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Cast shadow detection in video segmentation

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Abstract

In video segmentation, an intrinsic problem is that the moving cast shadows are always misclassified as part of the moving objects. This paper presents a novel moving cast shadow detection algorithm. The experiments demonstrate shadow region can be removed quite well and thus good video segmentation results can be obtained.

Keywords: Cast shadow; Video segmentation

1. Introduction

Video segmentation, the key technique for semantic object extraction, plays a very important role in content based video coding in (MPEG4, 1998). Several schemes (Chien et al., 2002; Mech and Wollborn, 1998; Meier and Ngan, 1999; Neri et al., 1998) have been applied for video segmentation, among which change detection based technique attracts more and more attention. Since the motion is the most important cue for distinguishing moving object and the static background, the efficiency of these kinds of algorithms is obvious. The frame difference between two consecutive frames is computed and thresholded firstly, thus the rough location and shape of the objects may be detected, and then spatial and temporal information is applied to tune the boundary (Chien et al., 2002).

However, there still exist several serious drawbacks in the traditional algorithms (Chien et al., 2002). These shortcomings always bring some false positives and false negatives to the system, especially, these problems increase obviously when the shadows exist. Cast shadow in background is generated because of the lack of light. Like moving objects, moving cast shadows can also cause large differences between two successive frames;

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meanwhile, the moving object and cast shadow region are usually connected together, so cast shadow must be processed definitely in the change detection based algorithms (Chien et al., 2002; Stauder et al., 1999).

Actually, some solutions were proposed to prevent shadow from being misclassified as moving object (Chien et al., 2002; Stauder et al., 1999). Chien et al. (2002) employed the gradient filter to remove shadow region. The criteria focuses on an observation that shadow area tends to have a gradual change in luminance value, in addition, it can remove some effects of the luminance or camera gain change because these changes effect is decreased obviously in gradient domain. Generally, it performs well in various conditions, nevertheless, some limitations occur simultaneously (Chien et al., 2002). First, since the algorithm relies on the smooth changing gradient in one region, so the benefit of gradient filter will reduce when processing the texture region. Second, some objects, with a weak edge and low texture, may be damaged because of the removal of image details. Stauder et al. (1999) analyzed the moving cast shadow behavior extensively and based their approach on four assumptions: (1) a strong light source causing a cast shadow, (2) a static camera, and static and textured background, (3) planar background, and (4) the light source with a certain extent.

A cast shadow is found mainly according to the results of change detection, static edge detection, shading change detection and penumbra detection. There are some problems in this approach. Some regions of a moving object, such as the facial part of a human, are easy to be misclassified as shadow regions because the uniform colors there present the same characteristics as the shadow regions. The regions that are always shadowed along the sequence cannot be detected by their algorithm, as pointed out by the authors (Stauder et al., 1999). Moreover, the computation is quite complex (Chien et al., 2002). So, nowadays, it is more and more necessary to establish an efficient and effective method for the shadow problem.

Shadow can be classified as significant shadow and insignificant shadow according to its extent. Shadow significance is a comparative concept. When the edge of a shadow region is as sharp as the corresponding moving object's edge, the shadow is defined as a significant shadow. Otherwise, it is thought as an insignificant shadow. Shadow significance depends on several factors, such as the light source, the width of penumbra, the background grey value, etc. In sunny days and on cement roads, the shadow cast by pedestrians or vehicles can be considered as significant shadow. Because under this condition, no penumbra area exists, and the contrast between cement road and dark shadow is obvious, so the edge of shadow region is as sharp as the moving object. However, shadow tends to be insignificant in normal indoor environment.Penumbra usually exists due to the fact that the size of light source cannot be ignored when compared with the distance between light source and object (Stauder et al., 1999). Moreover, the penumbra is usually quite wide, so the change of the grey values between un-shadowed regions to shadowed regions is quite smooth, and it is considered as insignificant shadow.

Facing the problem that the moving cast shadow is often misclassified as part of the moving object in change detection based video segmentation, we propose an effective approach to the detection and removal of insignificant moving cast shadows in normal indoor scenes where the camera is stationary. It is especially appropriate for the applications of indoor video surveillance and conferencing. The main contribution of this paper is that we successfully remove cast shadows from moving objects by the conditional dilation operation, where the edge and region information are used in a unified framework.Compared with the method in (Stauder et al., 1999), our approach does not require (or assume) the region uniform property, and thus seldom misclassifies the uniform moving object region as a shadow region. Moreover, it can detect insignificant shadows appearing along a whole image sequence. We have compared our approach with the gradient filter method (Chien et al., 2002) which is the most recent state of the art related to our approach, and the experimental results show that our approach improves the detection performance.

In our algorithm, the edge information plays an important role for shadow removal. Canny edge is