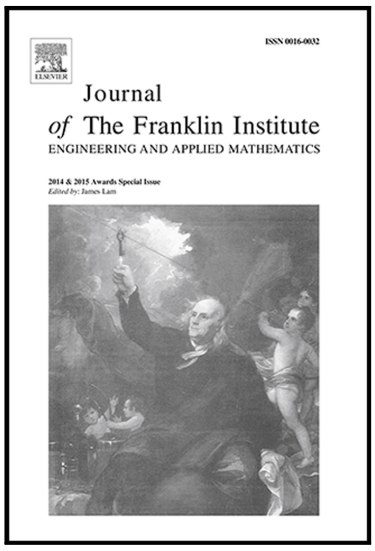


# Optimal formation control and collision avoidance in environment with multiple rectangle obstacles

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# Optimal formation control and collision avoidance in environment with multiple rectangle obstacles

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**Abstract:** This paper addresses formation control problem with collision avoidance for general linear multi-agent systems via an optimal control strategy. In the proposed optimal control strategy, a novel potential function is designed to accomplish formation of multi-agent systems (MASs) with obstacle/collision avoidance capability, which can avoid rectangle obstacles accurately. In this potential function, a novel relative velocity based self-adaptive detection region is proposed to avoid collisions with adjacent agents. Moreover, a non-quadratic avoidance performance index is constructed based on inverse optimal control approach. Then, the optimal control strategy is designed to guarantee the asymptotic stability of the closed-loop system and optimality of the proposed performance index. Finally, a simulation example is given to illustrate the efficiency of the proposed approach.
**Keywords:** MASs, optimal control, collision avoidance, obstacle avoidance, formation control

## 1. Introduction

Over the past decades, many researchers have devoted themselves to investigating cooperative control of MASs across many fields of science and engineering, which includes consensus control[1,2,32,33] , flocking control[3,4], containment control[5],and formation control[6,7,34]. As one kind of cooperative control, formation control of MASs has many applications in autonomous robots [8,9], distributed sensor network [10,11], unmanned aerial vehicles formation control area [12] and so on. In fact, formation control problems have been studied a lot in MASs in recent years, and three formation control approaches, namely, leader-follower based approach [13], behavior based approach [14] and virtual structure based approach [15], have been proposed. In this paper, we focus on solving formation problems for multi-agent systems within a cluttered environment, based on the leader–follower formation approach. Leader-following approaches use a hierarchical arrangement of individual controllers that reduces formation control to individual tracking problems.

The aforementioned works for formation control assumes that the agent is described as the point-mass model in an obstacle-free environment. However, in real world applications, a group of agents in environment with multiple obstacles is more applicable. In order to accomplish formation missions successfully in environment with multi-obstacles, main issues of formation control include how to achieve the desired formation and collision/obstacle avoidance simultaneously. A subset of literatures focuses on the formation control problem with the collision avoidance capability [16,18,19,22-31], particularly finite-time consensus with collision avoidance problems are investigated in [23]. There are two types of obstacle avoidance methods in formation control problem : potential functions [18-24,26-28] and path planning method [29-31]. Because it is easy to design and implement, the potential function method receives a lot of attention. However, research results based on potential

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