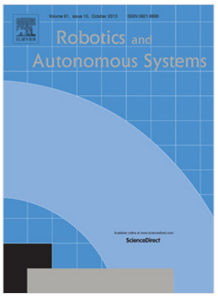
Accepted Manuscript



Distributed model predictive formation control with discretization-free path planning for transporting a load

Henrik Ebel, Ehsan Sharafian Ardakani, Peter Eberhard

PII: S0921-8890(16)30754-0
DOI: http://dx.doi.org/10.1016/j.robot.2017.07.007
Reference: ROBOT 2878

To appear in: *Robotics and Autonomous Systems*

Received date : 28 November 2016
Revised date : 16 June 2017
Accepted date : 14 July 2017

Please cite this article as: H. Ebel, E.S. Ardakani, P. Eberhard, Distributed model predictive formation control with discretization-free path planning for transporting a load, *Robotics and Autonomous Systems* (2017), http://dx.doi.org/10.1016/j.robot.2017.07.007

Distributed Model Predictive Formation Control with Discretization-Free Path Planning for Transporting a Load

Henrik Ebel[a], Ehsan Sharafian Ardakani[a], Peter Eberhard[a,*]

[a] *Institute of Engineering and Computational Mechanics*
University of Stuttgart
Pfaffenwaldring 9, 70569 Stuttgart, Germany
[henrik.ebel, ehsan.sharafian, peter.eberhard]@itm.uni-stuttgart.de

Abstract

This paper proposes a comprehensive control scheme tailored to the task of letting a formation of omnidirectional mobile robots transport a plate through an unknown environment purely by normal and friction forces between the robots and the plate. The scheme includes a graph-based path planning strategy that can deal with obstacles of arbitrary polygonal shapes without any discretization of the environment. The strategy permits a natural implementation of a memory functionality that allows the robots to navigate through maze-like environments by successively constructing an approximative map of the environment during the motion. Most characteristic for the proposed approach, the robots are controlled using distributed model predictive control which makes it possible to enforce constraints on the movements of the robots to allow for a successful transportation of the plate with only acceptable slipping between the robots and the plate. The proposed scheme is carefully and successfully tested in various simulations posing rather sophisticated challenges both to its navigation and formation control subaspects.

Keywords: Formation Control, Model Predictive Control, Distributed Control, Transportation, Path Planning, Motion in Unknown Environments

1. Introduction

In recent years, with the progress in automation, the possibility of autonomous agents or groups of agents fulfilling complex tasks in a self-reliant and self-organized way has drawn increasing interest both in scientific and industrial research. Trying to achieve certain goals or a desired overall system behavior not by employing a single, centrally controlled system but rather by making use of a group of loosely connected systems that are controlled in a distributed fashion

*Corresponding author