REGION-BASED FOREGROUND EXTRACTION

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Abstract

We propose a region-based method to extract foreground regions from colour video sequences. The foreground region is decided by voting with scores from background subtraction to the sub-regions by graph- based segmentation. Experiments show that the proposed algorithm improves on conventional approaches especially in strong shadow regions.

1 Introduction

Background subtraction is one of the most common approaches for detecting foreground regions. However, conventional methods based on colour models do not provide enough information to effectively segment foreground regions as seen in Fig. 1(a)~(d). In this paper, we propose a region-based foreground extraction method which is robust against strong shadows and preserves object boundaries.

2 Proposed algorithm and results

Initial classification is performed by subtracting *RGB* channels and refining it with the difference of *H*(hue) components from background model. We classify the subtracted values into four classes using three thresholds and allot scores from 3 to 0 according to their classes: definite foreground; possible foreground; possible background; and definite background.

A graph $G=(V,E)$ is constructed for the input image, where $v_i \in V$ is the set of pixels and $(e_{ij}) \in E$ is the edge between neighbouring elements (v_i, v_j) with a weight $w(e_{ij})$. We set the edge weights with according to the neighbour difference after background subtraction I_{BS}, gradient of the input image ∇I and attenuated edge weight $G(i) = \left|Sobel(I(i)) - Sobel(I_{back}(i))\right| \cdot$

$$w(e_{ij}) = \left|I_{BS}(i) - I_{BS}(j)\right| + \lambda\left|\nabla I_j(i)\right| \cdot \left(1 - \frac{1}{1+(G(i)/30)^2}\right) \quad (1)$$

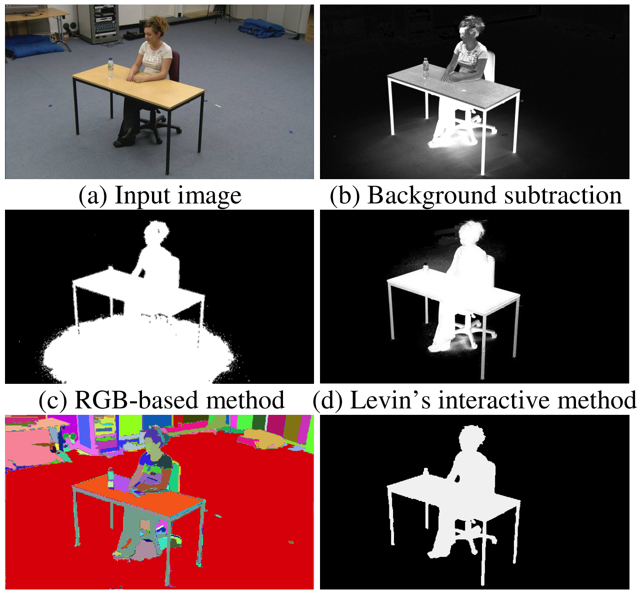
The graph is cut into regions *R* using the minimum spanning tree (MST) [1] so that it minimizes the internal difference $Int(R_r)$ and maximizes external difference $Ext(R_r,R_s)$ between different regions. We use Felzenszwalb's criteria to optimize the graph-cut [2]. The method cuts edges if two neighbouring regions satisfy the following condition.

$$Ext(R_r, R_s) > Int(R_r, R_s) \quad (2)$$

$$Ext(R_r, R_s) = \min_{i\in R_r, j\in R_s} w(e_{ij})$$

$$Int(R_r, R_s) = \min\left(\max_{e\in R_r} w(e) + k/|R_r|, \max_{e\in R_s} w(e) + k/|R_s|\right)$$

Finally, each region is classified into background or foreground by voting with the scores of pixels in the region.



(a) Input image (b) Background subtraction
(c) RGB-based method (d) Levin's interactive method
(e) Regions by graph (f) Final result

Figure 1: Segmentation results

The algorithm has been tested with the same parameters on a set of 24 images with various indoor scenes. Consistent improvements in foreground segmentation are obtained over several state-of-the-art approaches [3]. Figure 1(e) shows the sub-regions segmented by the graph, and Fig.1(f) is the final result. Comparing to Fig. 1(c) by RGB-based background subtraction and Fig. 1(d) by Levin's closed-form solution algorithm [3], the proposed algorithm produces improved results especially in the strong shadow regions.

3 Conclusion

In this paper, we proposed a region-based algorithm for foreground extraction that is robust against shadows. The approach can fail to segment if the image has serious motion blur or highly complicated backgrounds. Future work aims to overcome limitations due to complicated backgrounds.

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References

[1] C.T. Zahn. "Graph-theoretical methods for detecting and describing Gestalt clusters," *IEEE Trans. Computers*, vol.20, pp. 68-86, (1971)

[2] P.F. Felzenszwalb et al. "Efficient Graph-Based Image Segmentation," *IJCV*, vol.59, pp.167-181, (2004)

[3] A. Levin et al. "A Closed Form Solution to Natural Image Matting," *IEEE PAMI*, vol.30, pp.228-242,(2008)