

Master Thesis Defense

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ABSTRACT

Intruder detection is an important application area for wireless sensor networks. Given a region of interest to be defended, we are interested in detecting the presence of an intruder inside the region who originated from outside the region with a minimum number of sensors. We model the region of interest by a polygon and the trajectory of the intruder by a straight line segment crossing the polygon. A collection of wireless sensors can be employed to construct virtual barriers against intruders, which can be modeled as a set of line segments L .

The type of wireless sensors and their allowable positions lead to four intruder detection problems. The *Optimal Opaque Cover* problem is to find a set of line segments L of minimum total length inside or on the perimeter of the polygon P , such that any line segment crossing the polygon intersects at least one element of L . If the line segments are restricted to be on the perimeter of P , we obtain the *Minimum Perimeter Defense* problem. The *Minimum-Edge Opaque Cover* problem is the problem of finding a minimum-sized set of line segments S inside or on the perimeter of P , such that any straight line segment crossing P intersects at least one element of S . Similarly, if the line segments are restricted to be on the perimeter of P , we obtain the *Minimum-Edge Perimeter Defense* problem.

For the Opaque Cover problem, for regular polygons, we prove a performance ratio on the quality of the solutions given by a Minimum Spanning Tree and another known solution. For triangles, we conjecture that the Steiner Minimum Tree is the optimal opaque cover, and prove that any opaque cover consisting of two or three disjoint components cannot be optimal.

We observe that the Minimum-Edge Perimeter Defense problem is equivalent to a new hiding problem, the Max Hidden Edge Set problem. We prove the APX-hardness of the Max Hidden Edge Set problem for polygons without holes and rectilinear polygons without holes, by providing gap-preserving reductions from the Max 5-Occurrence-2 SAT problem.