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How to Compare Noisy Patches? Patch Similarity Beyond Gaussian Noise

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Abstract Many tasks in computer vision require to match image parts. While higher-level methods consider image features such as edges or robust descriptors, low-level approaches (so-called image-based) compare groups of pixels (patches) and provide dense matching. Patch similarity is a key ingredient to many techniques for image registration, stereo-vision, change detection or denoising. Recent progress in natural image modeling also makes intensive use of patch comparison.

A fundamental difficulty when comparing two patches from "real" data is to decide whether the differences should be ascribed to noise or intrinsic dissimilarity. Gaussian noise assumption leads to the classical definition of patch similarity based on the squared differences of intensities. For the case where noise departs from the Gaussian distribution, several similarity criteria have been proposed in the literature of image processing, detection theory and machine learning.

By expressing patch (dis)similarity as a detection test under a given noise model, we introduce these criteria with a new one and discuss their properties. We then assess their performance for different tasks: patch discrimination, image denoising, stereo-matching and motion-tracking under gamma and Poisson noises. The proposed criterion based on the generalized likelihood ratio is shown to be both easy to derive and powerful in these diverse applications.

Keywords Patch similarity · Likelihood ratio · Detection · Matching

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1 Introduction

Patches are small image parts that capture both texture and local structure information. Though being crude low-level features compared to higher level descriptors, they have led to very powerful approaches in a wide range of computer vision tasks and image processing models.

To classify textures, Varma and Zisserman (2003) have shown that patch-based classifiers lead to better performance than higher-level features computed using filter banks. State-of-the-art methods for texture synthesis (i.e., generation of a larger image from a given texture image) or inpainting (i.e., filling missing information in images) heavily rely on the concept of patch (e.g. Efros and Freeman 2001; Liang et al. 2001; Kwatra et al. 2003; Criminisi et al. 2004). Image editing based on user-defined constraints is also performed through a decomposition into image patches (Cho et al. 2009).