

Object Extraction Using Cost Function with Intensity and Disparity in 3D Stereoscopic Images

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Abstract. In this paper, we propose the method to extract objects with excessive disparities in 3D stereoscopic images using cost function considering the intensity and the depth information. The traditional region segmentation methods use only intensity in 2D images. The 3D stereoscopic images have the additional information that is disparity. In the proposed method, first, the excessive disparity candidate regions are decided using the adaptive threshold in the disparity-map. Next, the extracted excessive disparity candidate regions are labeled to object regions and the other regions are background. The object regions are set as ROI (region of interest). The proposed segmentation method is applied in the ROI of 3D stereoscopic left image. Finally, the excessive disparity object is extracted through eliminating small regions.

Keywords: 3D Stereoscopic images, Region-based Segmentation, Adaptive Threshold.

1 Introduction

Stereoscopic image viewing comfort is one of the main problems that should be solved before the mass market proliferation of stereoscopic 3D content services. Some visual discomforts may occur due to excessive demand on the accommodation-vergence linkage, that is excessive disparities, fast local and global motion, and various stereoscopic distortions [1-3].

In Yuan's method [4], the discomfort and fatigue in 3D stereoscopic images occur from the recognition error of depth information made by excessive positive and negative disparities. The recognition error of depth information is detected by measurement of perceived depth on screen and fixed by depth tuning methods as the depth shift and the depth scaling. Here, if some perceived depths are outside the pre-defined threshold in histogram of disparity map, those perceived depths are regarded as the excessive disparities and fixed by depth tuning methods.

There are some problems in detection of the excessive disparities based on the histogram. Because objects in 3D stereoscopic images have three-dimensional

position and depth depending on the difference of lighting effects, such as smoking. The excessive disparities are also generated locally by particular objects. The histogram based method does not correctly detect it because of inaccuracy in disparity detection made from occlusion or noise. The many small isolated excessive disparity regions may be occurred. To reduce the problem, segmentation method is required additionally.

In this paper, we propose the method to extract objects with excessive disparities in 3D stereoscopic images using cost function considering the pixel intensities and the depth information that is disparities. The traditional region segmentation method such as CLRG(Centroid Linkage Region Growing)[5] used in the general images is processed only based on intensity information. 3D stereoscopic images have the additional information that is depth. In the proposed method, first the excessive disparities regions are extracted using the adaptive threshold in the disparity-map. Next the extracted regions are labeled to object regions and the other regions are background. The regions labeled as object are set as ROI that will be segmented in 3D stereoscopic left image. The proposed segmentation method considering the intensity and the depth is applied in this ROI region. To eliminate small regions, the morphological filter is used as post processing.

2 The Proposed Method

We propose the method to extract objects with excessive disparities in 3D stereoscopic images using cost function considering the pixel intensities and the depth information, disparities. The conventional segmentation method considers the only pixel intensities in 2D images. Because 3D stereoscopic images have the additional information that is depth or disparities, the proposed method considers the both pixel intensities and the disparities.

The block diagram of the proposed method is as follows:

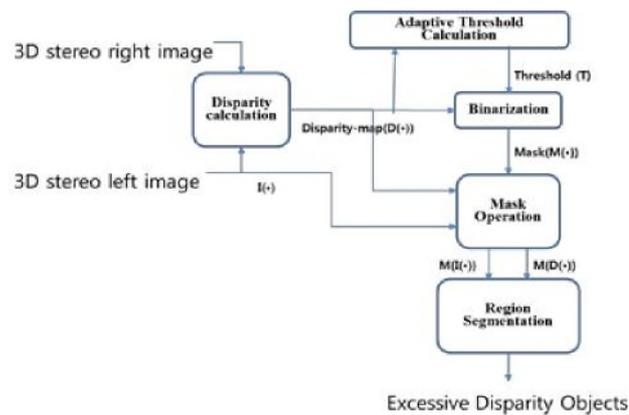


Fig. 1. Block diagram of the proposed method.

Disparity calculation: A block matching algorithm is used to calculate disparities between left and right images.

