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Moving Cast Shadow Detection

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1 Overview

Motion perception is an amazing innate ability of the creatures on the planet. This adroitness entails a functional advantage that enables species to compete better in the wild. The motion perception ability is usually employed at different levels, allowing from the simplest interaction with the *'physis'* up to the most transcendental survival tasks. Among the five classical perception system , vision is the most widely used in the motion perception field. Millions years of evolution have led to a highly specialized visual system in humans, which is characterized by a tremendous accuracy as well as an extraordinary robustness. Although humans and an immense diversity of species can distinguish moving object with a seeming simplicity, it has proven to be a difficult and non trivial problem from a computational perspective.

In the field of Computer Vision, the detection of moving objects is a challenging and fundamental research area. This can be referred to as the 'origin' of vast and numerous vision-based research sub-areas. Nevertheless, from the bottom to the top of this hierarchical analysis, the foundations still relies on when and where motion has occurred in an image.

Pixels corresponding to moving objects in image sequences can be identified by measuring changes in their values. However, a pixel's value (representing a combination of color and brightness) could also vary due to other factors such as: variation in scene illumination, camera noise and nonlinear sensor responses among others. The challenge lies in detecting if the changes in pixels' value are caused by a genuine object movement or not. An additional challenging aspect in motion detection is represented by moving cast shadows. The paradox arises because a moving object and its cast shadow share similar motion patterns. However, a moving cast shadow is not a moving object. In fact, a shadow represents a photometric illumination effect caused by the relative position of the object with respect to the light sources.

Shadow detection methods are mainly divided in two domains depending on the application field. One normally consists of static images where shadows are casted by static objects, whereas the second one is referred to image sequences where shadows are casted by moving objects. For the first case, shadows can provide additional geometric and semantic cues about shape and position of its casting object as well as the localization of the light source. Although the previous information can be extracted from static images as well as video sequences, the main focus in the second area is usually change detection, scene matching or surveillance. In this context, a shadow can severely affect with the analysis and interpretation of the scene.

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The work done in the thesis is focused on the second case, thus it addresses the problem of detection and removal of moving cast shadows in video sequences in order to enhance the detection of moving object.

2 About the thesis

Nowadays, we witness a significant increase in demand of visual information processing systems. The most desired areas are: visual surveillance, sport event interpretation, and human-computer interaction, among others. The huge amount of recorded data requires an automatic analysis and understanding of the scene, with a particular focus on moving objects.

In Computer Vision, motion analysis refers to detection, identification and tracking [1, 2] of objects in video sequences, where one of the most important goal is to understand and to predict the objects behavior. Even though there has been much progress in moving object detection (MOD) [3, 4] during the past decades, robust and accurate moving object detection still remains an open problem. MOD process segments the scene into foreground (moving) and background regions. MOD is often one of the first tasks in vision-based applications, making it a critical part of the system. The success of many vision based applications is highly related to how accurately the MOD algorithm performs the segmentation of the moving objects. However, in many circumstances the task of MOD is strongly hindered due to factors such as: global illumination changes, local illumination changes (moving cast shadows), camera noise etc. Moving Cast Shadows are one of the principal factors affecting vision-based system's performance [5], since they can easily be misclassified as foreground. This misclassification undoubtedly leads to a drastic and severe degradation in the moving object segmentation. In the referenced thesis a new moving shadow detection method was proposed. Shadows could be defined as the parts of the scene that are not directly illuminated by a light source due to obstructing object or objects. In the thesis first moving shadow detection methods were exhaustively overviewed. Beside the mentioned methods from literature and to compensate their limitations a new moving shadow detection method was proposed. It requires no prior knowledge about the scene, nor is it restricted to assumptions about specific scene structures. Furthermore, the technique can detect both achromatic and chromatic shadows even in the presence of camouflage that occurs when foreground regions are very similar in color to shadowed regions. The method exploits local color constancy properties due to reflectance suppression over shadowed regions. To detect shadowed regions in a scene the values of the background image are divided by values of the current frame in the RGB color space. In the thesis how this luminance ratio can be used to identify segments with low gradient constancy is shown, which in turn distinguish shadows from foreground. Experimental results on a collection of publicly available datasets illustrate the superior performance of the proposed method compared with the most sophisticated state-of-the-art shadow detection algorithms.

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