Following Multiple Unpredictable Coherent Targets Among Obstacles

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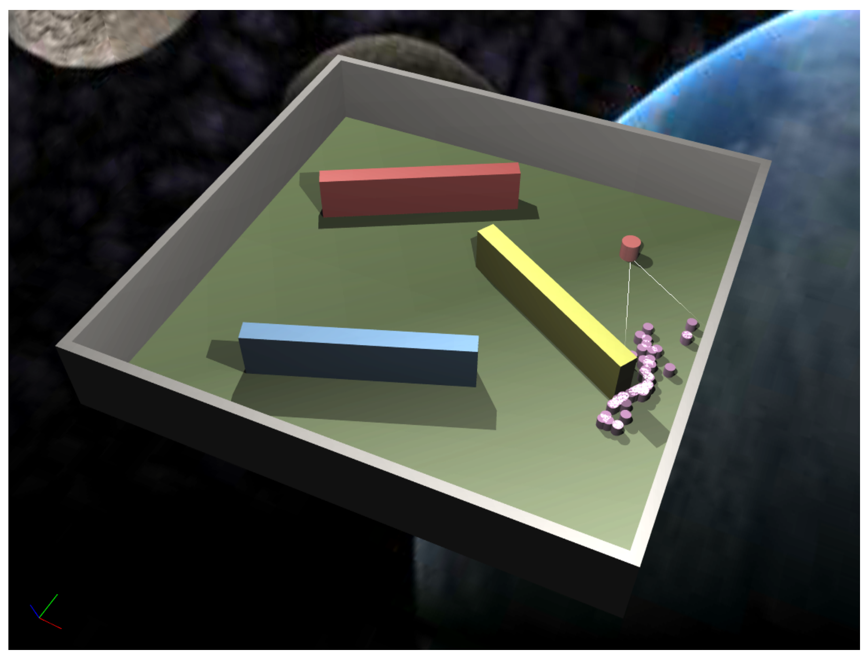
Overview

Camera control is essential in both virtual and real-world environments. Our work focuses on an instance of camera control called ***target following***, and offers algorithms for following ***multiple targets*** with ***unpredictable trajectories*** through a ***known environment***.

