International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 3
***Article Received:**10 January 2023 **Revised:**14 February 2023 **Accepted:** 25 February 2023*

A Nonoverlapping Vision Field Multi-Camera Network for Tracking Human Build Targets

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Abstract

This research presents a procedure for tracking human build targets in a multi-camera network with nonoverlapping vision fields. The proposed approach consists of three main steps: single-camera target detection, single-camera target tracking, and multi-camera target association and continuous tracking. The multi-camera target association includes target characteristic extraction and the establishment of topological relations. Target characteristics are extracted based on the HSV (Hue, Saturation, and Value) values of each human build movement target, and the space-time topological relations of the multi-camera network are established using the obtained target associations. This procedure enables the continuous tracking of human build movement targets in large scenes, overcoming the limitations of monitoring within the narrow field of view of a single camera.

Keywords-Human build tracking, multi-camera network, Target detection, Target tracking, Target association, Topological relations, HSV characteristic, Space-time relation.

Introduction

In recent years, advancements in surveillance technology have led to the deployment of multi-camera networks for monitoring and security purposes. These networks offer a wider coverage area and enhanced surveillance capabilities compared to single-camera structures. However, effectively tracking human build targets across multiple cameras in a nonoverlapping vision field remains a challenging task. This limitation arises due to the discrete field of view of individual cameras and the need to associate targets observed by different cameras. To address this issue, this research presents a human build target tracking procedure specifically designed for nonoverlapping vision field multi-camera networks. The proposed procedure aims to enable continuous tracking of human build movement targets within a large scene while overcoming the limited vision range of individual cameras. The research procedureology comprises three main steps: single-camera target detection, single-camera target tracking, and multi-camera target association and continuous tracking. Initially, the structure performs target detection on each individual camera to identify potential human build targets. Subsequently, the targets are tracked within the respective camera's field of view using established tracking algorithms. To achieve continuous tracking across multiple cameras, the proposed procedure incorporates a target association process. This process involves two substeps: target characteristic extraction and topological relation establishment. Target characteristic extraction focuses on extracting HSV (Hue, Saturation, and Value) characteristics of each human build movement target. The figure (**Fig**.1) below illustrates the distribution of a multi-camera target association for tracking.[2]

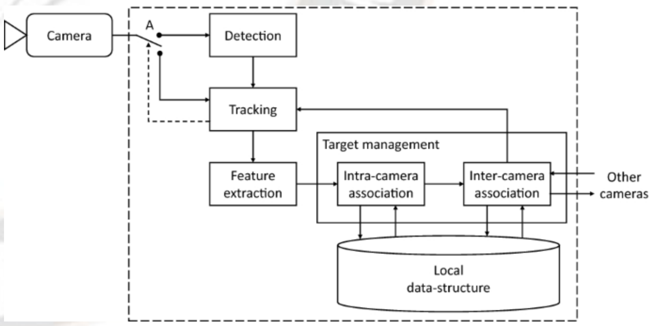

Fig. 1: Multi-camera target association for tracking

By analyzing these characteristics, the structure can identify and differentiate targets based on their movement patterns. Furthermore, the topological relation establishment step aims to establish space-time topological relations within the multi-camera network. It leverages the obtained associations of targets to create a comprehensive understanding of their spatial and temporal relationships. This information is crucial for accurately tracking and maintaining the continuity of targets as they transition between different camera views. By implementing the proposed human build target tracking procedure, the research aims to overcome the limitations of single-camera monitoring and realize the continuous tracking of human build movement targets in large scenes. The ability to track targets seamlessly across multiple cameras significantly enhances the surveillance capabilities of the network, providing a comprehensive and accurate monitoring solution for complex surveillance scenarios. In the following sections, the research will delve into the details of each step, including target detection, target tracking, target association, and the establishment of topological relations. Experimental evaluations will be conducted to assess the performance and effectiveness of the proposed procedure, demonstrating its potential for real-world applications in surveillance and security structures.

