http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (3): 518-521, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.518.521

Shadow Verification Based on Feature Matching and Image Matting

Liang Zhang, Xiaomei He and Haili Wang
Tianjin Key Lab for Advanced Signal Processing, Civil Aviation University of China, China

Abstract: Moving object detection is the basis for reliable high level processing such as object tracking and action recognition. Shadow verification processes are very important to ensure integrality of extracted moving objects. Moving features appear in detected shadow regions indicate classification errors. The proposed method identifies false detected shadows by detecting moving features and corrects those classification errors by means of image matting operated on candidate shadow regions. Existing approaches for image matting require manual labeling of foreground and background. We propose an automatic scribbling method followed by a closed-form matting process to solve the coefficient alpha. Then, the alpha image is binarized directly to avoid time-consuming computation for reconstructing foreground. Experiments demonstrate that our method can improve the moving object segmentation effectively even in the case of object parts and shadows presenting similar characteristics.

Key words: Moving object detection, shadow verification, feature matching, image matting

INTRODUCTION

In intelligent visual surveillance system, robust tracking of objects calls for a reliable and effective moving object segmentation. Shadows can cause object merging, shape distortion and even object losses. In order to keep the integrality of detected moving objects, the shadow regions in the foreground must be identified carefully (Prati *et al*., 2003; Cohen and Medioni, 1999; Graham *et al*., 2009). Many cues, such as color, edge, texture and shape, can be used to do shadow classification (Wen *et al*., 2011).

A common way for shadow detection is to use gray level and color information (Cucchiara *et al*., 2001; Salvador *et al*., 2004; Horprasert *et al*., 1999). But foreground objects may have very similar features with the real shadow, i.e., the foreground objects have similar color and lower intensity than corresponding background. So it becomes not reliable to detect moving shadows using only gray level and color information of the isolated points (Wang *et al*., 2006). To solve this problem, a verification step can be performed to reject false shadow detections after using gray level and color information. Most existing methods are designed for vehicle and strongly depend on geometric properties of shadow regions (Wang *et al*., 2006; Chen and Chen, 2006; Dong *et al*., 2009; Roser and Lenz, 2011; Lee *et al*., 2009). In this study, we settle the problem using SIFT (Scale Invariant Feature Transform) matching and image matting.

Image matting requires manual labeling of foreground and background in advance. We propose an automatic scribbling method based on feature matching to provide proper scribbles of the foreground and background. And then, a closed-form matting method proposed by Levin *et al*. (2008) is utilized to perform matting. After obtaining the alpha image, we make binarization directly to localize false detected shadows, avoiding time-consuming computation for reconstructing foreground.

THE PROPOSED APPROACH

We identify fake shadow regions by the following steps. First, foreground regions are obtained through background subtraction. Second, candidate shadow regions are detected by exploiting rgb color model proposed by Chen and Chen (2006). Third, an automatic scribbling method based on feature matching is used for foreground scribbles and part of background scribbles. The other part of background scribbles is just the result of background subtraction. Finally, a closed-form matting method is utilized to extract an alpha matte matching the scribbled image.

SIFT has been designed for extracting highly distinctive invariant features from images (Lowe, 2004). In theory, SIFT features located in real shadow regions are stationary. But in fact, there might be a little change in these locations due to noise or other factors. The average displacement (μ_x, μ_y) of all the SIFT features can be set as a threshold T. The displacement of a feature point is

Corresponding Author: Liang Zhang, Tianjin Key Lab for Advanced Signal Processing, Civil Aviation University of China, 300000, Tianjin, China

denoted as (Δx, Δy). Then the rules are as following: If $\Delta x>\mu_x$ or Δy, μ_y then the feature point is considered as a moving one.

We introduce a label vector for each frame to avoid classify the feature points in real shadow regions as moving ones. The label vector record motion information for feature points. It is composited of zero, one and two. Where the number zero indicates an unmatched feature point, the number one indicates a moving feature point and the number two indicates a static feature point.

The label vectors of frame (N-1) and N are denoted as f and e, respectively. For the current frame N, the label vector e is obtained by above mentioned rule. The speed of the object is variable in different frames, so it may appear that certain features in the object are classified as moving feature points in several consecutive frames but later classified as static feature points in current frame. To avoid wrong classification, we use the following rule: if e (i) = 2 and f (match (i)) = 1, then e′ (i) = 1. Where match (i) denotes the index of the matched feature point in the frame (N-1) corresponding to the i-th feature point in the frame N. After finishing the above process, the label vector is updated by f = e′.

