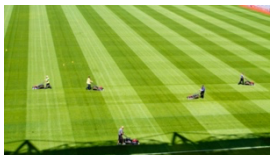
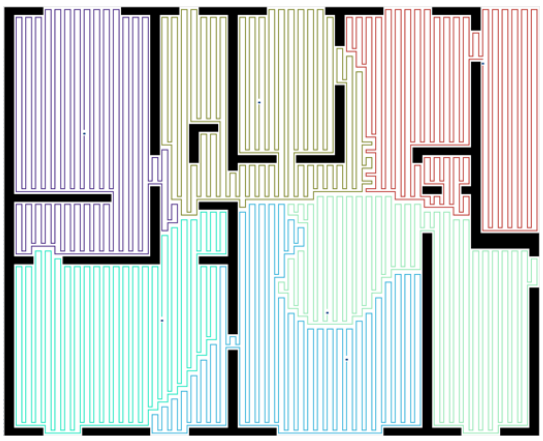
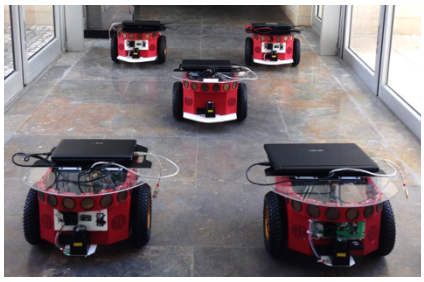
Co-Coverage – Cooperative Coverage with Multiple Robots

M.Sc. Dissertation Theme for 2022/23

A robot coverage task can be defined as the robot covering completely a given area of interest to perform therein a given useful operation [1]. Practical examples of coverage tasks include vacuum cleaning the floor of a residence, mowing the lawn, plowing, spraying, weeding, grain harvesting, landmine detection, *etc*. Many of these tasks are required by precision agriculture where the use of autonomous robots is nowadays rapidly increasing, especially in field crops, so as to increase crops productivity, circumvent shortages in labor force and fulfill needs of food commodity of a constantly growing population.

In a coverage task, the mobile robot or unmanned vehicle navigates autonomously within the area to be covered, while avoiding obstacles and using motion patterns that allow covering completely the area [2]. These motion patterns aim at visiting at least once, and preferably only once, every point within the area to be covered, as well as maximizing the use of straight movements to minimize energy expenditure in turns. The use of multiple robots to perform cooperatively the task can potentially reduce the time required to cover completely the environment but requires proper coordination of the robots actions. While coverage with a single robot has been extensively studied, multi-robot coverage has been less studied [2].



Many of the coverage methods proposed in literature abstracts the environment through a cellular decomposition, *e.g*. grid-based decomposition, exact cell decomposition, boustrophedon decomposition, *etc*. The grid-based decomposition [3] is the most popular due to its simplicity.

The main goal of this M.Sc. dissertation is studying multi-robot coverage. After reviewing the state of the art of coverage robotics, a cooperative coverage solution will be integrated in ROS [4]. The sought solution will seek to optimize the coverage in terms of motion patterns exhibited by each robot and to coordinate the allocation of different areas to each robot. A solution based on distributed decision without a central point of failure will be priviliged. It will be tested and validated with large number of robotic agents in a robotics simulation (*e.g*. Stage) and in a team of Pioneer P3-DX physical robots

The research work will be carried out in the Mobile Robotics Lab of ISR – University of Coimbra.

Keywords: Coverage; multi-robot system; distributed coordination; ROS.

References:

[1] Choset, H. (2001). Coverage for robotics – a survey of recent results. Annals of Mathematics and Artificial Intelligence, 31, 113–126.

[2] Galceran, E., & Carreras, M. (2013). A survey on coverage path planning for robotics. Robotics Autonomous Systems, 61, 1258-1276.

[3] Gabriely, Y., & Rimon, E.D. (2002). Spiral-STC: an on-line coverage algorithm of grid environments by a mobile robot. Proceedings of 2002 IEEE International Conference on Robotics and Automation (pp. 954-960).

[4] ROS.org: Powering the World's Robots [Online]. Disponível em: www.ros.org. (última visita: 05/05/2022)

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