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Editorial

Editorial introduction to the special issue on "Image Understanding for Real-World Distributed Video Networks" – Computer Vision and Image Understanding Journal

Cities around the world are increasingly relying upon cameras to provide visual coverage of extended spaces. Surveillance cameras are an essential component of the overall crime prevention strategy. Law enforcement agencies now heavily use imagery collected by surveillance cameras in solving crimes. Cameras installed on roadways are used to collect traffic data with the aim to better manage traffic, relieve congestion, respond to accidents, etc. Surveillance cameras are also used in high-stake public places, such as airport, train stations, metro stations and bus terminals. In recent years, cameras have also been used to record and prevent incidents of police brutality. The current security climate has necessitated the need of increased monitoring and surveillance of citizenry. In short, as a society, we are increasingly reliant on cameras.

Advances in camera hardware and communication technologies have enabled us to set up camera or video networks providing surveillance and monitoring capabilities over large areas. In the past, video collected from these cameras was monitored by human operators trained to view these videos and respond appropriately to any incidents visible in these videos. In many cases, the video was simply recorded somewhere and it was accessed for forensic purposes only after an incident has already occurred. The capacity to "observe and analyze" data collected by all these cameras simply did not exist. Automatic analysis of video collected from these cameras is an important capability and consequently there is significant interest in the computer vision community to develop theory and techniques to automatically analyze and understand data collected from video networks.

It is helpful to remind ourselves that video networks are fundamentally different from multi-camera systems of yore. Multi-camera systems often assume that the data collected by each camera is collected at a central location where it is available to the video analysis algorithms. This assumption does not hold for video networks. Simply because the sheer scale of video networks necessitates the use of distributed techniques for video analysis. These techniques do not assume that video from cameras is gathered at a central location and that all of it is available to the video analysis algorithms.

This special issue deals with computer vision techniques that are especially suited for automatic video analysis in distributed video networks. Distributed video networks is an exciting and emerging multi-disciplinary field that draws upon areas as diverse as, sensor networks, distributed systems, embedded devices, computer vision and pattern recognition, networking, etc. We received 21 submissions from authors of 12 different countries (USA, France, UK, Germany, Italy, Spain, Israel, Turkey, Japan, Tunisia, India, and Poland). A few of these submissions were considered off-topic after a careful review by the editors. The rest of the submissions went through a thorough reviewing process and only 7 of these were deemed suitable for publication in this special issue. The accepted papers tackle relevant issues in distributed video networks, including object tracking, automatic calibration, scene modeling, and the applications of in-vehicle video networks. We sincerely hope that you will find this issue timely and relevant.

As it is understandable and supported by the fact that a large number of papers on this topic have been published in the literature, one of the main topics addressed in this special issue is related to the tracking of multiple objects (people or vehicles) from a network of cameras. For instance, the paper **"Pedestrian Tracking with Crowd Simulation Models in a Multi-Camera System"**, by Zhixing Jin and Bir Bhanu (University of California, Riverside – USA) proposes to exploit crowd simulation models to make homography more helpful when dealing with object tracking among cameras with overlapping fields-of-views (FoVs). Two crowd simulators with different strategies are used to improve and compare tracking performance with/without using the simulators. The results are shown on crowded scene with medium density using PETS dataset.

The paper **"Tracking Multiple Interacting Targets in a Camera Network"**, by Shu Zhang, Yingying Zhu, and Amit Roy-Chowdhury (University of California, Riverside – USA) extends to the case of both overlapping and non-overlapping FoVs. Tracklets of moving objects (either individuals or groups of targets) are extracted and a structural SVM is applied to identify merge and split events in the groups. Tracking of multiple interacting targets is then solved by converting it into a network flow problem and using K-shortest paths algorithm to find the solution.

