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AN ADAPTIVE ALGORITHM FOR LOCALIZATION IN HIGHLY SYMMETRIC ENVIRONMENTS

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Abstract. *To solve the problem of premature convergence when using Monte Carlo localization (MCL) in highly symmetric environments, samples in MCL are clustered into species, each of which represents a higher level of hypothesis of the robot's pose than a single sample, and a co-evolutionary model derived from competition of ecological species is used to make the species evolve cooperatively. The sample size can be adjusted adaptively over time according to the uncertainty of the robot's pose by using the population growth model to reduce the computational cost. In addition, by using the crossover and mutation operators in evolutionary computation, intra-species evolution can drive the samples move towards the regions where the desired posterior density is large, so a small size of samples can represent the desired density well enough to ensure precise localization. The new algorithm is termed co-evolution based adaptive Monte Carlo localization (CEAMCL). Experiments have been carried out both with a real robot and a simulated robot to prove the efficiency of the new localization algorithm.*
Keywords: Monte Carlo localization, Co-evolution, Evolutionary computation, Robot localization

1. **Introduction.** Self-localization, a basic problem in mobile robot systems, can be divided into two sub-problems: pose tracking and global localization. In pose tracking, the initial robot pose is known, and localization seeks to identify small, incremental errors in a robot's odometry [1]. In global localization, however, the robot is required to estimate its pose by local and incomplete observed information under the condition of uncertain initial pose. Global localization is a more challenging problem. Only most recently, several approaches based on probabilistic theory are proposed for global localization, including grid-based approaches [2], topological approaches [3,4], Monte Carlo localization [5] and multi-hypothesis tracking [6,7]. By representing probability densities with sets of samples and using the sequential Monte Carlo importance sampling [8], Monte Carlo localization (MCL) can represent non-linear and non-Gaussian models well and focus the computational resources on regions with high likelihood. So MCL has attracted wide attention and has been applied in many real robot systems.

But traditional MCL may fail to localize the robot properly due to the premature convergence in highly symmetric environments where several hypotheses have to be tracked for a long time. And the most of the indoor environments are symmetric, so solving the premature problem of MCL is of great importance when MCL is applied to localize