After obtaining the label vector e′, the foreground and background are scribbled according to e′.

As to the i-th feature point, if e′ (i) = 1, a small image window with the size of 5*5 is placed around the feature point and set the pixel values inside the window to be 255 (Fig. 1a). As illustrated in Fig. 1b, the label foreground scribbles (1). After doing this, a small pot of real shadow points may be labeled as moving ones. In order to identify the moving features more exactly, we utilize the variance of the pixel intensities over the small window to verify the labeled foreground pixels. If the variance of the intensities in the j-th scribbled window is very small, the pixel values are set to be 0. As illustrated in Fig. 1b, the label background scribbles (1).

The second part of the foreground scribbles is based on the shadow detection results of normalized rgb. Small

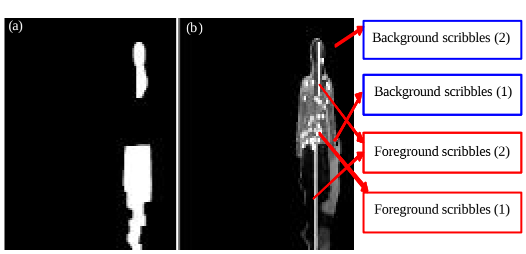

Fig. 1(a-b): Scribbles of foreground and background, (a) Incomplete object regions and (b) Final constrained image. The pixels scribbled in white indicate foreground and the pixels scribbled in black indicate background

windows with the width of 3 or 5 pixels are placed around the sub-region centroids of object regions obtained via normalized rgb. The pixels over those small windows are set to be 255. As illustrated in Fig. 1b, the label foreground scribbles (2).

The background regions in binary image obtained through background subtraction are all considered as background scribbles. As illustrated in Fig. 1b, the label background scribbles (2). Due to so many background scribbles, the computation of matting algorithm will be greatly reduced.

The closed-form matting algorithm proposed by Levin *et al*. (2008) is used to extract a high-quality alpha image with a small amount of user input. This method can compute α directly by roughly estimating for foreground and background. To obtain an alpha matte matching the constrained image, the following linear system is solved.

$$(L+\lambda D_S)\ \alpha = \lambda b_S \tag{1}$$

where, L is matting Laplacian, λ is some large number, D_S and b_S are, respectively a diagonal matrix and a vector containing the constraint information. Details about (1) can be referred to Levin *et al*. (2008).

We use the gray level images for matting to reduce computation. Due to time consuming computation for reconstructing foreground, we binarize the alpha image directly. After binarization, morphologic processing for the binary image is performed to get the corrected object region.

RESULTS AND DISCUSSION

The proposed method is tested with a video sequence captured with a fixed camera in an office. The image is of size 320×240. When the method of normalized fgb is used, false shadow detection appears in sixty frames, from 310th to 369th frame.

The result of the binarization and morphologic processing of an alpha image is shown in Fig. 2. An example of the whole matting process is depicted in Fig. 3.

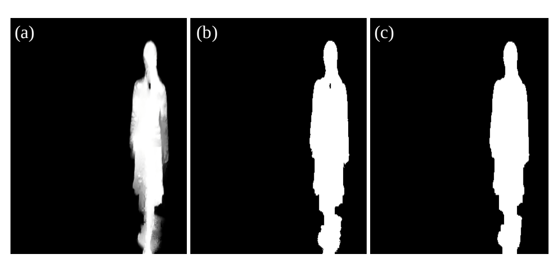

Fig. 2(a-c): From the alpha image to the object mask, (a) The alpha image, (b) Binarized image and (c) After morphologic processing

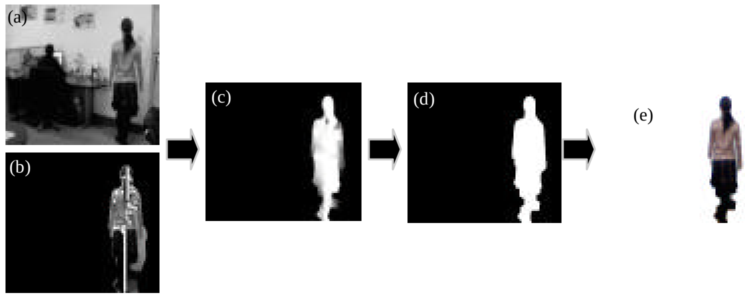

Fig. 3(a-e): Result of the matting process, (a) The input image (b) Automatically scribbled image, (c) Alpha image, (d) Binarization, morphologic processing and (e) The final object

