers 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.

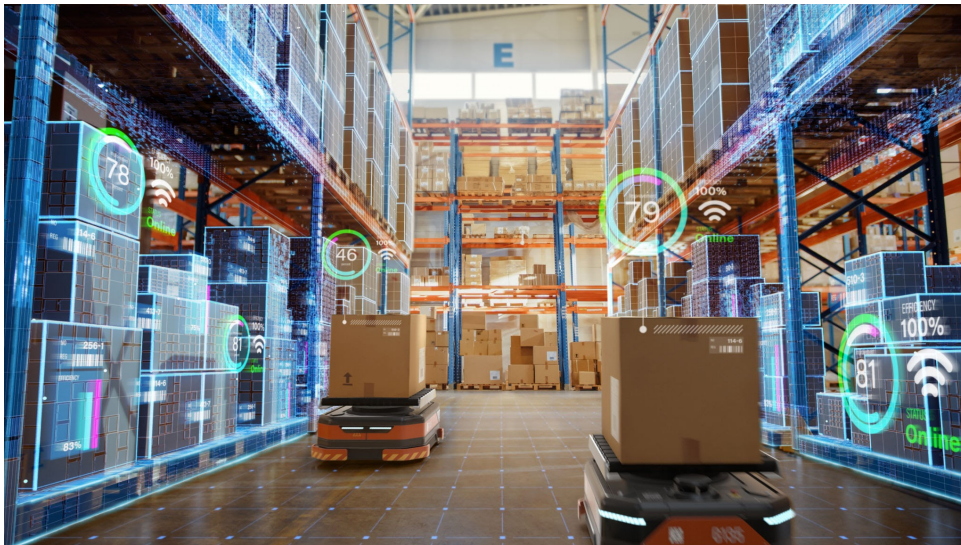


Figure 1.1: A visualization of a modern warehouse with fleet of autonomous robots.

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