Research Statement

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I have been working as a Postdoc Researcher in school of Computer Science at Institute for Research in Fundamental Sciences (IPM) since February 2021. My research is about clearing and searching polygons for finding the intruders using sliding robots.
The problem of guarding orthogonal art galleries with sliding cameras is a special case of the well-known art gallery problem when the goal is to minimize the number of guards. Each guard is considered as a point, which can guard all points that are in its visibility area. In the sliding camera model, each guard is specified by an orthogonal line segment which is completely inside the polygon. The visibility area of each sliding camera is defined by its line segment.

This research statement is organized as follows: The first section discusses my works which i have done recently as a postdoc researcher and in my PhD thesis. The second section discusses my future works which i am interested in working on them.

Thesis Works

Inspired by advancements in wireless technologies and the need to offer wireless services to clients, a new variant of the problems for covering the regions has been studied. In this problem, a guard is modeled as an omnidirectional wireless modem with an infinite broadcast range and the power to penetrate up to k walls to reach a client. One of the problems that we study is the problem of covering orthogonal polygons with sliding cameras with the power to penetrate up to k walls. The goal in this problem is to place some k-transmitters in the polygon such that their cardinality or the total length of their line segments is minimized.

- We consider a new variant of covering in an orthogonal art gallery problem where each guard is a sliding k-transmitter. Such a guard can travel back and forth along an orthogonal line segment, say s, inside the polygon. A point p is covered by this guard if there exists a point $q \in s$ such that $\overline{pq}$ is a line segment normal to s, and has at most k intersections with the boundary walls of the polygon. The objective is to minimize the sum of the lengths of the sliding k-transmitters to cover the entire polygon. In other words, the goal is to find the minimum total length of trajectories on which the guards can travel to cover the entire polygon. We prove that this problem is NP-hard when $k = 2$, and present a 2-approximation algorithm for any fixed $k \geq 2$. The proposed algorithm also works well for an orthogonal polygon where the edges have thickness.

After finding the set of sliding cameras which can guard an orthogonal art gallery, the important problem is how to move these sliding cameras along their line segments to guard the art gallery. So, we study the problem of motion path planning

for a group of sliding robots to guard an art gallery.

In a multi-robot system, a number of autonomous robots would sense, communicate, and decide to move within a given domain to achieve a common goal. In the pursuit-evasion problem, a polygonal region is given and a robot called a pursuer tries to find some mobile targets called evaders. The goal of this problem is to design a motion strategy for the pursuer such that it can detect all the evaders.

We study the problem of presenting the motion path planning for a group of sliding robots to find the evaders an x-monotone orthogonal polygon and also in a simple orthogonal polygon, and present polynomial time algorithms for solving them.

- For a simple orthogonal polygon, we propose the first motion-planning algorithm for a group of sliding robots, assuming that they move along the pre-located line segments with a constant speed to detect all the evaders with bounded speed. Also, we prove an upper bound for the length of the paths that all pursuers move in the proposed algorithm.

- For an x-monotone simple orthogonal polygon, we propose the first output-sensitive motion-planning algorithm for a group of robots with a constant speed to detect all the evaders.

The more detail about my research results are available in my published papers (refer to my CV).

Future work

We proved that the problem of covering a simple orthogonal art gallery with minimum-length sliding k- transmitters is NP-hard, even for k = 2. The calculation of the hardness of guarding an orthogonal polygon with the minimum cardinality of sliding cameras remains open. Also, finding the lower bound for the approximation factor of the algorithm is a challenging problem.

When the environment is known for the sliding robots, we propose an algorithm for planning the motions of a group of sliding robots to detect all the unpredictable moving evaders with bounded speed. We use a set of line segments S where the sliding robots move along them. In the case where S is a set of minimum-cardinality sliding cameras that guard P, the proposed algorithm uses the minimum number of sliding robots to clear P. As an open problem, we can consider a case where the environment is unknown to the robots, and the robots can only plan their motions based on the local visible area. A challenging problem in practice is to consider the case where the robots send the information to those robots that are visible to them.

When we consider an x-monotone orthogonal polygon, investigating the problem in which the environment is unknown to the robots, and in which the robots could only plan their motions based on the local visible area, would be challenging. Additionally, letting the robots send information only to those that are visible to them may make the problem more usable in real-life multi-robot systems.

As i have studied my Master and Bachelor in computer science, i have a good background in mathematics which helps me in my researches.
I am excited to continue my researches as a postdoc student with your Professors. Also, I would like to work with your students and have a group sessions for working together.
Except the future works related to my PhD thesis, i am interested in working on the other problems in Robotics and Artificial intelligent.