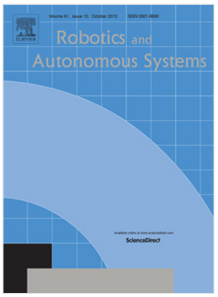
Accepted Manuscript



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Chen Fan, Zetao Chen, Adam Jacobson, Xiaoping Hu, Michael Milford

PII: S0921-8890(16)30799-0
DOI: http://dx.doi.org/10.1016/j.robot.2017.07.015
Reference: ROBOT 2886

To appear in: *Robotics and Autonomous Systems*

Received date : 18 December 2016
Revised date : 22 June 2017
Accepted date : 28 July 2017

Please cite this article as: C. Fan, Z. Chen, A. Jacobson, X. Hu, M. Milford, Biologically-inspired visual place recognition with adaptive multiple scales, *Robotics and Autonomous Systems* (2017), http://dx.doi.org/10.1016/j.robot.2017.07.015

Biologically-inspired Visual Place Recognition with Adaptive Multiple Scales

Chen Fan[12], Zetao Chen [3], Adam Jacobson[2], Xiaoping Hu[1] and Michael Milford[2]
[1]College of Mechatronic Engineering and Automation
National University of Defense Technology
[2]Australian Centre for Robotic Vision
Queensland University of Technology
[3]Department of Mechanical and Process Engineering
Swiss Federal Institute of Technology in Zurich
fanchen.nudt@hotmail.com

Abstract

In this paper, we present a novel *adaptive* multi-scale system for performing visual place recognition. Unlike recent previous multi-scale place recognition systems that use manually pre-fixed scales, we present a system that adaptively selects the spatial scales. This approach differs from previous multi-scale methods, where place recognition is performed through a non-optimized distance metric in a fixed and pre-determined scale space. Instead, we learn an optimized distance metric which creates a new recognition space for clustering images with similar features while separating those with different features. Consequently, the method exploits the natural spatial scales present in the operating environment. With these adaptive scales, a hierarchical recognition mechanism with multiple parallel channels is then proposed. Each channel performs place recognition from a coarse match to a fine match. We present specific techniques for training each channel to recognize places at varying spatial scales and for combining the place recognition hypotheses from these parallel channels. We also conduct a systematic series of experiments and parameter studies that determine the effect on performance of using different numbers of combined recognition channels. The results demonstrate that the adaptive multi-scale approach outperforms the previous fixed multi-scale approach and is capable of producing better than state of the art performance compared to existing robotic navigation algorithms. The system complexity is linear in the number of places in the reference static map and can realize the online place recognition in mobile robotics on typical dataset sizes. We analyze the results and provide theoretical analysis of the performance improvements. Finally, we discuss interesting insights gained with respect to future work in robotics and neuroscience in this area.

Keywords

Visual place recognition, SLAM, adaptive multiple scales, metric learning, biologically-inspired, grid cells

1. Introduction

Visual place recognition techniques operating at one fixed spatial scale, or over two, achieve impressive performance in robotic mapping and localization tasks [1-3]. Recent high profile discoveries in neuroscience have demonstrated that animals such as rodents, and likely many other mammals including humans, can navigate the world using multiple parallel maps, each of which encodes the world at varying spatial scales [4]. Unlike hybrid metric-topological multi-scale robot mapping systems, rodent maps are homogenous,