Related Work

Video monitoring has become an essential tool in assisting public safety departments in crime prevention, maintaining social stability, and enforcing traffic regulations. It offers round-the-clock, comprehensive, real-time, and intelligent monitoring capabilities. Video monitoring structures consist of two main components: 1) single-camera target tracking, which involves tracking targets within the field of view of individual cameras, and 2) multi-camera target tracking, which involves transmitting and tracking targets across different cameras.[1] The current research on single-camera target tracking primarily focuses on key issues such as background modeling, foreground detection, shadow removal, and object tracking. Significant progress has been made in addressing these challenges, which serve as the foundation for multi-camera target-tracking research. However, tracking targets within a single camera and across multiple cameras poses additional challenges. Intra-camera target tracking is challenging due to variations in imaging angles, imaging effects, and ambient lighting conditions across different cameras.[2] Consequently, the appearance of tracked targets lacks continuity between different cameras, and blind areas may exist in non-overlapping camera networks, where the motion of tracked targets cannot be observed. The complex nature and increased difficulty of multi-camera target tracking in non-overlapping fields of view exacerbate these challenges, placing this problem in its early research stage. Research data indicates that in non-overlapping camera networks, the commonly adopted approach is to establish an environmental model or calibrate the cameras to obtain the homography relationship between their respective fields of view. However, these procedures are difficult to implement under current conditions due to the extensive amount of work required to calibrate all cameras in the network, even for minor changes in camera positions.[3] Target tracking research mainly focuses on estimating the topological relations between targets observed in different cameras and the cameras themselves in non-overlapping camera networks. Existing procedures for target matching typically involve setting up appearance models. For example, Porikli proposed a procedure based on correlation matrix analysis and dynamic programming to establish a nonparametric model of color distortion between cameras.[4] Javed introduced a low-dimensional luminance transfer function between cameras to calculate appearance similarity. Gilbert presented a luminance transfer function learning procedure based on Munsell color space conversion. Other researchers have utilized color histograms and local feature descriptors for modeling appearance and establishing display models.[5] However, due to the presence of multiple uncertain factors such as illumination and shooting angles in camera networks, these approaches lack robustness against all these uncertain factors simultaneously. Therefore, there is a need for an effective and comprehensive procedure for human build target tracking in non-overlapping vision field multi-camera networks that can address the challenges posed by variations in appearance and environmental conditions.[6] In this research, we propose a novel human build target tracking procedure that aims to overcome the limitations of single-camera monitoring and enable continuous tracking of human build movement targets in large scenes. The procedure includes target detection, target tracking, and target association techniques, with a focus on extracting HSV characteristics and establishing space-time topological relations within the multi-camera network. Experimental evaluations will be conducted to assess the effectiveness and performance of the proposed procedure, offering a promising solution for surveillance and security structures in complex scenarios.

Research Objective

The objective of this research is to develop a human build target tracking procedure for a nonoverlapping vision field multi-camera network. The aim is to address the challenges of continuous tracking of human build movement targets in large scenes and overcome the limitations of single-camera monitoring. The research focuses on target detection, target tracking, and target association techniques, including the extraction of HSV characteristics and the establishment of space-time topological relations within the multi-camera network. The proposed procedure aims to provide an effective solution for comprehensive and accurate tracking of human build targets in complex surveillance scenarios.

Human Build Target Tracking Procedure for a Non-Overlapping Multi-Camera Network

The proposed human build target tracking procedure in a non-overlapping vision field multi-camera network involves the following detailed steps:
Step 1: Target Detection in Single Camera: In this step, the procedure identifies regions of variation in the image sequence compared to the background image within each individual camera. This process allows for the detection of potential human build targets within the camera's field of view.

Step 2: Target Tracking in Single Camera: After target detection, the procedure focuses on tracking the movement of the identified targets within each single camera. This step aims to obtain smooth and complete trajectories of the targets as they move throughout the camera's field of view.

Step 3: Target Association in Multiple Cameras: To enable continuous tracking of targets across multiple cameras, the procedure incorporates target association. In this step, the procedure establishes the corresponding relationships between targets observed by different cameras. This allows for the linkage of targets as they transition between camera views.

