Development of Correspondence Algorithm for Flickering Effect in Dynamic Images

Gowramma Y.P.[1] and RaviKumar C.N.[2]
[1]Dept. of CSE, Kalpataru Institute of Tech, Tiptur-572202, Karnataka, India, gowriyp@yahoo.co.in
[2]Dept of CSE, SJ college of Engineering ,Mysore ,Karnataka,India, kumarcnr@yahoo.co.in

Abstract- This paper presents an algorithm to identify the correspondence of objects in the flickering or fluctuating environment for the dynamic image analysis. The correspondence is the matching of the similar data sets or entities or the features such as the points, corners, edges between a set of images. The correspondence of the features between the set of images is the central crucial fundamental evergreen open key problem in the Computer Vision (CV) and Pattern Recognition (PR) domain. The Correspondence of the dynamic images in the flickering environment and the flickering object is a highly challenging problem. In this domain Correspondence of features is a high dimensional NP-hard problem, because of their exhaustive search for the features in the sequence of image frames. The current algorithm works on the successive frame difference based segmentation, threshold based binary conversion and 2 dimensional 8-connectivity based correspondence. This work proposes the tracking window, generated dynamically which depends on the size of the object in the current frame. Here we have considered every element present in the segmented region as the features. The experiment is carried out on image sequence having multiple objects moving independently. This experiment is carried out on the gray scale dynamic image sequence, RGB color image sequence and on the binary image sequence. This correspondence algorithm is especially suitable for tracking in indoor images illuminated by unconstrained multiple light sources, objects in the varying illumination environment, noisy image sequence, video surveillance and slow moving dynamic image sequence for indoor scenes of the constant background.

Keywords: Flickering, Successive Frame Difference, Threshold Based Binary Conversion, Logical Image, 8-Connectivity

