Multi-Agent Path Optimization using Calculus of Variations

Course Project
MATH 146 — Methods of Applied Mathematics

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Abstract

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1 List of Symbols

N	number of robots
M	number of circular obstacles
x_i	initial position of the i-th robot
y_i	target position of the i-th robot
p_i	path of the i-th robot
r	radius or repulsive distance of robots
c_j	center of the j-th circular obstacle
R	radius of circular obstacles
F	objective function
L	Lagrangian function
g	barrier function

2 Introduction

3 Theory

3.1 Problem Definition

Add description of problem here.

Let $p_i \in C^1([0,1])^2$ be the vector valued function corresponding to the path of the i-th robot. Then we have that $p_i(0) = x_i$ and $p_i(1) = y_i$. The length of the path is defined as

$$l_i = \int_0^1 \left\| p_i'(t) \right\| \, dt. \tag{1}$$

3.2 Objective Function

We wish to minimize the total length of all robot paths. Define F as the total path length

$$F(P) = \sum_{i=1}^{N} l_i = \int_0^1 \sum_{i=1}^{N} \left\| p_i'(t) \right\| \, dt. \tag{2}$$

We will modify the objective function in order to represent the no-collision and obstacle constraints.

A barrier function is a function that goes to infinity as it approaches a "barrier" value. In this case, we wish to devise a function that goes to infinity when approached from above to act as a repulsor.

We can use a log function

Appendices