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Distributed Painting by a Swarm of Robots with Unlimited Sensing Capabilities and Its Simulation

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This paper presents a distributed painting algorithm for painting a priori known rectangular region by swarm of autonomous mobile robots. We assume that the region is obstacle free and of rectangular in shape. The basic approach is to divide the region into some cells, and to let each robot to paint one of these cells. Assignment of different cells to the robots is done by ranking the robots according to their relative positions. In this algorithm, the robots follow the basic *Wait-Observe-Compute-Move* model together with the *Asynchronous* timing model. This paper presents a simulation of the proposed algorithm. The simulation is performed using the Player/Stage Robotic Simulator on Ubuntu 10.04 (Lucid Lynx) platform.

Keywords : Distributed Coverage, Painting, Robot Swarm, Unlimited Visibility.

1. INTRODUCTION

Distributed coverage of any polygonal region has been an important area of research over the past few years. Applications of covering a free space can be found in the areas like automated humanitarian demining, lawn mowing and milling [1], sweeping [2], terrain mapping, space explorations, aerial reconnaissance, search and rescue of victims [3] *etc.*. Coverage of a particular region requires the robots to scan or pass over a designated region. When the robots cover or pass all the parts of that region, coverage is said to be complete. High quality coverage guarantees exhaustive coverage with minimum repetition. Each robot in a swarm, distributedly and simultaneously covering different parts of the area minimizes time and cost of the work while increasing overall performance.

In this paper, one of such coverage problems is addressed. We consider a problem for painting a known rectangular region without any obstacle. The overall painting will be performed by a swarm of autonomous mobile robots. We assume that a set of N swarm robots are initially deployed within the given rectangular region. The robots can be located at any place within that region. These robots are assigned the responsibility to paint the whole region. Here, the proposed algorithm will be executed by each of the robots, to solve this problem collectively. We assume that the robots will work in a completely distributed environment. Painting a region is same as covering or scanning the region. From now on, the two words *coverage* and *painting* will be used interchangeably.

In this paper, the robots follow a basic model for computation which is known as *wait-observe-compute-move* model [4] or CORDA model [5]. The algorithms based on this basic *wait-observe-compute-move* model consists of a sequence of computational cycles. In every computational cycle, a robot executes the following four steps:
Wait: A robot is initially in a waiting or idle state, but cannot stay infinitely idle.

Observe: At any point of time a robot observes the positions of all other robots, asyn-

stacles. The size and shape of the area may vary. They may be convex or concave. The area may or may not contain obstacles. Moreover, the shape and size of the obstacles may vary.

- **Visibility:** The robots could have limited range of visibility. They can view upto a certain distance.
- **Model:** We have considered *direction-only* and *asynchronous* models. Other models related to direction, orientation and timing may be used to solve similar problems.

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