Fig. 4(a-c): Shadow detection compared with normalized rgb, (a) Nnormalized rgb, (b) The proposed method and (c) The extracted objects, respectively. The white regions indicate foreground

Figure 4 shows visual comparisons between the proposed method and the commonly used shadow eliminating method of normalized rgb. The left pictures in Fig. 4 are results of the normalized rgb method, from which we can see that a large part of moving object has been detected as shadow. This is due to the fact that the clothes and corresponding background have similar color. In addition, the clothes are slightly darker than the background. This portion of the clothes has therefore the same characteristics as a shadow cast on the background. The right ones are the corresponding results of our method from which we can see that the object of interest is retained as much as possible and the real shadow is removed as much as possible. The small remaining shadow under the object's elbow has not been eliminated. But it doesn't change the shape of the moving object obviously.

CONCLUSION

This study presenteda scheme to deal with the incomplete extraction of moving human objects due to shadow elimination. The key point of this work is mainly focused on using SIFT matching to provide automatic scribbles for image matting. Experiments show that this method can improve the moving object segmentation effectively.

ACKNOWLEDGMENT

This work is supported by the Natural Science Foundation of China under grant 61179045.

REFERENCES

Chen, B.S. and D.S. Chen, 2006. Shadow detection based on rgb color model. Intell. Comput. Signal Process. Pattern Recognit., 345: 1068-1074.

Cohen, I. and G. Medioni, 1999. Detecting and tracking moving objects for video surveillance. Proceedings of IEEE International Conference on Computer Vision and Pattern Recognition, Volume 2, June 23-25, 1999, Fort Collins, pp: 319-325.

Cucchiara, R., C. Grana, M. Piccardi, A. Prati and S. Sirotti, 2001. Improving shadow suppression in moving object detection with HSV color information. Proceedings of IEEE International Conference on Intelligent Transportation Systems, August 25-29, 2001, USA., pp: 334-339.

Dong, X., K.D. Wang and G.H. Jia, 2009. Moving object and shadow detection based on RGB color space and edge ratio. Proceedings of the 2nd International Congress on Image and Signal Processing, October 7-19, 2009, Tianjin, China, pp: 1-5.

Graham, D.F., S.D. Mark and C. Lu, 2009. Entropy minimization for shadow removal. Int. J. Comput. Vision, 85: 35-57.

Horprasert, T., D. Harwood and L.S. Davis, 1999. A statistical approach for real-time robust background subtraction and shadow detection. Proceedings of IEEE International Conference on Computer Vision, September 20-27, 1999, Kerkyra, Greece..

Lee, B.E., T.B. Nguyen and S.T. Chung, 2009. An efficient cast shadow removal for motion segmentation. Proceedings of the 9th WSEAS International Conference on Signal Processing, Computational Geometry and Artificial Vision, August 20-22, 2009, Moscow, Russia, pp. 83-87.

Levin, A., D. Lischinski and Y. Weiss, 2008. A closed-form solution to natural image matting. PAMI, 30: 228-242.

Lowe, D.G., 2004. Distinctive image features from scale-invariant keypoints. Int. J. Comput. Vision, 60: 91-110.

Prati, A., I. Mikic, M.M. Trivedi and R. Cucchiara, 2003. Detecting moving shadows: Algorithms and evaluation. Pattern Anal. Mach. Intell., 25: 918-923.

Roser, M. and P. Lenz, 2011. Novel two-stage algorithm for non-parametric cast shadow recognition. Proceedings of the Intelligent Vehicles Symposium, June 5-9, 2011, Baden-Baden, Germany, pp: 1116-1121.

Salvador, E., A. Cavallaro and T. Ebrahimi, 2004. Cast shadow segmentation using invariant color features. Comput. Vision Image Understanding, 95: 238-259.

Wang, Y.Q., M. Tang and G. X. Zhu, 2006. An improved cast shadow detection method with edge refinement. Proceedings of the Sixth International Conference on Intelligent Systems Design and Applications, Volume 2, October 16-18, 2006, Jinan, pp: 794-799.

Wen, F., Z.S. Qu and J.H. Yan, 2011. Moving shadow detection by integrating multiple features. J. Harbin Inst. Technol., 43: 13-19.