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BEHAVIOUR BASED MULTI-ROBOT INTEGRATED EXPLORATION

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Abstract. *This paper presents an approach to the integrated exploration problem for a team of mobile robots. This technique is based on a combination of several basic behaviours that model a potential field. These behaviours are designed to quickly explore the environment jointly with a visual SLAM technique. As a novelty, this method considers returning to previously explored areas when the localization uncertainty is high. Consequently, the accuracy obtained in the construction of the maps is higher than with other classical exploration techniques. The known problem of local minima in potential field based techniques is also considered. In this sense, a strategy of detection and escape from local minima is used. Several simulations show the validity of the approach.*
Keywords: Integrated exploration, Cooperative robots, Potential fields, Behaviour based robotics

1. **Introduction.** During the last years, applications that require the deployment of mobile robots have become more frequent. These approaches require the navigation through unstructured and unknown environments in which the task of exploration is crucial. Exploration consists in the coverage of an unknown environment by a robot or a group of mobile robots building a common map at the same time. The use of a team of robots is an advantage [1], since the exploration time can be reduced and the precision of the maps can be improved [2]. Exploration techniques can be applied to surveillance, search and rescue services, map building or planetary exploration.

The problem of exploration is related to the Simultaneous Localization and Mapping (SLAM). The maps built by a robot while it is exploring the environment can consist of occupancy grids from the information supplied by range sensors or they can consist of visual features from the environment [3]. Figure 1 graphically shows the concepts of exploration and SLAM and how they are related [4, 5]. On the one hand, SLAM techniques are able to build a map and locate the robots within it, nevertheless they are passive due to the fact that they do not control the motion of the robots. On the other hand, classic exploration algorithms direct the robots trying to perform a fast coverage of the environment. However, the SLAM algorithms are affected by the performed trajectories. That means that the results in terms of accuracy depend on the trajectories followed by the robots [4]. Even though path generation and following has been studied as the case of parallel robots [6], the trajectories performed by the robots when they explore a completely undetermined environment play an essential role. In this sense, when the robots travel through unknown environments, the localization uncertainty continuously grows. This fact may lead to inaccurate or useless maps. Therefore, in order to obtain a precise map, it is necessary that the robots make also movements considering the uncertainty in their localization. As Figure 1 shows, the exploration algorithms that take into account all