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Renzaglia, A.

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A. Renzaglia, L. Doitsidis, S. A. Chatzichristofis, A. Martinelli, E. B. Kosmatopoulos

Abstract— **In this paper we present a solution to the problem of positioning a team of Micro Aerial Vehicles for a surveillance task in an environment of arbitrary and unknown morphology. The problem is addressed taking into account physical and environmental constraints like limited sensor capabilities and obstacle avoidance. The goal is to maximize the area monitored by the team, by identifying the best configuration of the team members. The proposed method is a distributed extension of our previous work based on the Cognitive Adaptive Optimization (CAO) algorithm. This distributed and scalable approach allows us to obtain coordinated and safe trajectories to accomplish the task in 3D environments. The different formulation of the problem considered in this paper allows also dealing with communication constraints. We provide extensive experimental results using data collected by a team of aerial robots and compare the efficiency of the distributed and centralized approach.**

I. INTRODUCTION

The use of Unmanned Aerial Vehicles (UAVs) teams has gained a lot of attention in recent years. This is due to the extended capabilities that flying robots are able to offer comparing to the use of ground robots for the same task. The ability to fly allows robots to easily avoid obstacles on the ground and to have an excellent birds eye view. Moreover, it is possible to access to environment where no human or other vehicles can access to. If they are further realized in small scale, they can also be used in narrow out- and indoor environment and they represent only a limited risk for the environment and people living in it. As a result, Micro Aerial Vehicles (MAVs) teams can be employed in a variety of very important missions including and not limited to: surveillance of buildings and large indoors and outdoors areas, search and rescue missions, surveillance of dangerous areas (i.e chemical or nuclear plants), environmental monitoring and many others. In all the aforementioned tasks the deployment of limited resources (robots) to optimize the monitoring of the area of interest is a key issue. Moreover, as these platforms become more and more affordable and robust, the use of teams of aerial vehicles that cooperatively and autonomously search and cover an assigned area is becoming a viable alternative. In order to exploit the advantages of robot mobility, active sensing strategies need to be determined for coordinating the motion of groups of robots while optimizing the use of the available sensing, communication, and processing resources. Furthermore, in every multi-robot systems, a distributed approach is desirable for several fundamental reasons. The most important are failure of the central station and limited communication capabilities. In a very common scenario each robot has no global knowledge about the surrounding environment or about the group as whole. So, the global behavior of the team can be seen as the sum of the local actions taken by its members, which sense their immediate environment, communicate with their neighbors, process the information gathered and move according to it.

As far as it concerns the optimal coverage using a team of robots, two main problems have been identified and formally approached up to now and both can be expressed by introducing a suitable optimization function. The first problem deals with the optimal arrangement of the team members, so that for every point in the area, the closest robot is as close as possible to that point. This might correspond to the need to intervene as fast as possible in all the points of the area with at least one robot. In this case, the corresponding cost function to minimize depends on the distance of the robots from the points of the area to be covered. The second problem deals with the maximization of the area monitored by a team of robots using vision sensors. In this case, a point is considered monitored as long as it is in the field of view of at least one vision sensor. In this paper we consider only the latter: the visibility problem.

The first problem previously described has been largely studied in literature and several different approaches have been proposed. In [1], the authors present a controller for a team of mobile robots in a convex environment, i.e. without obstacles, based on the Voronoi partition. A similar solution, is proposed in [2], where additionally the robots estimate a function indicating the relative importance of different areas in the environment, using information from the sensors. An approach for non-convex regions is proposed in [3]. In this work the Voronoi partition is obtained by using the geodesic distance instead of the Euclidean one, taking into account the particular topology of the problem. A possible solution for environments with obstacles is proposed also in [4]: the idea is to combine the classical Voronoi coverage and the local path planning algorithm TangentBug.

As far as it concerns the second problem previously described, in [5] the authors present two methods based

A. Renzaglia is with the Department of Computer Science & Engineering, University of Minnesota, Minneapolis, USA, e-mail: arenzagl@umn.edu.
L. Doitsidis is with the Dept. of Electronics, Technological Educational Institute of Crete, Chania, 73133, Greece and the Informatics & Telematics Institute, Center for Research and Technology–Hellas (ITI-CERTH), 6th km Xarilaou - Thermi, 57001, Thessaloniki, Greece, ldoitsidis@chania.teicrete.gr.
S. A. Chatzichristofis is with Informatics & Telematics Institute, Center for Research and Technology–Hellas (ITI-CERTH), 6th km Xarilaou - Thermi, 57001, Thessaloniki, Greece,
A. Martinelli is with INRIA Rhône-Alpes, Grenoble, France, agostino.martinelli@inria.fr.
E. B. Kosmatopoulos is with the Dept. of Electrical and Computer Engineering, Democritus University of Thrace, Xanthi 67100, Greece and the Informatics & Telematics Institute, Center for Research and Technology–Hellas (ITI-CERTH), 6th km Xarilaou - Thermi, 57001, Thessaloniki, Greece, kosmatop@ee.duth.gr.

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