

An Interactive Approach to Solving Correspondence Problems

Stefanie Jegelka · Ashish Kapoor · Eric Horvitz

Received: 24 February 2013 / Accepted: 29 August 2013
© Springer Science+Business Media New York 2013

Abstract Finding correspondences among objects in different images is a critical problem in computer vision. Even good correspondence procedures can fail, however, when faced with deformations, occlusions, and differences in lighting and zoom levels across images. We present a methodology for augmenting correspondence matching algorithms with a means for triaging the focus of attention and effort in assisting the automated matching. For guiding the mix of human and automated initiatives, we introduce a measure of the expected value of resolving correspondence uncertainties. We explore the value of the approach with experiments on benchmark data.

Keywords Human interaction · Active learning · Value of information · Matching · Correspondence problems

1 Introduction

Identifying correspondences among similar or identical objects appearing in different images is a ubiquitous problem in computer vision, and promising advances have been made with algorithms for identifying such correspondences. Nevertheless, the success of these methods is variable and can be sensitive to multiple factors, including differences in image

resolution, lighting conditions and zoom level across images, occlusions that block views, and rigid or non-rigid deformations of objects. In hard cases, correspondence algorithms may return partial results where some subset of matches is identified with confidence. We describe a methodology for refining such partial matching results. Our methods selectively seek human or machine effort to resolve key uncertainties in correspondences.

We specifically pursue answers to the following questions: (1) *What kind of* additional information can be used to improve the mapping while being obtainable with reasonable effort, (2) how can such information be obtained *efficiently* in terms of computational effort and other costs, and finally (3) how can such additional information be *integrated* with ease so as to refine the correspondences?

We analyze the information gained with verifying correct and incorrect matches in a partial solution to a correspondence problem. Such verification resolves uncertainty about selected correspondences and, importantly, also introduces new structural and topological constraints in an interactive manner that guide forthcoming human efforts at resolving uncertainties about other correspondences. Beyond focusing the attention and effort of people, our methods can be used to triage the application of computationally intensive subroutines.

We focus on the use of methods that alternate between recruiting human assistance to verify the most informative matches and propagating their implications to compute an updated solution. Engaging people to assist introduces additional considerations of usability where we wish the tasks to be simple enough to be completed successfully by people. For example, we limit the verification of correspondences to pairwise checks.

Core contributions of this paper include (1) a decision-theoretic criterion for a cost-efficient, active selection of cor-

Work done during an internship of S.J. at Microsoft Research.

S. Jegelka (✉)
UC Berkeley, Berkeley, CA, USA
e-mail: stefje@eecs.berkeley.edu

A. Kapoor · E. Horvitz
Microsoft Research Redmond, Redmond, WA, USA
e-mail: akapoor@microsoft.com

E. Horvitz
e-mail: horvitz@microsoft.com