Sub-pixel Stereo Matching

Neus SABATER, CMLA
Andres ALMANSA, LTCI
Jean-Michel MOREL, CMLA

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The obtention of 3D information from two images requires the perfect control of a long chain of algorithms: internal and external calibration, stereo-rectification, correlation, and finally 3D reconstruction. In this work we focus on the improvement of the correlation step.

Stereo matching is a key technique in computer vision. Its performance has improved significantly in the last decade [4, 2, 3]. The existing techniques can be divided between local and global. In this work we focus on local (block-matching) methods. Local methods rely on a comparison of a small number of pixels surrounding a pixel of interest and are sensitive to local ambiguities (occlusions, uniform textures, or lack of information). Blocks are usually compared by the normalized cross correlation (NCC) or the sum of squared differences (SSD).

To the best of our knowledge, the precision that can be attained in block matching has never been calibrated. The aim of this work is to discuss how to achieve (reliably) high precision block matches (up to 1/20 pixel accuracy and below). This discussion is not valid for completely general stereo matching tools. The observation conditions under which the discussion makes sense are: a wholly and accurately calibrated acquisition system, a small baseline (ranging from 0.2 to 0.05) and a very short time difference between both acquisitions, so that the acquired images are nearly identical. Such a highly accurate system has been recently proposed for information geographic systems in urban areas by [1]. The authors called this new stereo concept “small baseline stereovision” and discussed its feasibility. However, they did not develop a crucial point in the strategy, namely the algorithm by which high precision matches can be obtained from a small baseline stereo pair of images, or the practically attainable precision. In that setting a very strong sub-pixel accuracy is possible. We show mathematically and experimentally that if the images are carefully taken, then the disparity map in stereo-rectified images can be computed for a majority of image points to a 1/20 pixel precision under realistic noise conditions.

Références