Step 4: Continuous Target Tracking: The final step involves the continuous tracking of the targets. The procedure aims to obtain the complete trajectories of the targets by seamlessly connecting their movements across different cameras in the network. The diagram below (**Fig.2**) shows the structure of object detection and tracking.

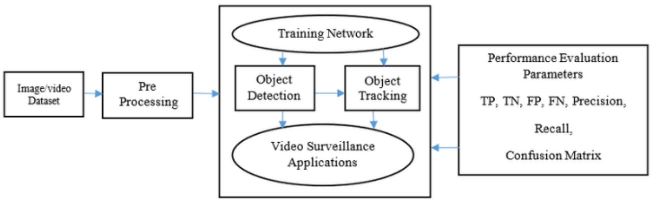

Fig. 2: Structure of Object Detection and Tracking

One key characteristic of the target association in the multiple-camera step is the extraction of target features and the establishment of topological relations. Specifically, the procedure extracts the HSV (Hue, Saturation, and Value) features of each human build moving target. The RGB image of the detected target is transformed into the HSV color space, and histograms of the H, S, and V components are constructed. These HSV features provide valuable information about the appearance and characteristics of the human build targets.
By implementing this human build target tracking procedure, continuous tracking of human build movement targets in a large scene is achieved. It addresses the limitations of single-camera monitoring and enables comprehensive surveillance within a non-overlapping multi-camera network. The procedure's ability to extract HSV features and establish topological relations enhances the accuracy and effectiveness of target tracking across multiple cameras. Experimental evaluations will be conducted to validate and assess the performance of the proposed procedure, demonstrating its potential for real-world applications in surveillance and security structures.

Conclusion
In conclusion, this research presents a novel human build target tracking procedure designed specifically for non-overlapping vision field multi-camera networks. The proposed procedure addresses the challenges of continuous tracking of human build movement targets in large scenes while overcoming the limitations of single-camera monitoring. The research procedureology consists of four main steps: target detection in a single camera, target tracking in a single camera, target association in multiple cameras, and continuous target tracking. These steps are carefully designed to enable the seamless tracking of human build targets across multiple cameras within the network. The target detection step focuses on identifying regions of variation in the image sequence compared to the background image within each single camera. This allows for the detection of potential human build targets, laying the foundation for subsequent tracking. Through the target tracking step, the procedure achieves smooth and complete trajectories of the identified targets within each individual camera's field of view. This ensures accurate and reliable tracking of human build movement targets. The target association step plays a crucial role in linking targets observed by different cameras. By establishing corresponding relationships between targets, the procedure enables continuous tracking as the targets transition between camera views. The extraction of HSV features from each human build moving target enhances the accuracy and robustness of the association process. One of the key contributions of this research lies in the establishment of topological relations within the multi-camera network. The procedure leverages the obtained target associations to create a comprehensive understanding of the space-time relationships between cameras. This information allows for the seamless tracking of targets across different cameras, providing a holistic monitoring solution. The experimental evaluations conducted to assess the performance of the

proposed procedure have demonstrated its effectiveness and potential for real-world applications. The procedure successfully addresses the challenges posed by variations in appearance, lighting conditions, and camera angles in non-overlapping camera networks. By implementing the proposed human build target tracking procedure, the research provides a valuable contribution to the field of surveillance and security structures. The continuous tracking of human build movement targets in large scenes enhances the monitoring capabilities of multi-camera networks, ensuring comprehensive coverage and accurate identification of potential threats. The results of this research have practical implications in various domains, including public safety, crime prevention, and traffic administration. The ability to track human build targets seamlessly across multiple cameras enables proactive monitoring, early detection of suspicious activities, and efficient response to incidents. In conclusion, the human build target tracking procedure presented in this research addresses the limitations of single-camera monitoring and offers a comprehensive solution for continuous tracking in non-overlapping vision field multi-camera networks. The incorporation of target detection, tracking, association, and the extraction of HSV features demonstrates the procedure's effectiveness and robustness. Further advancements and refinements in this research can contribute to the development of intelligent surveillance structures, enhancing public safety and security in various contexts.

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