Capturing Hiders with Moving Obstacles

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Abstract

The classic hide-and-seek game is an abstraction for many real- world scenarios like capturing intruders in a closed space, locating objects, patrolling an area, etc. Since most of the present work is based on static obstacles, we address solutions for the hide-and- seek game in an environment where the obstacles are not static. We design strategies that would facilitate seekers to capture hiders in an environment with moving obstacles. We have three strategies: Baseline strategy, Set-cover strategy, and Sweep strategy, which use different surveillance techniques to be followed by the seekers. We simulate the methods and compare their performance in different scenarios. While the baseline strategy demands many seekers in large environments, the other two strategies, set-cover and sweep, are ideal for applying in large environments as they require fewer seekers in the same environment.

Environment Properties

The environment (E) is divided into a grid with obstacles and two types of agents: hiders and seekers. Hiders aim to avoid seekers and stay in the environment, while seekers try to find all hiders. Agents have a field of vision (v) determining the visible cells, with obstacles blocking their vision. Obstacles can be static or dynamic, either helping hiders or hindering seekers. Seekers can catch hiders on the exposed surface of obstacles within their field of vision. Obstacles can move in hider-friendly, seeker-friendly, or random patterns. Strategic Points (SP) are hiding spots for hiders, located on obstacle edges, while Coverage Points (CP) are ideal seeking positions for seekers. CPs are imaginary cell positions known only to seeker agents.

Seeker Strategies

The paper defines two new strategies to be used by seekers in the simulation environment.
The first strategy is the Set-Cover Strategy, which aims to minimize the number of coverage points needed to track strategic points in the environment. It utilizes the seeker's field of vision and a set-cover algorithm to determine the optimal positions of coverage points. The minimum number of coverage points required is calculated based on the dimensions of the environment and the seeker's visibility range. The Cell Ranking strategy is also employed to minimize overlap and optimize the tracking area of coverage points.
The second strategy is the Sweep Strategy, used by seekers to locate hiders. Seekers systematically traverse the entire grid, starting from one corner and covering all grid cells to eliminate potential hiding places for hiders. Seekers capture strategic points associated with obstacles within their field of vision, and additional seekers are assigned to inspect unguarded nodes. The maximum number of coverage points required is determined by the longest sequence of cells in the grid, typically the diagonal in rectangular environments. The duration of the game depends on both the time required to cover the entire grid and the need to monitor each obstacle individually.

Results

We conducted simulations to compare the set-cover and sweep surveillance strategies for finding hiders in a large environment. To avoid quickly capturing all hiders, the number of seekers assigned to coverage points in the set-cover strategy was intentionally lower than what would be optimal. The experimental results, as shown in Table 1, indicate that the set-cover strategy can effectively capture targets in a large environment even with fewer seekers available. However, it requires a higher number of seeker agents compared to the sweep strategy, which proves to be more efficient in terms of seeker requirements and game completion time. Overall, the study concludes that the sweep strategy offers better performance in terms of capturing hiders while requiring fewer seekers.

Obstacle Movement	Set-Cover (3792)			Sweep (577)
	20%	50%	80%	
Random	2297	1347.5	1071	746.5
Hider Friendly	3234.75	1921	1515.3	1023.71
Seeker Friendly	1369.26	884.741	674.11	618.08

Table 1: Median Game Completion Steps in a 100 x 100 grid across 50 game rounds. The average number of seekers required by each strategy is given in brackets.

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