NOM – Prénom
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TITRE DE LA THESE

Cooperative navigation of a fleet of mobile robots

Résumé

The interest in integrating multi-robot systems (MRS) into real-world applications is increasing more and more, especially for performing complex tasks. Logistics is one of the emerging applications of MRS. Indeed, rather than having one single large machine, it is possible to turn to a fleet of small robots in order to be more flexible and robust to different kinds of missions. For load-carrying tasks, various load-handling strategies have been proposed such as: pushing-only, caging, and grasping.

In this thesis, we aim to use a simple handling strategy: placing the carrying object on top of a group of wheeled mobile robots. Thus, it requires a rigid formation control. We propose two formation algorithms. The consensus algorithm is one of them. We adapt a dynamic flocking controller to be used in the single-integrator system, and we propose an obstacle avoidance that can prevent splitting while evading the obstacles. The second formation control is based on hierarchical quadratic programming (HQP). The problem is decomposed into multiple task objectives: formation, navigation, obstacle avoidance, and velocity limits. These tasks are represented by equality and inequality constraints with different levels of priority, which are solved sequentially by the HQP. With these constraints, the formation can strictly hold on to the defined shape while moving and avoiding obstacles. Experimental tests with different configurations of shapes have been implemented on wheeled mobile robots in an actual industrial environment.

Last but not least, a study on task allocation algorithms is carried out in order to determine an appropriate solution for allocating tasks in the industrial environment. Two approaches are studied and compared, namely Tabu Search and Contract Net Protocol. The former is an optimization-based approach whereas the latter is a market-based or auction-based approach. Simulations with a various number of tasks and robots have been done to understand the strength and weakness of each approach.

Mots-clés : Multi-robot system, formation control, consensus algorithm, hierarchical quadratic programming, optimation-based task allocation, auction-based task allocation.