Region-based top-down segmentation adapted to stereo matching

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Abstract

We present region based image processing algorithms participating in task sequencing for stereo vision. The algorithms described here are prior to stereo matching. Requirements in image similarity provide helpful additional knowledge for their improvement. We describe first a resursive region division algorithm using a thresholding method based on contrast maximization. The regions are processed in parallel and absorb their noise before being thresholded. Subsequent morphological processes improve similarity and matching results. Additional knowledge is produced by analytical processes, and is useful for both segmentation and match control. Results are presented for a stereo pair of gray level images, see figure 1.

1 Introduction

The main tasks contributing to 3-D reconstruction of a scene are : segmentation of a stereo pair of images, stereo matching and depth computation. The success of each job depends on the results of the previous one. The basic tenet of our study is that, although none of these processes must be committed to any particular prior one, all of them should rely on correct input. Especially, segmentation results and any input for the matching process will have to respect the following principle, see [1] : *The two images of a stereo pair have to be similar except where the two eyes see different things.*

2 Description of Work

Parallel Recursive Region Thresholding The algorithm is a region-recursive application of Kohler's thresholding method, see [2]. The selected threshold s^* maximises $avcs(s)$ which is the average relative contrast measured at pixels whose feature value is s. The regions are processed in parallel. Only one image scanning is necessary for one image division step. Results are shown in figure 2.

Noise Cleaning Region division often produces numerous very small and meaningless regions. They increase computational complexity and perturb similarity between the two images. See figure 2. Noise cleaning concerns 1 or 2 pixels regions. Their label and feature value are merged into their context *during* segmentation, in order to maintain data ho mogeneity. See results in figure 3.

Erosion and Dilatation The splitting algorithm pro duces numerous filiform outgrowths of regions. Segmentin a "valid" region leads to the separation of the interior of region from its boundary. The latter is composed of sma filiform regions which can neither be approximated nor in terpretated nor matched. A single one-pixel wide erosio removes all 2-pixel wide elements. The gaps are then fille by a maximum of n constrained dilatation steps, n being th number of image divisions already done. Only the labelle images are transformed; see results in figure 4.

Matching Results The algorithm, has been written b [3]. It maintains a hierarchy of segmented regions in eac image, corresponding to analysis at different levels. Regio matches are evaluated according to similarity in the follow ing attributes: size, feature mean and position of center o gravity. Matches are searched accross levels of segmentatio Figure 5 compares results for one level.

Analytical Approximation The intensity of the re gions produced by this division method may mostly be fitte by a 1st-order analytical approximation. The results are us able for segmentation enhancement. Overdivided adjacen regions can be merged into 2nd-order approximated one Significant error clusters within a region may lead to its fu ther division. The algorithm, see [4], minimizes an L1-norm by using a dual simplex method. Approximation results ca also be exploited during the matching and 3-D reconstructio steps. Approximated images are shown in figure 6.

3 Conclusions

Direct matching oriented segmentation improvement, includ ing a region division strategy, "integrated" noise cleaning erosion, and dilatation have been shown. Analytical post processing provides additional knowledge and more indirec segmentation correction.

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Figure 1: the original stereo pair of grey level images

Figure 3: segmentation including noise cleaning. Le
image: 4th level, right image: 5th level.Both speed an
similarity are improved

Figure 2: the 6th level of segmentation without elimination of noise

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Figure 4: erosion and constrained dilatation

Figure 5: matching results. Top pair: on raw segmented images 19 matches were found. Bottom pair: on dilatated images 35 were found

Figure 6: first order analytical approximation, too small regions were given their original grey level value