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Original research article

Collaborative target tracking in lopor with multi-camera

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ABSTRACT

The moving target tracking results of multiple single cameras can rarely be efficiently collaborated by using the current multi-camera target tracking algorithms, in the layout of partly overlapping regions (LOPOR) with multi-camera. To solve this problem, a novel algorithm of moving target collaborative tracking with multi-camera, based on LOPOR with multi-camera, is presented. The completely overlapping region in LOPOR with multi-camera is taken by the algorithm to calibrate multiple single cameras collectively. The results of single camera target tracking and tracking targets significance rank are collaborated. Finally, the results of single camera targets tracking are modified using the targets' overall information. Then, interaction and sharing of each single camera target tracking are realized. The experimental results show that the single camera target tracking can be collaborated efficiently using the algorithm in LOPOR with multi-camera, with high monitoring efficiency and accurate location. In this manner, moving targets were tracked sustainably over a long distance for a large scene.

1. Introduction

Collaborative multi-camera tracking has been widely applied to fields such as video surveillance, human computer interaction, traffic control and medical diagnostics. Because single camera target tracking is vulnerable to occlusion, chaotic scenes, lighting mutations and other factors, multi-camera collaborative tracking based on single camera target tracking has emerged as a very challenging problem in computer vision field. The present research shows that multi-camera target tracking can be divided into the following two cases, according to whether the cameras can be calibrated collectively.

Target tracking of multi-camera without collective calibration focuses on the research into the multi-camera topological relationship and the relay of target tracking from one camera to another. In Ref. [1], targets are segmented by Bayesian model and the intended target is tracked by mean shift algorithm in single view. Meanwhile, the target is traced across different cameras in accordance with the relative location of all cameras and the distance between them. In Ref. [2], people-image among each camera is extracted and then labeled with color vector. Subsequently, targets are identified by combining the pedestrian's trajectory with relations between different surveillance areas. In Ref. [3], the graph theory method is adopted to track targets in a camera's view, and the targets' track in the blind region between cameras is obtained using Kalman filtering. On the basis of target motion and position in the ground plane view, the Gaussian distributions of the tracking parameters across cameras are computed for multi-camera correspondence matching. In Ref. [8], map view mapping is introduced to camera calibration. Tracking information from multiple cameras is fused using redundancy information, which is provided

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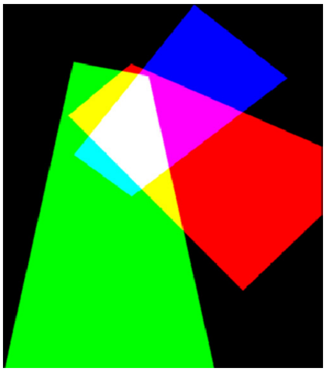

Fig. 1. Schematic diagram of multi-camera in panoramic view. (The black represents the unmonitored regions, the white represents three overlapping regions, three main colors (R, G and B) represent non-overlapping regions, and the remaining part represents double regions.) (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

by the overlapped field-of-view of the cameras. In Ref. [9], targets are tracked in single view in the case that controlling frame rate and adaptive resource management mechanism are chosen to switch cameras. In Ref. [10], the moving target is recognized by establishing the Markov random field model of foreground and background. The target is also positioned and tracked by combining Kalman filtering with an improved Camshift algorithm. Then more cameras relay target tracking is achieved on the basis of coordination and synchronous between cameras. From the references above, we determine that a multi-camera without collective calibration tracking algorithm, mainly depends on a single camera to track targets, and therefore some of the drawbacks of the single camera tracking algorithm also exists in this algorithm. However, because the algorithm does not calibrate cameras collectively by taking the advantage of the overlapping regions of multiple cameras, there are significant problems with incorrect target information transfer between two cameras, and information exchange between the cameras is very difficult.

Target tracking using multi-camera with collective calibration focuses on the research of target tracking in the overlapping regions of multi-camera. In Ref. [4], targets from any single camera or camera pair are neither detected nor tracked. Data is gathered from all cameras into a synergistic framework, with detection and tracking results then propagated back to each view. In Ref. [5], the background is modeled using codebook model. Location information on different levels is acquired by calculating a homography matrix, and then target tracking is obtained based on the shortest path optimization algorithm. In Ref. [6], the classifiers' responses from different target classes are handled at the top view, based on the premise that the ground plane location of the targets estimated in the light output of several target detectors applied at each viewpoint on the one hand, and the model of an energy minimization with a Conditional Random Field (CRF) on the other hand. In Ref. [7], targets are analyzed, registered and tracked using detection information from three surveillance cameras to reconstruct the 3D room model. In Ref. [12], a fast, dedicated data association process is selected in the ground plane based on the principal axis; this method takes advantage of local trackers from an MCMC sampling step when needed for handling close targets in a joint state. Each camera is calibrated from the overlapping region of multiple cameras, with the moving target in the foreground detected from a single camera in a global coordinate system is fused, and the targets are located and tracked by the target tracking algorithm of multi-camera with collective calibration. Detection information from a single camera, rather than a trace function of a single camera, is used in the algorithm.

When there is no overlapping region between every pair of cameras, or the overlapping region is only a very small part of the monitored region, we find that the tracking algorithm of multi-camera without calibration has a wide surveillance region and is highly efficient in overall monitoring. In contrast, the surveillance region of the multi-camera with calibration tracking algorithm is centralized in the collective region of multiple cameras, giving a smaller surveillance region and low efficiency in overall monitoring. Therefore, it cannot be applied to large surveillance scenes. In Ref. [11], a new monitoring layout is presented. Multi-camera are calibrated collectively in completely overlapping regions (white area in Fig. 1). Weak overlapping and non-overlapping regions are utilized to expand the monitoring scope. The monitoring layout (as shown in Fig. 1) presented in Ref. [11] has the advantage of a large monitored region, as with the tracking algorithm of multi-camera without calibration. The multiple overlapping regions are used to calibrate multiple cameras collectively.

The layout in Ref. [11] can be divided into a multiple overlapping region, a weak overlapping region and a non-overlapping region. The overlapping region takes up only a small part of the monitored region and is used to calibrate the multi-camera collectively. Because the weak overlapping region contains only a few cameras, large location information clumps [5] will be extracted. Determining the location of targets by the method of target tracking of multi-camera with collective calibration may be inaccurate. Since non-overlapping region contains only a single camera's information, the target tracking may be wrong in the case where the foreground detection method of target tracking of multi-camera with collective calibration is adopted. In conclusion, the method of target tracking of multi-camera with collective calibration is not suitable for the layout of Ref. [11]. As the method of target tracking of multi-camera with collective calibration does not use the target tracking of