Introduction

The correspondence of features across two or more images is well known to be of crucial importance for many Computer Vision, Image Analysis and Pattern Recognition tasks. Reliable inter image feature correspondence and its closely related problems such as image registration, structure from stereo approaches, motion analysis , image mosaicing, 3D reconstruction, object recognition, stereo matching, feature and object tracking, reconstruction of large environments, video surveillance which involves the fundamental problem termed as the correspondence problem. Correspondence of flickering is one of the challenging problems in surveillance and dynamic image analysis related problems. The aim of the correspondence is an object or features over time by locating its position in every frame of the video at every time instance. It also finds the location of the interested moving objects in the consecutive frames from entry to exit. Flickering is a natural phenomenon which occurs due to various reasons both on indoor and outdoor images. Outdoor flickering occurs due to natural light condition and it changes slowly as time passes, the wind causes swaying movements of flexible background object (e.g. foliage). In the indoor scenes, artificial light i.e. the fluorescent light flickers at the frequency of power supply. Other factors that create flickering are sunrise, sunset, rainfall, snow, swaying trees, moving backgrounds, camoflages, etc. There is no general algorithm to solve all the correspondence problems. It is one of the difficult tasks in any of the dynamic image analysis problem. There are several algorithms proposed in the literature for correspondence under the highly constrained environment such as velocity smoothness, illumination constraints, noise free images, restriction on the number of moving objects, objects geometric transformation, degrees of freedom of the sensor. Establishing the automatic image correspondence in the unconstrained environment is a challenge. Not only establishing correspondence but also finding the correspondence in the flickering is much more challenging problem. In computer vision and pattern recognition colour, texture and shape are the three important features of recognition. But during flickering constrained environment and movement of the objects it is difficult to consider colour, texture and shape because they change according to the light intensity. So connectivity of the features or pixels for correspondence can be considered. For instance, this method can be applied to observe the movements of a patient in ICU. In the last two decades, many fast correspondence methods have been proposed to give a faster intensity based correspondence algorithms, when compared with the full search algorithm that has high intensive computation which is more accurate. The proposed algorithm can work under flickering environment without the colour, texture, and shape information of both rigid and nonrigid articulated objects efficiently. This forms a significant contribution in solving a high level complexity issues in correspondence problem. The proposed algorithm also automatically establishes the correspondence under photometric variations and geometric transformation such as scaling, transformation, rotation. There are no restrictions on the parameters of the sensor. The proposed work establishes the correspondence to track features of object in the dynamic image analysis. We come across many research works on correspondence in constraint environment but there is only a few papers on flickering environment. There is no much literature on the correspondence for the flickering environment. Payman Moallem [1] describes the stereo correspondence for a feature point in the first image obtained by searching in a predefined region of the second image based on the epipolar line and the maximum disparity. Here for matching, Normalized Cross Correlation criteria (NCC) are used for different sizes of the matching blocks. Here the searching space allowed is 15*15 window as the search region. Liu Hao [2] proposed the block matching motion estimation algorithm using Variable Shape Search (VSS) proposed on diamond search and hexagonal search. Here the search features are diamond shape and hexagonal shape designed to fit the directional center based blocks. Here search window size is[-15,+15] and has no skipped frames. The matching algorithm used is Mean Absolute Difference [MAD] and Mean Square Error [MSE]. These are the simple evaluation function, which does not contain much of the complicated operations. Banon and SergioDonizete [5] they presented the area based matching of features from satellite images. They considered eight different matching criteria and compared the accuracy of matching in different methods. As a matching pattern they considered 23*23 block sizes. Various research scholars in [6,7,8,9,10] have presented various algorithms searching of similar patterns in the sequence of image frames in slow moving objects of video conferencing in which the different shapes of searching patterns are considered in the segmented blocks such as the diamond shape patterns, cross diamond shape patterns, Hexogonal shape patterns ,Cross Hexagonal shape patterns, Kite shape patterns for the motion estimation. Chistian [11] has described the general concept of the matching algorithm. Where as we[12,13,14], in our research work have discussed the feature based correspondence and the area-based correspondence. Now we propose another novel algorithm which optimizes the correspondence algorithm based on the Cost Function, searching Pattern and searching space. This paper is organized in 7 sections. In section 2 the problem statement is detailed. The sections 3 describe problem formulation and section 4 discusses assumptions, and constraints respectively. The section 5 describes the proposed methodology in detail. Sections 6 and 7 presents the details of experiment analysis and conclusion.

Problem Statement

Image acquisitions in the Dynamic images are considered from the following cases.

1. Static sensor and Moving objects in the scene
2. Moving sensor and Static objects in the scene
3. Both Sensor and Scene objects are moving.

Dynamic Images are also called as the sequence images. These images are the spatio temporal images which may be also termed as sequence image analysis. Sequence Images are the set of frames such as f_1, f_2,…. f_i,……, f_n which are considered at the distinct time instance t_1, t_2,…..,t_i,$t_{i+1,\ldots\ldots}$$t_n$ respectively. Depending on the application and the problem the time may vary from less than a second to decades. These frames are considered as the 2-D images. From these set of frame images f_1 is considered as the reference image and the remaining image frames f_2, f_3…f_n are considered as search images.

Here we have considered the problem of finding the correspondence of features for the multiple objects in the image sequence frames f_1, f_2,…. f_i,……, f_n at the distinct time instance t_1,t_2,…..,t_i,$t_{i+1,\ldots\ldots}$$t_n$ respectively from the flickering image and the flickering environment of the indoor sequence . In this work we have proposed a solution methodology for the correspondence of tracking the objects in the RGB color image sequence, gray image sequence, and binary image sequence under the flickering environment and also multiple objects moving independently.

Problem formulation

The images considered in this work are the monocular image sequence which is acquired from the single sensor. The sequences considered are the single sensor image frames. The objects presented in the image frames are the slowly moving objects with varying velocities. As the intensity of the light varies under uncontrolled multiple light sources in each frame the intensity of the object also varies. Regarding the reference coordinate system, the static sensor and moving scene is considered. The rigid and the articulated objects move independently in the scene is considered. Long sequences of more than 1000 frames are considered for the analysis.

