Moving Vehicle Tracking for the Web Camera

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Abstract. In this paper, color invariant co-occurrence features for moving vehicle tracking in a known environment is proposed. It extracts moving areas shaped on objects in Web video sequences captured by the Web camera and detects tracks of moving objects. Color invariant co-occurrence matrices are exploited to extract the plausible object blocks and the correspondences between adjacent video frames. The measures of class separability derived from the features of co-occurrence matrices are used to improve the performance of tracking. The experimental results are presented.

1 Introduction

Tracking the motion of objects in video sequences captured by the Web camera is becoming important as related hardware and software technology gets more mature and the needs for applications where the activity of objects should be analyzed and monitored are increasing [1]. In such applications lots of information can be obtained from trajectories that give the spatio-temporal coordinates of each object in the environment. Information that can be obtained from such trajectories includes a dynamic count of the number of object within the monitored area, time spent by objects in an area and traffic flow patterns in an environment [2][3][4][5]. The tracking of moving object is challenging in any cases, since image formations in video stream is very sensitive to changes of conditions of environment such as illumination, moving speed and, directions, the number and sizes of objects, and background. Color image can be assumed to contain richer information for image processing than its corresponding gray level image. Obviously three color channels composing color images give richer information than gray level counterparts. Invariance and discriminative power of the color invariants is experimentally investigated here as the dimensions of co-occurrence matrix and the derived features for finding correspondences of objects. William [7] suggests motion tracking by deriving velocity vectors from point-to-point correspondence relations. Relaxation and optical flow are very attractive methodologies to detect the trajectories of objects [8]. Those researches are based on the analysis of velocity vectors of each pixel or group of pixels between two neighboring frames. This approach requires heavy computation for calculating optical flow vectors. Another method infers the moving information by computing the difference images and

J.M. Cueva Lovelle et al. (Eds.): ICWE 2003, LNCS 2722, pp. 267–270, 2003.

edge features for complementary information to estimate plausible moving tracks [4][9]. This method may be very sensitive to illumination and noise imposed on video stream.

2 Methodology

Many block detection methods assume that the lighting in the scene considered would be constant. The accuracy of these methods decreases significantly when they are applied to real scenes because of constantly changing illumination conditioned on background and the moving objects. Kubelka-Munk theory models the reflected spectrum of a colored body based on a material-dependent scattering and absorption function, under assumption that light is isotropically scattered within the material [12][13]. *H* is an object reflectance property independent of viewpoint, surface orientation, illumination direction, illumination intensity and Fresnel reflectance coefficient. These color invariants may show more discriminative power than gray levels, so can be used

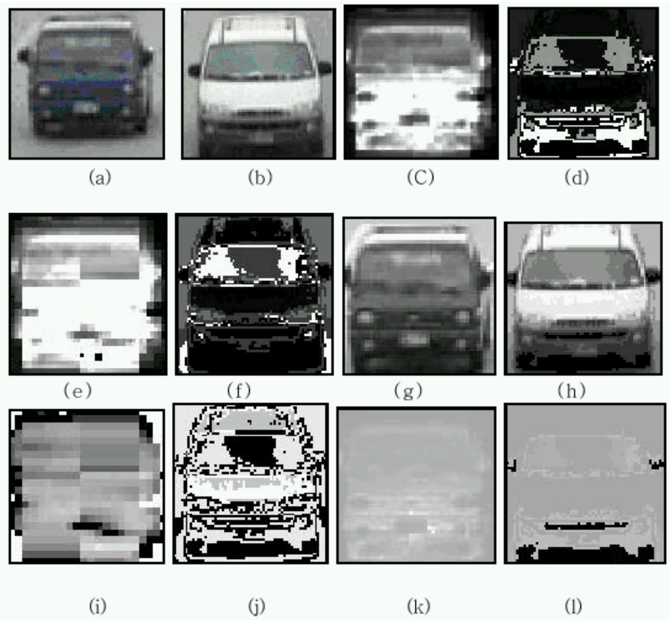
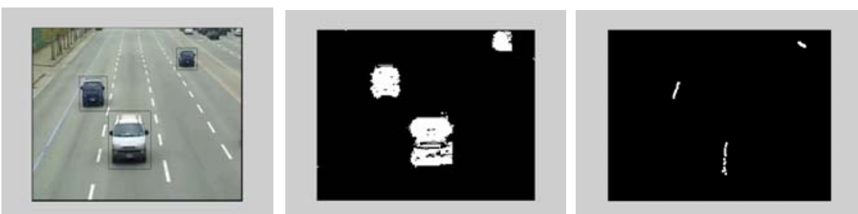


Fig. 1. (a) (b) Two original color images (truck and van), (c)(d) *C_invariant*, (e)(f) *E_variant*, (g)(h) *Intensity* (i)(j) *Hue*, and (k)(l) *Saturation*. The intensities are rescaled for viewing.

