Improved Particle Filtering for Pseudo-Uniform Belief Distributions in Robot Localisation

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Abstract. Self-localisation, or the process of an autonomous agent determining its own position and orientation within some local environment, is a critical task in modern robotics. Although this task may be formally defined as a simple transformation between local and global coordinate systems, the process of accurately and efficiently determining this transformation is a complex task. This is particularly the case in an environment where localisation must be inferred entirely from noisy visual data, such as the RoboCup robot soccer competitions. Although many effective probabilistic filters exist for solving this task in its general form, pseudo-uniform belief distributions (such as those arising from course-grain observations) exhibit properties allowing for further performance improvement. This paper explores the RoboCup 2D Simulation League as one such scenario, approximating the artificially constrained noise models as uniform to derive an improved particle filter for self-localisation. The developed system is demonstrated to yield from 38.2 to 201.3% improvement in localisation performance, which is further shown as corresponding with a 6.4% improvement in goal difference across approximately 750 games.

Keywords: Robotics, localisation, particle filter, robot soccer

1 Introduction

The RoboCup 2D Simulation League incorporates a number of critical challenges in the areas of artificial intelligence, machine learning and distributed computing [6, 9, 10]. These include, but are not limited to:

- Distributed client/server model, introducing the challenges of fragmented, localised and imprecise information (both in terms of noise and latency) about the environment [8].
- Asynchronous perception-action activity, and a limited window of opportunity to perform a desired action [5].
- No centralised controllers or central world model, resulting in a lack of global vision or localisation information [11, 12].