While tracking multiple objects from multiple fixed cameras presents its own advantages (in terms of quantity and quality of the data, multiple perspectives, fault tolerance, etc.), an interesting approach is presented in the paper **"Non-Myopic Information Theoretic Sensor Management of a Single Pan-Tilt-Zoom Camera for Multiple Object Detection and Tracking"**, by Pietro Salvagnini, Federico Pernici, Marco Cristani, Giuseppe Lisanti,

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Alberto Del Bimbo, Vittorio Murino (IIT, Italian Institute of Technology – Italy; University of Florence – Italy; University of Verona – Italy). The authors propose a novel approach for tracking multiple targets from a single PTZ camera by developing a method which takes into account plausible future target displacements and camera poses, and solves the complex hypothesis system using a multiple look-ahead optimization strategy.

While the above three papers are mostly related to new computer vision algorithms for tracking multiple objects in multiple cameras, the paper **"Dynamic Task Decomposition for Decentralized Object Tracking in Complex Scenes"**, by Tao Hu, Stefano Messelodi, and Oswald Lanz (FBK, Fondazione Bruno Kessler – Italy) focuses on decentralized object tracking. In fact, system scalability of multiple camera systems becomes a serious problem using a centralized solution (where all the video feeds are sent to and processed by a single processing unit). This paper proposes a method for dynamic task decomposition through an efficient three-layer architecture, in which the overall task (tracking all the objects using all the cameras) is formulated as a state estimation problem which aims to maximize utility and sharing of computational and sensing resources.

The paper **"Cross-calibration of Time-of-Flight and Colour Cameras"** by Miles Hansard, Georgios Evangelidis, Quentin Pelorson, Radu Horaud (INRIA Grenoble – France; Queen Mary University of London – UK) still deals (as the previous papers) with multiple cameras, with two important distinctions: the network of cameras is hybrid, including ToF and color cameras; the aim of the paper is not related to a specific application (e.g., tracking of multiple objects), but on the proposal of a cross-calibration technique to register the different views which may result from different viewpoints, and have different resolutions and fields of view.

A quite different approach to multi-camera systems is proposed in the paper **"Scene Shape Estimation from Multiple Partly Cloudy Days"**, by Scott Workman, Richard Souvenir, Nathan Jacobs (University of Kentucky – USA; University of North Carolina at Charlotte – USA). The approach proposed in this paper exploits clouds as a cue for estimating weak correspondences between outdoor cameras. It can be used for estimating scene geometry from a single calibrated camera, a network of calibrated cameras, or a collection of uncalibrated cameras. This is achieved by imposing simple geometric constraints based on the appearance changes caused by cloud shadows in the different views.

Finally, the paper **"On Surveillance for Safety Critical Events: In-Vehicle Video Networks for Predictive Driver Assistance Systems"**, by Eshed Ohn-Bar, Ashish Tawari, Sujitha Martin, and Mohan M. Trivedi (University of California, San Diego – USA) changes the perspective of the cameras: from cameras looking from outside and long distance to targets, to cameras mounted in a vehicle to understand human activities. Though this paper still relates to video networks and techniques might be similar, this setup poses additional challenges. Driver head pose estimation, hand and foot tracking, ego-vehicle parameter estimation are some of the functionalities of the proposed solution.

We would like to this opportunity to thank all of those who chose to submit their work to this special issue. Clearly, without a large body of submissions to choose from, it is not possible to put together a high-quality special issue. Our most sincere thanks to the reviewers. We were lucky to have the support and attention of such a great group of reviewers. Thank you for all your hard work. We would also like to extend our thanks to the past Editor-in-Chief, Professor Avinash Kak, who championed our cause. This special issue would not have been possible without his support. Thanks also to the current Editor-in-Chief, Professor Nikos Paragios and the editorial staff at the Computer Vision and Image Journal. Nikos guided and supported us throughout the long and arduous journey of producing this special issue.

Preparing this special issue has been a rewarding experience and we hope that researchers interested in studying and developing the next generation of distributed video networks will find this issue useful.

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