The Disparity Pyramid: An Irregular Pyramid Approach for Stereoscopic Image Analysis

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Abstract

The disparity pyramid is a proposed solution for the problem of disparity estimation using a stereoscopic pair of images. This pyramid can be classified within the class of data-dependent irregular pyramids. The hierarchy of the pyramid is achieved by successive calculations of a set of levels. These calculations are done over a disparity range to get the difference in intensities between the two images. Unlike some other pyramids, and according to input values and/or distances between disparity vectors, the top level of this pyramid may consist of more than one cell. Thus, in terms of geometry, its shape looks like an incomplete pyramid with a flat top level and irregular sides.

1 Introduction

Disparity Estimation concerns finding pairs of point features in two perspective views of a scene such that each pair corresponds to the same scene point. Usually, the relationship between the viewpoints used to obtain the two images is unknown. In general, the two subsets of points are locally intensity matched and preserve the interpoint geometrical structure. As is true for most matching algorithms, the underlying principle for matching is geometrical similarity and/or intensity (or colour) similarity [5]. However, this similarity measure may cause some confusion when repeated many times within the same region and unfortunately this is the usual case. So we claim that the segmentation of the image according to the disparity variation would help eliminate this problem.

There is no standard approach to segment a scene. Many different types of image or scene parts can serve as the segmentation. Depending on which descriptions are based, there are many ways in which one can attempt to extract these parts from the image. However, we need tools that rapidly provide useful information and we claim that pyramids are such tools. For example, Jolion and Montanvert proposed the adaptive pyramid [6] which is an irregular pyramid used to segment the image according to the different gray levels included. Another similar pyramid called the stochastic pyramid was proposed in [10]. A few attempts using the regular pyramids in disparity estimation were introduced, e.g., refer to [2, 17, 14, 4, 16]. However, they were all constrained by the structure of the quad-pyramid in which one parent has exactly four children. For further discussion on the regular pyramids, refer to [7] and on stereo vision, refer to [11, 1, 3, 9, 13, 15, 8, 12]. One proposed technique using the concepts of disparity and irregular pyramids is presented in this paper.

2 Intensity-based matching

Applying to all the points in the image, a difference measure is computed over a window W. This window is determined by a disparity range $(dx_{min}, dx_{max}, dy_{min}, dy_{max})$. Let $f_1(x, y)$ be the image intensity at the point (x, y) in the first image and $f_2(x, y)$ be the image intensity at the point (x, y) in the second image. Then, over all the points in the window W, we apply the difference formula:

$$F_{xy}(dx, dy) = \sum_{i,j=-1}^{i,j<2} \{f_1(x+i, y+j) - f_2(x+i+dx, y+j+dy)\}^2 \quad (1)$$