Adaptive Threshold Calculation and Binarization: The histogram represents the relative frequency of occurrence of the various gray levels in the image. The histogram of disparity-map is generally not uniform but concentrated in the specific range. To decide the adaptive threshold, we first find the upper and lower limits of the range that the histogram is concentrated. In the only upper 75% area between upper and lower limits, we apply the Otsu's threshold decision method. This method selects the value that maximizes the between-class variance defined as

$$\sigma_B^2(T) = P_1(T)(\mu_1(T) - \mu)^2 + P_2(T)(\mu_2(T) - \mu)^2 \quad (1)$$

where μ is the mean of the total pixels, $\mu_i(T)$ is the mean of each class defined by the threshold T , and $P_i(T)$ is the relative frequency of each class. To determine the threshold T maximizes $\sigma_B^2(T)$, $\mu_i(T)$ and $P_i(T)$ have to be determined for all T . If the value of a pixel is over the threshold T , it is classified into the excessive disparity candidate pixel.

Mask operation: The extracted excessive disparity candidate pixels are labeled to object pixels and the other pixels are labeled to background pixels.

Region Segmentation: The masked 3D stereoscopic left image will be segmented using image segmentation method. CLRG is the region-based method which is the simple and the most frequently used. CLRG cannot distinguish the neighboring regions which have the similar intensities at region boundary partially. In the entire image the specific target object detection is not easy. Although in our method, the mask(ROI) operation improves the performance of the target object segmentation to reduce the range of segmentation, the additional method is required. The 3D stereoscopic images have the additional information that is depth, disparities. We can define the cost function considering the additional depth information as follows:

$$C(R_m, X_0) = \sqrt{(R_m - I(X_0))^2 + \alpha(D_m - d(X_0))^2} \quad (2)$$

Here, D_m and R_m are the disparity and intensity mean of the m -th region R_m , and $d(X_0)$ and $I(X_0)$ are disparity and intensity value of a pixel X_0 , α is the constant.

3 Simulation Results and Remarks

The "Art" image in Middlebury University dataset was used in this paper's simulation. Fig. 2 shows the histogram and the binary image made by the adaptive threshold ($T = 198$) in disparity-map of the "Art" image. Fig. 3(a), (b) shows the segmentation results in 3D stereoscopic left image. Fig. 3(c) shows the extracted object as the excessive disparity region in the proposed method. In Fig. 3(a), a small plaster manipulation is partitioned to a number of small regions but the front part of table is made to a region linked to small plaster manipulation. It's impossible to separate the small plaster manipulation from the front part of table using the post processing. On the other hand, in Fig. 3(b), the proposed method's result, the front part of table is

partitioned to a number of small regions because its disparities are spread. The small plaster manipulation is made to almost one region. In simulation results, we extracted the object which has the excessive disparities and the similar disparities with those of the neighbor objects using the additional intensity information effectively.

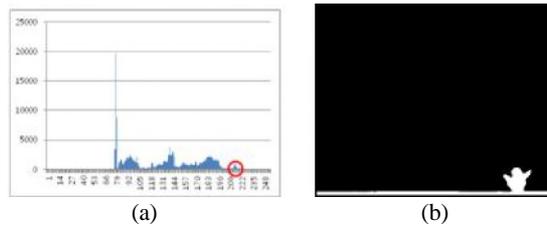


Fig. 2. The Binary image obtained by adaptive threshold in disparity-map: (a) Histogram of disparity-map; (b) binary image.

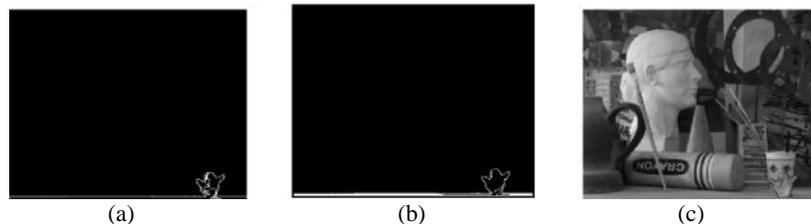


Fig. 3. Segmentation results in the left image: (a) The segmentation result using only intensity; (b) the segmentation result using intensity and disparity; (c) the excessive disparity object.

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