Luminous Robot Swarms in 3D Environments

Master Internship

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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 [4].

A growing number of research studies consider a specific model: *luminous robots* [5]. 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.* [2,3]. However, most of those studies consider two-dimensional environments, *e.g.*, a ring or a grid.

Objectives

The main goal of this Master internship is to study coordination problems for luminous robot fleets in 3D environments. 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).

Only a few studies considered luminous robots in 3D environments [1]. 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 for other settings.

This internship may be followed by a Ph.D thesis.

Prerequisites

Candidates 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. Candidates should also be good programmers.

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.

References

[1] Q. Bramas, S. Devismes, A. Durand, P. Lafourcade, and A. Lamani. Beedroids: How luminous autonomous swarms of uavs can save the world? In *FUN'22 - 11th International Conference on Fun with Algorithms*, pages 7:1–7:21, Island of Favignana, Sicily, Italy, May 30-June 3, 2022.

[2] Q. Bramas, P. Lafourcade, and S. Devismes. Finding water on poleless using melomaniac myopic chameleon robots. In *FUN'21 - 10th International Conference on Fun with Algorithms*, pages 6:1–6:19, Favignana Island, Sicily, Italy, May 30-June 1, 2021.

[3] S. Das, P. Flocchini, G. Prencipe, N. Santoro, and M. Yamashita. Autonomous mobile robots with lights. *Theor. Comput. Sci.*, 609:171–184, 2016.

[4] P. Flocchini, G. Prencipe, and N. Santoro. *Distributed Computing by Oblivious Mobile Robots*. Synthesis Lectures on Distributed Computing Theory. Morgan & Claypool Publishers, 2012.

[5] D. Peleg. Distributed coordination algorithms for mobile robot swarms: New directions and challenges. In *IWDC'05 - 7th International Workshop on Distributed Computing*, pages 1–12, Kharagpur, India, December 27-30, 2005.