Parametric Analysis for Modeling and Simulation of Stochastic Behavior in the Predator–Prey Pursuit Domain

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Modeling and simulation are very useful tools when analyzing complex systems. Multipredator, multiprey pursuit-evasion games, with stochastic vision, constitute an example of such a complex system. We present a careful parametric analysis for the multipredator–multiprey domain. Previous work on the predator–prey domain has mainly been focused on the strategies to intercept all prey, leaving out the analysis about how their parameters, which describe the capabilities of the predator–prey pursuit, would affect the time to intercept all prey. In this paper we use a fixed strategy proven to be effective in previous studies. In most predator–prey studies, most of the capabilities and parameters that describe the pursuit have been fixed (e.g. the number of predators and prey in the arena, their velocities and detection zones, among others). Assuming that some of the capabilities and parameters describing the prey are given, and that the parameters and capabilities of the predators could be designed, many questions arise. How would the different capabilities of the mobile robotic predator affect the probability to intercept all prey? How many mobile robotic predators would be required to guarantee a probability of intercept within a finite, and perhaps tactically useful, time period within a given region? It is proposed that stochastic modeling of predator–prey scenarios lend insight into such problems. A probabilistic approach to the predator–prey domain is thus shown. Parametric analysis for the pursuit-evasion game, Monte Carlo simulations and a significance test are presented. In the following simulations, the prey and predators have only local information provided by their detection and observance zones. These zones are modeled mathematically via a probabilistic model, and each predator and prey in the scenario has a probability of being detected based on distance. As a prey is geometrically closer to a predator, its probability of intercept increases.

Keywords: Parametric analysis, Monte Carlo simulations, significance test, pursuit-evasion game

1. Introduction and Previous Work

A first approach towards understanding complex systems is to perform a parametric analysis. In this paper we use the predator–prey domain with a fixed strategy, proven to be effective in previous studies, and we investigate the trends about how the parameters involved in a pursuit-evasion game would affect the time to intercept all prey.

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Assuming that some of the capabilities and parameters describing the prey are given, and that the parameters and capabilities of the predators could be designed, how would the different capabilities of the mobile robotic predator affect the probability to intercept all prey? What are the trends the time to intercept all prey will follow as a result of changing parameters in the pursuit-evasion domain? It is proposed that stochastic modeling of predator–prey scenarios might lend insight into such problems. Previous work on the predator–prey domain has mainly been focused on the strategies to intercept all prey, leaving out the analysis about how their parameters, which describe the capabilities of the predator–prey pursuit, would affect the time to intercept all prey. In most predator–prey stud-