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Probabilistic Search by Mobile Robots and Robot Teams

Abstract

The problem of search for a hidden object, chasing a prey and catching a target is one of the oldest mathematical problems; it was already known to Leibnitz and Huygens who treated it in 1672-1676. In 1732 Pierre Bouguer formulated it as a problem of pure calculus and in such form it was considered during the next 200 years.

A probabilistic formulation of the problem of search was originated by Koopman in 1942 in response to the German submarine threat in the Atlantic. It requires to know

"how best to search for an object when the amount of searching effort is limited and only probabilities of the object's possible positions are given."

The report gives a general overview of the main existing methods of probabilistic search for static and moving targets and presents recently developed algorithms of search including the approach suggested in the foraging theory that hypotheses an optimality of the search by animals and requires to mimic such behaviour.

In addition, the report presents a brief discourse in the history of mobile robots and multi-robot systems, stresses their essential properties and the problems appearing in the search by mobile robot teams and present recently developed algorithms of collective search.

The presented probabilistic algorithms of search were developed in collaboration with Prof. Irad Ben-Gal (Tel Aviv University) and the methods of foraging and agent-based techniques were studied in collaboration with Prof. Hava Siegelmann (University of Massachusetts, Amherst) and Prof. Ronald Yager (Yona Colledge, New York). The recent results, especially in the activity of mobile robots and multi robot teams, were obtained in collaboration with students in the robotics lab in the Ariel University.