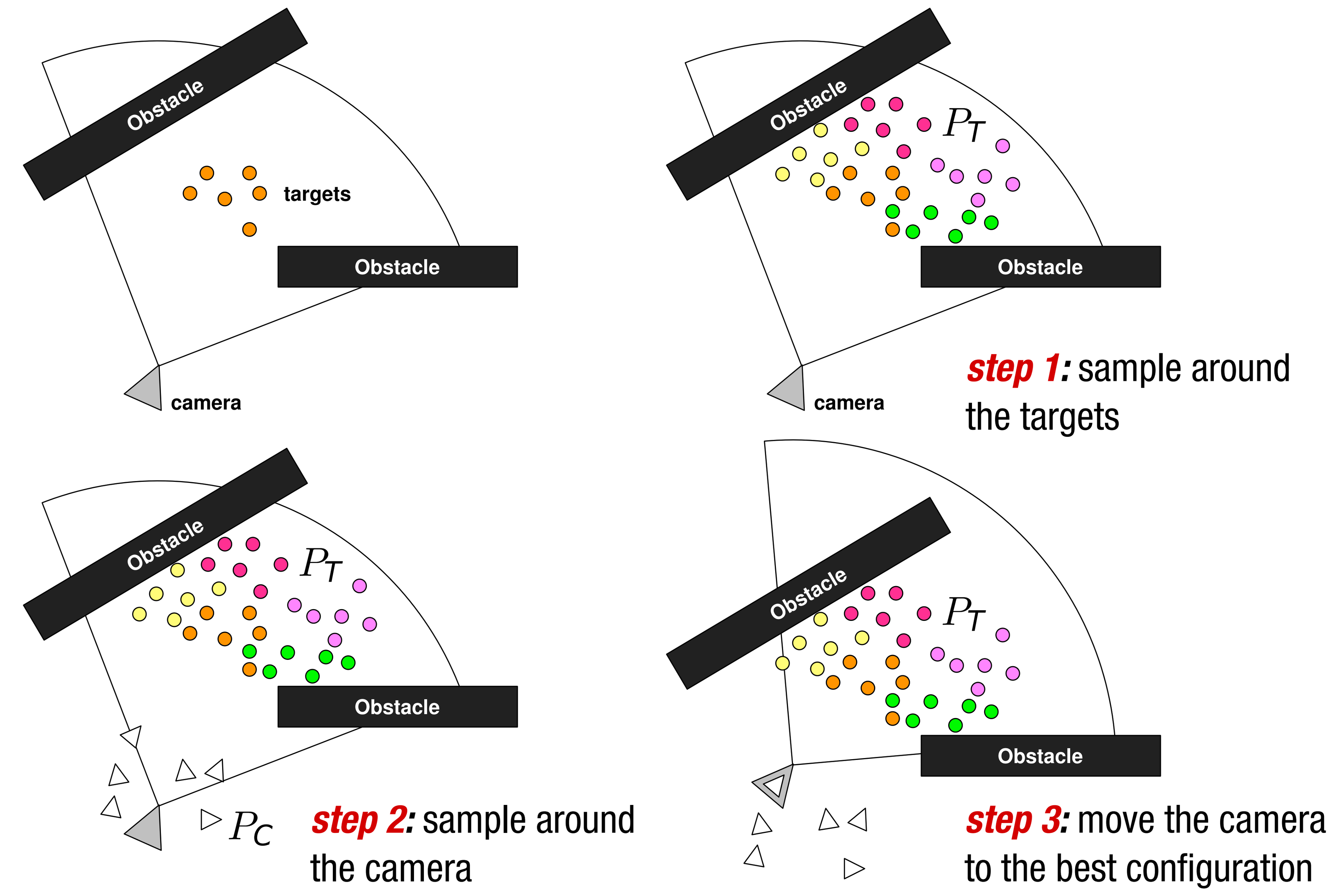


The ***multiple-target following problem*** is unique compared to single-target following because:

- the targets can split into separate groups, and
- deform around obstacles, thus flock members can be partially occluded.

Our method is capable of maintaining high visibility of the targets during the entire simulation. ***To the best of our knowledge, this work is the first attempting to address this important problem.***

Sampling-based Camera



Method

We view the multiple-target following problem as an ***online motion planning problem*** where the planner has to generate a trajectory and generate motions in real time. We assume that:

- the workspace is populated with polygonal obstacles, which are known to the planner and projected into 2D,
- the targets exhibit some degree of coherence in their movement (similar to the flocking behavior of birds), and
- the targets maximum velocities are known, but their trajectories are not known a priori.

Reactive Camera

Reactive camera determines its next configuration (camera position and view direction) by placing the visible targets as centered in the view as possible, based only on the target's current positions.

The motivation is that by placing the visible targets at the center of its view, the camera will have better chance of making invisible targets visible.

Sampling-based Camera

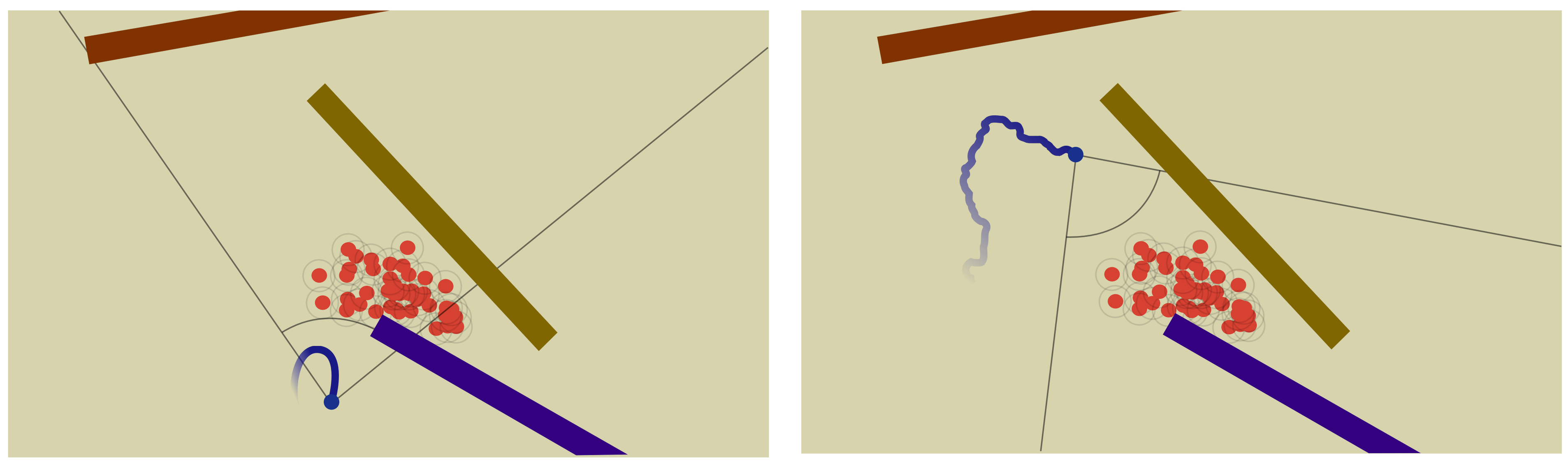
Sampling-based camera determines its next configurations by