Constraints and Assumptions

The correspondence is made simple by imposing constraints on the motion and appearance of the objects. In this application we have tried to minimize the number of constraint on the motion and appearance of the objects. The only constraint on the motion of the object is that it should not make sudden change in the direction of motion while moving out of the viewing range of the camera. No color information is required for tracking the object. There is no major constraint on the appearance of the object though an object which is a little brighter than the background gives better tracking result.

Proposed methodology for Correspondence

The figure (1) shows the schematic diagram of the proposed correspondence approach for the flickering. Input: The indoor color image sequence with the flickering caused by the source of light. Output: The correspondence of the objects in the consecutive frames shown as the rectangle window enclosing the object.

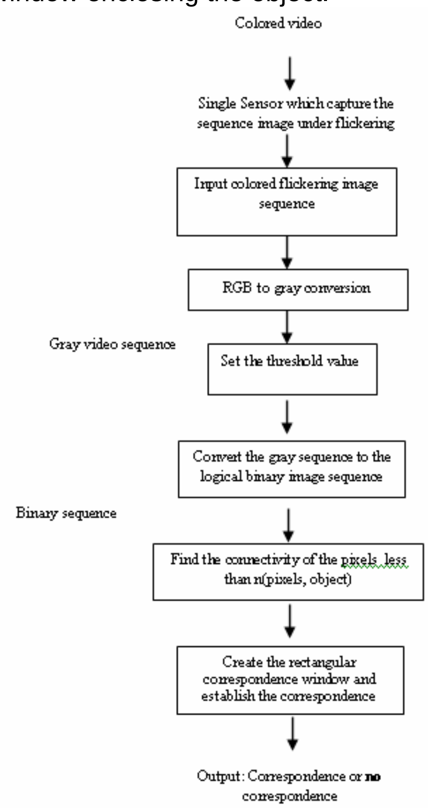

Fig. 1-Schematic diagram of the proposed approach

Image acquisition:

A video camera capable of capturing the moving (dynamic) scene is used as the sensor. There is no restriction on the sensor movements or on the movement of the objects present in the scene. It will capture the image sequence in the RGB color format. There is no restriction on the illumination variation, smoothness of the velocity of the object, the velocity of the sensor and there is no restriction on the degree of freedom of the camera movements. The output of the image acquisition system is the RGB dynamic image frames under the flickering effect due to the illumination variation with the multiple objects present in the scene. We have captured the image sequence using the single sensor under three combinations of the sensor and the scene. Such as the static sensor and moving scene, moving sensor and static scene and finally the moving sensor and the moving scene in the constant background and the indoor scene, under flickering or fluctuating illumination. The captured image sequence is in RGB color format at the rate of the 25 frame per second. This RGB image sequence is converted into the grayscale sequence image. Since the RGB color format has 24-bits per pixel it takes more processing time compared to the gray scale image and binary image. The first frame is considered as the reference image by default. The construction of the reference image depends on the application and input sequence for accuracy and time complexity.

RGB to gray scale conversion

In this step the RGB sequence image frames (dynamic image) are converted into the grayscale image. While conversion it illuminates the hue and saturation components and it will retain the luminance components and convert into the gray scale image.

Reference frame construction

Usually in the dynamic image analysis reference frame consideration is one of the important factors which affect the searching space , accuracy of the result and execution time. There are several possible ways to consider the reference frame. Normally the first frame is considered as the reference frame. Alternatively consecutive frames are considered as the reference frames.

