Luminous Robot Swarms in Adversarial Discrete Environments

Ph.D. Thesis

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Context

Robot swarms are a very active branch of robotics and have many applications in particular in industry and farming. This field studies coordination problems for fleets of a large number of robots. Those robots are *autonomous*, *i.e.*, they can make their own decisions, without any *a priori* global coordinator, based only on their environment and using their computational abilities. They can be wheeled robots or UAVs. The robots must cooperate to fulfill complex tasks, *e.g.*, patrolling in an industrial complex, surface cleaning a warehouse, spreading treatment over a field, or mapping the health and condition of crops. The decentralization allows them to be more robust against the failure of one robot. Yet, designing distributed algorithms to coordinate robots without central control is a difficult task [7].

A growing number of research studies consider a specific model: *luminous robots* [8]. They are equipped with a few lights of different colors that can be switched on and off by the robot and can be seen by other robots in its surrounding. These lights can be used both as memory and communication channel. Robots do not have any other communication ability or persistent memory. They may have other limited capabilities such as limited visibility distance, no compass, *etc.* This model has been extensively studied, in particular for coordination problems in discrete environments, *e.g.* [5,6]. However, most of those studies consider static, simple, two-dimensional environments, *i.e.*, environments whose topology does not change over time and is modeled by a two-dimensional graph, for example, a ring or a grid.

Objectives

The main goal of this Ph.D. position is to study coordination problems for luminous robot fleets in more adversarial environments to tackle more realistic scenarios. Classical problems are exploration (going through every location of the discrete environment), gathering (assembling every robot to the same location), and scattering (dispersing robots to different locations). Several directions can be explored:

1. Adding an extra dimension and consider tori, 3D grids, *etc.*

2. Adding obstacles and holes which can obstruct movements and visibility.

3. Considering dynamic environments whose topology might change over time, *e.g.*, obstacles appearing or disappearing, traffic jams obstructing some journeys...

Only a few results exist for those environments, *e.g.* [1–4], and even less for luminous robots [4]. The aim is to study the feasibility, *i.e.*, what abilities of the robot are necessary to fulfill their objective, and the complexity, *i.e.*, how many robots and how many colors are necessary.

Prerequisites

Candidates should hold a Master or equivalent in a relevant field, preferably computer science/informatics. They should be motivated by the theory of robotic swarms and distributed algorithms. Bonus to prior experience in those fields or to a solid mathematical background.

Contact. If interested, contact Anaïs Durand (`anais.durand@uca.fr`) with a CV, a motivation letter, and a transcript of the grades in master degree.

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