- predicting the targets next positions by sampling
- find the configuration that can see most targets by sampling, i.e., the camera will solve

$$\arg\max_{x \in P_C} \Big(\sum_{X \in P_T} \mathrm{vis}(x, X) \Big)$$

P_C: a sample of camera configurations
P_T: a set of sampled target positions
$\mathrm{vis}(x, X)$: # of targets in X visible by x

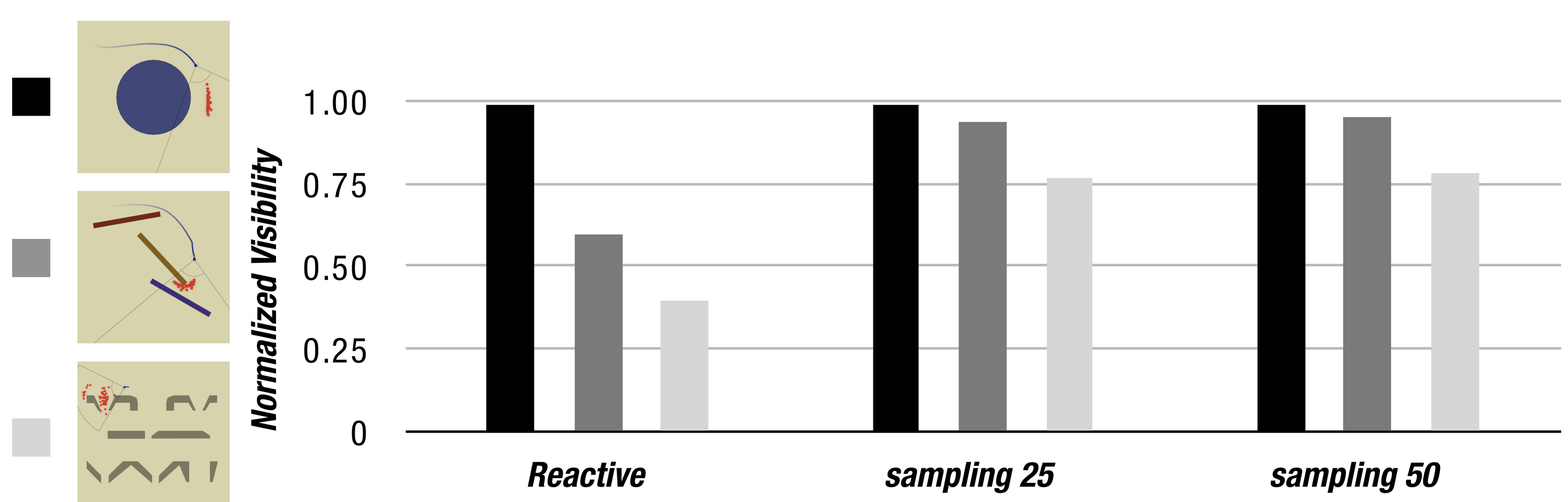
Results



(a) Using reactive ***(b)*** Using sampling-based planner

Figure 1 above visually shows the difference between reactive and sampling-based cameras as the targets turn into an empty corridor. The sampling-based planner is able to move proactively to maintain visibility of the targets, whereas the reactive planner loses the targets.

Figure 2 below depicts our results for following 50 targets in three environments. We measure the normalized visibility, which we define as the ratio of visible targets during the entire simulation.



sampling 25 (50) means 25 (50) sample sets are generated for the targets and the camera

Sampling-based cameras provide better visibility than the reactive camera, and sampling 25 and sampling 50 provide similar performance.

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