Successive Frame difference based segmentation

The long sequence dynamic images are segmented using successive frame difference. In the dynamic image analysis the various combination of the successive frame difference is used to segment the dynamic image. Let

$$\mathbf{I_d(x,y) = absolute(I_c(x,y) - I_p(x,y))}$$

Where $\mathbf{I_c(x,y)}$ is the current frame , $\mathbf{I_p(x,y)}$ is the previous frame and finally $\mathbf{I_d(x,y)}$ is the difference frame. The difference frame is the combined information of the object movement and the sensor movement and the light source available with the sequence. The differences between the consecutive frames are usually created by a combination of camera motion and the movement of the objects. The frame difference on consecutive frames in the image acquisition identifies moving objects from the portion of a video frame that differs significantly from the previous frame. The frame difference method basically employs the image subtraction operation. The image subtraction operator takes two images as input and produces as output a third image whose pixel values are simply that of the first image minus the corresponding pixel values from the second image. The subtraction of two images is performed straightforwardly in a single pass. There are many challenges in developing a good frame difference algorithm for object detection. First, it must be robust against changes in illumination and also it should avoid detecting non stationary background objects such as moving leaves, rain, snow, and shadows caused by the moving objects. Here the difference frame sequence is stored separately and this sequence is used to convert the gray scale sequence to the binary image sequence. Then the threshold based conversion is considered.

Threshold based Conversion

$I_d(x,y)>T$
bin_img (j,k)=1;
else
bin_img (j,k)=0;
We treat this binary image in the logical binary sequence useful to find the connectivity of pixels to find the objects.

Finding the correspondence window boundary

In the detection of the boundary first convert the grayscale image into the binary image using the pixel threshold. The difference image is converted into the binary image. A higher value for the threshold increases the level of denoising and flicking. However, it should be noted that selecting very high value of the threshold, T can reduce the high-frequency signal content and can result in loss of detail.

Pixel connectivity

Connectivity of the binary image pixels is one of the important concepts in the image analysis and object recognition. The two dimensional images derives the 4-connectivity and the 8-connectivity .By default we consider the 8-connectivity to recognize the objects in 2 dimensional images. The connectivity less than n numbers of pixels are considered as the objects. The number of pixels connectivity defined for any experiment depends on the size of object in the sequence.

Correspondence window detection

In this stage the correspondence object boundary is detected. Here it starts growing in rectangular window which encloses the object wherever the connectivity is less than the specified pixel.

Construction of the window and matching

Here we have to draw the rectangular window about the boundary of the object in the gray scale and the RGB sequence. The window is constructed as and when it is required depending on the size of the object to enclose it.

Matching or Correspondence:

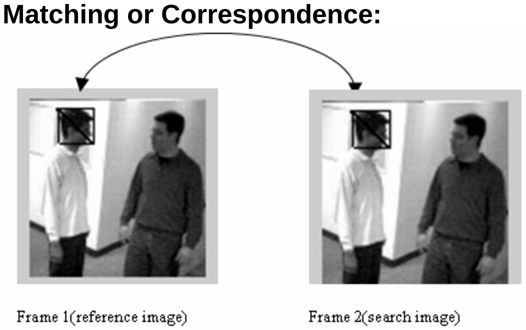

Fig. 2-Searching for the correspondening object

The correspondence is established based on the number of pixels matching. The searching for the connectivity is 15 pixels in horizontal direction and vertical direction.

Algorithm

Step 1- Read the color dynamic image sequence frame under flickering environment

Step 2- Identify the reference image

Step 3- Convert the RGB image sequence to the gray image sequence

Step 4- Apply the successive image subtraction

Step 6-If the difference is gray value is greater than the threshold is considered as foreground else it is considered as background.

Step 7- Convert the binary sequence image into the logical image which is used to find the connectivity.

Step 8- Find the 8-connectedness of each image frame.

Step 9- Find the number of objects in the scene which has less than n pixels connectivity.

Step 10- Construct the rectangular correspondence boundary and when required depends on the size, appearance of the object and the connectedness of the object.

Step11- The correspondence windows are generated as and when the appearance of the object changes. Hence the object correspondence establishes the consecutive frames.

