3D reconstruction, omnidirectional vision and understanding of scenes

(Extended abstract)

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1 Introduction

This text is related to the invited talk at the British Machine Vision Conference in Cardiff in September 2002 and highlights several recent contributions of our group to computer vision research. The aim is to hint the reader to several quite self-contained topics which we developed: omni-directional vision, scene reconstruction from images, and computational stereo. Pointer to results and references to appropriate publications are provided.

2 3D reconstruction from images

We built on our results in 3D reconstruction from N, $N > 3$, uncalibrated views having one view in common [15]. The issues related to known orientation of the rays in imaging geometry was studied [16, 17].

The method for recovery of projective shape and motion from multiple images by factorization of a matrix containing the images of all scene points was proposed. The approach can handle perspective views and occlusions jointly. The method is particularly suited for wide base-line multiple view stereo [4].

3 Omni-directional vision

We have been studying omni-directional cameras since 1996, designed several cameras using hyperbolic mirrors, derived the epipolar geometry for central catadioptric cameras [14, 9]. Our design was adopted by our spin-off company Neovision which manufactures and sells mirrors or cameras (see http://www.neovision.cz). The omni-directional camera used for self-localization of an observer using zero phase representation can be roughly compared with image-based compass [8].

Within the EU IST project *Omniviews* the hyperbolic mirror was combined with University of Genova (G. Sandini) log-polar sensor and called SVAVISCA. The question of uniform image resolution arose and was solved [3].

A technique was suggested for $360^\circ \times 360^\circ$ mosaicing with a very wide field of view fish eye lens. Standard camera calibration was extended for lenses with a field of view

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bigger than $180°$. The calibration was demonstrated on a Nikon FC-E8 fish eye converter. The setup was used to create a $360° \times 360°$ mosaic which provides $360°$ field of view in both vertical and horizontal direction [1].

The epipolar geometry task and related geometric constraints were generalized for non-central cameras, i.e. cameras with rays not intersecting in one point [6, 7].

4 Computational stereo

The stereo reconstruction from polynocular stereo and its novel components is described in [10].

The stable monotonic matching as a principled way how to find stereo correspondence [11]. The technique is further developed to find the largest unambiguous component of stereo matching [12].

Rectification of three independent views is proposed. Through decomposition to projective and affine components, we obtain the rectifying homographies with a linear computational method [18].

J. Matas suggested a new concept called distinguished regions. The idea is to provide more rich image structure for image retrieval or wide-baseline stereo [5]. Several image modalities lead to distinguished regions. One example is texture [2]. Three related papers will be presented at this very British Machine Vision conference: (1) Object Recognition using Local Affine Frames on Distinguished Regions by S. Obdržálek and J. Matas, (2) Robust Wide Baseline Stereo from Maximally Stable Extremal Regions by J. Matas, O. Chum, M. Urban, and T. Pajdla, (3) Randomized RANSAC with $T(d, d)$ test by J. Matas and O. Chum.

The statistical and structural pattern recognition in computer vision methods are penetrating to computer vision. A few theoretical contributions to pattern recognition can be found in our recent monograph [13].

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