Patrolling with Mobile Robots

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The study of mobile robots having communication, locomotive, and interactive capabilities is a relatively new field with applications to distributed computing, robotics, computer games, operations research and overlay networks. Consider a domain modelled either by an arbitrary graph or a simply connected geometric region. Robots are placed in arbitrary positions within the domain and are capable of moving along this domain without exceeding a certain predefined maximal speed (which may be different for each robot). The robots are required to patrol the domain or parts thereof (e.g., the boundary, or some critical predefined sub region(s)) so as to monitor potential intrusions from unauthorized intruder(s) which may attempt to penetrate the interior of the domain through a point that is unknown to the robots.

> Given that the intruder requires some time interval, say of length τ, to accomplish the intrusion, is there an algorithm allowing the agents to move (possibly perpetually) along the domain, so that no point remains unmonitored for a time period $\geq \tau$?

To solve the problem it is required to design algorithms defining the movement of the robots along the domain so that the longest possible time interval during which any point of the domain remains unmonitored by some robot never exceeds the "safety" parameter τ. Some of the specific domains and models to be investigated include

1. one-dimensional segments and cycles with robots of varying speeds and visibility ranges, and regions of variable traversal characteristics,
2. two dimensional regions with and without obstacles and robots with directional antennae capabilities,
3. patrolling in communication networks (by software agents) modelled by arbitrary directed or undirected graphs.

In the one dimensional problems the most common strategy adopted includes the "cyclic strategy", where agents move in one direction around a cycle covering the environment, and the *partition strategy*, whereby the environment is partitioned into sections patrolled separately by individual robots. In the two dimensional setting the problem has never been studied before. Despite the apparent simplicity of the problems, designing algorithms that take advantage of the *communication and locomotive capabilities* of the robots in distributed and/or local settings and proving their correctness turns out to be quite a challenging problem and the proof methodology required is quite complex [1].

References

[1] J. Czyzowicz, L. Gasieniec, A. Kosowski, and E. Kranakis. Boundary patrolling by mobile agents with distinct maximal speeds. *Algorithms–ESA 2011*, pages 701–712, 2011.