Experimental Analysis

In this work the sequence image frames considered for the experiment are captured by mega pixels camera at the rate of 30 frames per second. The object undergoes flickering effect from the uncontrolled natural and artificial illuminations in indoor image sequence. The video is indoor sequence of the constant background, captured on a stationary camera. The correspondence process in flickering effect results are shown in separate windows of different types of images such as color image, gray-scale image, binary images with different frames. This is possible from varying the value of the threshold using trial and error method and the results of this process are shown in the window. The present experimental sequence consists more than 500 frames. This experiment has six indoor sequences. The sequences having two objects with the flickering objects of varying illumination and the algorithm which track the sequence will find the correspondence. The next sequence has a burning candle which continuous movement due to wind results in the change of light around it. Our algorithm finds the correspondence in all this circumstances. It works accurately for any sequence image which undergoes motion due to sensor movement or object movement where the objects are little brighter than the background. The object correspondence for two attached objects, the single object and two separate objects are enclosed in rectangular windows in the Fig. 3, Fig. 4 and Fig. 5. The experimental details are in the table 1. X,Y coordinates results the location of correspondence window.

Fig. 3- Single object correspondence in window single window

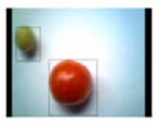

Fig. 4- Two objects correspondence in two different windows

Fig. 5- Two objects correspondence in single window

Table 1- experimental details

Figure number	Frame number	Execution time	X,Y coordinates of object anti diagonal corners
Figure(3)	120	0.1094	(184,381)(320,120)
Figure(4)	125	0.2031	(68,187)(35,120) (183,379)(151,320)
Figure(5)	130	0.1094	(96,378)(150,317)

Conclusion

In this Paper, we have successfully proposed the correspondence of dynamic images for the moving objects in the flickering environment .The proposed algorithm locate the features of the reference frame to the search frame. The experiment is conducted on the binary image sequence; gray scale image sequence and RGB color image sequence in which the sequence undergoes slow moving indoor sequence which is captured by the static sensor and moving object. Hence we can conclude that our algorithm satisfactorily locate the moving object features in a consecutive image frames in the flickering environment. This method is suitable for image sequences having slow motion and tracking of faces or any objects in the sequence which has motion.

References

[1] Payman Moallem, Karim Faez (2001) *VMV 2001,Stutgart, Germany*.

[2] Liu Hao, ZHANG Wen-jun, CAI Jun *Journal of Zhejiang University Science*.

[3] Zhou Wang, Yinglin Yu and David Zhang (1998*) IEEE Transaction on IP*, 7(7), 1057-1061.

[4] Steven M. Seitz, Charles R. Dyer (1995) *Proc.Fifth Int.Conf.On Computer Vision, Cambridge MA*, 330-337.

[5] Banon and SergioDonizete Faria (2001) *Proc 8th ECS and Image Analysis*,*Bordeaux, France*, 573-577.

[6] Tham J.Y., Ranganath S., Ranganath M. and Kasa A.A. (1998) *IEEETrans.CircuitsSyst.Technol*., 8(4), 369-377.

[7] Cheung C.H. and Po L.M. (2002) *IEEE Circuits Syst.Video Technol*., 12(12).

[8] Cheung C.H. and Po L.M. (2002) *Proc.IEEE ICIP*.

[9] Yao Nie, Kai-Kuang Ma (2002) *IEEE Trans. Image processing* 11, 1442-1449.

[10] Anastasios Hamosfakidis, Yakup Paker (2002) *EURASIP Journal on Applied Signal Processing,* 6,595-600.

[11] RaviKumar C.N. and Gowramma Y.P. (2001) *NCMCM-2001,* 339-344.

[12] Ravi Kumar C.N. and Gowramma Y.P. (2002) *NCAC-2002*, 231-238.

[13] Gowramma Y.P. and Ravi Kumar C.N. (2006) *ADCOM-2006*, 263-266.