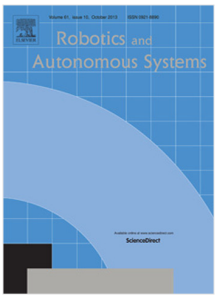
Accepted Manuscript



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PII: S0921-8890(16)30039-2
DOI: http://dx.doi.org/10.1016/j.robot.2016.12.003
Reference: ROBOT 2763

To appear in: *Robotics and Autonomous Systems*

Received date : 24 January 2016
Revised date : 28 October 2016
Accepted date : 11 December 2016

Please cite this article as: S. Choi, et al., Real-time nonparametric reactive navigation of mobile robots in dynamic environments, *Robotics and Autonomous Systems* (2016), http://dx.doi.org/10.1016/j.robot.2016.12.003

Real-Time Nonparametric Reactive Navigation of Mobile Robots in Dynamic Environments

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Abstract

In this paper, we propose a nonparametric motion controller using Gaussian process regression for autonomous navigation in a dynamic environment. Particularly, we focus on its applicability to low-cost mobile robot platforms with low-performance processors. The proposed motion controller predicts future trajectories of pedestrians using the partially-observable egocentric view of a robot and controls a robot using both observed and predicted trajectories. Furthermore, a hierarchical motion controller is proposed by dividing the controller into multiple sub-controllers using a mixture-of-experts framework to further alleviate the computational cost. We also derive an efficient method to approximate the upper bound of the learning curve of Gaussian process regression, which can be used to determine the required number of training samples for the desired performance. The performance of the proposed method is extensively evaluated in simulations and validated experimentally using a Pioneer 3DX mobile robot with two Microsoft Kinect sensors. In particular, the proposed baseline and hierarchical motion controllers show over 65% and 51% improvements over a reactive planner and predictive vector field histogram, respectively, in terms of the collision rate.

Keywords: Autonomous navigation, dynamic environments, Gaussian process regression, and learning curve of Gaussian process regression

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