for detection of the trajectories of objects reliably. To get these spectral differential quotients, the following implementation of Gaussian color model in RGB terms is used (for details, see [12]). Figure 1 shows the original color images and the results after computing the color invariance maps. Since the object detected with its bounding rectangular block in current frame should be uniquely associated with the corresponding block in neighboring frame, each block should have local block features possessing proper discriminating power. There are many researches done in this area [8][9]. The co-occurrence matrix is a well-known statistical tool for extracting second-order texture information from images. Entropy is a measure of randomness and takes low values for smooth images. Inverse Difference Moment (IDM) takes high values for low-contrast images due to the inverse $(i - j)^2$ dependence. Correlation is a measure of image linearity, that is, linear directionality structures in a certain direction result in large correlation values in this direction. Energy or angular second moment is a measure of image homogeneity-the more homogeneous the image, the large the value. The optimal features and other related conditions for class separability should be determined from the implementation reasons,. In this paper, a set of simpler criteria built upon information related to the way feature vector samples are scattered in the *l*-dimensional space is adopted. The goal of object tracking is to determine the 3-D positions and the motion parameters of objects recognized by the local block detection phase at every time instant. The first requirement for this task is to determine the correspondence of each object detected from adjacent image frames. To establish the correspondence relations of blocks between sequential frames, the selected feature values of local blocks at time *t* are compared with those of blocks detected at time *t+1*.

$$(x^{'}, y^{'}) = \arg\min_{k} D_{\lambda}(D_t^k(x, y), D_{t+1}^k(x^{'}, y^{'})) \tag{1}$$

where (x,y) is the central position of D_t^k, which is the *k*th detected blocks in D_t. The function D_λ is defined by computing the weighted L_2 error of the transformed data using a combination of feature value difference and Euclidean distance C_t^k between the central positions of D_t^k and D_{t+1}^k.



(a) (b) (c)

Fig. 2. (a) The original video frame tested and resultant detected blocks, (b) Detected blocks by color invariant features and (c) The detected tracks of three objects given in (a)

Figure 2 shows the detected tracks of three vehicles. In this experiment, d=1, and correlation feature is used.

3 Conclusions and Future Research

A system for tracking objects for a Web camera using color invariance features is presented. The system outputs tracks that give spatio-temporal coordinates of objects as they move within the field of view of a camera. We try to solve the occluded objects problem, which may be ignored in many researches intentionally by utilizing radial cumulative similarity measures imposed on color invariance features and projection. But the projection scheme presented here is too primitive to solve this problem. But this system is very fast to be used in real time applications and to eliminate noise, which may be very difficult when using gray level intensity only. Future research needs to address these kinds of issues and tracking objects across moving Web cameras.

References

1. Ismail Haritaoglu, "Real time Surveillance of people and their activities", IEEE Trans. on pattern analysis and machine intelligence, Vol. 22, No. 8, Aug. 2000
2. D. Beymer and K. Konolige, " Real-Time Tracking of Multiple People using Stereo, " Proc. IEEE Frame Rate Workshop, 1999
3. Gian Luca Foresti, et. al,"Vehicle Recognition and Tracking from Road Image Sequences," IEEE Trans. On Vehicular Tech., vol. 48, NO. 1, Jan. 1999.
4. Rita Cucchira, Massimo Piccardi, Paola Mello "Image analysis and rule based reasoning for a traffic monitoring system" IEEE, Intelligent transportation system, pp119-pp130VOL.1, No.2, June 2000
5. Robert M, Haralick, Linda G, Shapario "Computer and Robot vision Vol I ", Addision-wesley, USA pp 318–321, 1992
6. Jakub Segen and Sarma Pingali, "A Camera-Based System for Tracking People in Real Time," IEEE Proceedings of ICPR '96, 1996
7. Ross Culter, Larry S. Davis "Robust Real-Time Periodic Motion Detection, and analysis and Application ", IEEE Pattern analysis and machine Intelligence Vol22 No 8, pp781–795 August 2000
8. Milan Sonka, Vaclav Hiavac, Rogger Boyle " Image processing Analysis and machine vision," International Thomson Publishing Co., 1999, 2nd edition
9. Trevor Darrell and Michele Covel " Correspondence with cumulative similiarity transforms" IEEE pattern analysis and machine intelligence, pp 222–227 Vol.23 No2 February 2001
10. Dieter Koller, et. al, "Robust Multiple Car Tracking with Occlusion Reasoining," Proc. 3rd European Confer. On Computer Vision, May 2–6, 1994
11. Gerhard Rigoll, et. al, "Person Tracking in Real-World Scenarios Using Statistical Methods," IEEE Inter. Confer. On Automatic Face and Gesture Recognition, Grenoble France, March, 2000
12. Jan-Mak G., et. al, "Color Invariance,"IEEE Trans. On PAMI, vol.23, no. 12, Dec. 2001
13. Kristen Hoffman, "Applications of the Kubelka-Munk Color Model to Xerographic Images,"www.cis.rit.edu/research/thesis/bs/1998 / hoffman