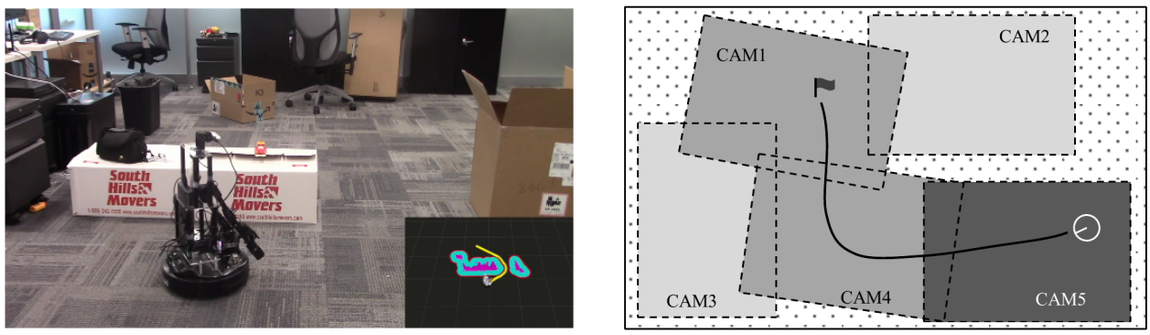
Master Thesis @ DTG

Indoor Environment Mapping using a RGBD-sensors Network

Premises - In the last decade, autonomous robotics is increasingly becoming an attractive research branch characterized by a peculiar mixture of theoretical issues to be solved and technological challenges to be faced. Its multidisciplinary nature constitutes the key aspect to solve complex tasks wherein any robot is typically required to dynamically interact and exchange information both with other systems and the environment. Arising from the classical theory of systems control and largely exploiting the paradigms of multi-agent systems and communication networks, autonomous robotics represents an innovative and effective technology in several applications coping with monitoring, exploration, transportation, manipulation and grasping tasks. Along this direction, recent advances in the field of artificial intelligence also applied to computer vision have allowed autonomous robots to become an essential element of Industry 4.0. In smart factories, these can be required to map the working environment in order to perform autonomous navigation but also to detect unexpected events. In this scenario (see Fig. 1), the presence of a distributed smart visual sensors network with communication capabilities can reduce the mobile robots effort by quickly capturing changes and enabling dynamic path planning [1, 2, 3, 4].



(a) (b)

Figure 1: (a) example of a mobile robot performing environment mapping and autonomous navigation, (b) schematic representation of a distributed visual sensors (cameras) network.

Thesis Focus - Accounting for an applicative scenario wherein multiple autonomous ground robots are required to navigate in an industrial environment benefiting from the presence of distributed smart visual sensors network, the thesis work will focus on the study and implementation of distributed algorithms aiming at mapping the environment through the information gathered by a fixed RGBD-sensors network suitably calibrated [5, 6]. In this perspective, the main issues concern the single-camera and multi-camera calibration, the multi-sensor information sharing, as well as some computer vision tasks such as obstacle detection and occupancy grid determination [7]. The thesis work will involve also some experimental tests on smart visual sensors constituted of a RGBD-sensor and a Rasberry 4 Pi.

Detailed Objectives - The thesis will evolve through the fulfill of (all/some) the following steps:

- study of the existing literature related to distributed camera networks for environment mapping;
- *calibration task*: study and design of a single and multi-camera calibration strategy;
- *map creation*: study and design of a strategy for the multi sensor map reconstruction;
- *occupancy map*: study and design of obstacle detection method and occupancy grid creation.

Expected and To-Be-Acquired Skills - From the methodological point of view, the proposed work deals with computer vision theory such as calibration of a distributed camera network, obstacle detection and mapping algorithms. In addition, it involves ROS as operative system, simulations in C++/Python environments, laboratory activities, tests on a real system.

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