

Rešerše článků zaměřených na sledování objektů ve videu

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Abstrakt

Tato technická zpráva obsahuje přehled článků a jiných publikací zabývajících se problematikou sledování objektů ve videu (video tracking). V první části jsou vybrané abstrakty článků seřazeny abecedně podle názvu publikace. V části druhé pak seznam publikací v časopisech, knihy a jiné zdroje. K vyhledávání byla použita následující klíčová slova:

video tracking, video frames, frame rate, video compression, Blob tracking, Kernel-based tracking, Contour tracking, Visual feature matching, Macroblock, Key frame, Blob detection, Optical flow, Affine transformation, Bhattacharyya distance, Bhattacharyya coefficient, Kalman filter, Particle filter, Match moving, Motion capture, SwisTrack

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1 Úvod

V této technické zprávě jsou shrnuty články zabývající se problematikou sledování objektů ve videu. Jednotlivé algoritmy lze rozdělit dle mnoha kritérií. Články lze dělit abecedně, časově nebo podle typu algoritmu, který popisují. V elektronické podobě jsou k dispozici varianty všechny, zde jsou pak jednotlivé články v kapitole 2 seřazeny abecedně. V kapitole 3 jsou pak uvedeny informace (název, odkaz, abstrakt apod.) o dalších článcích, které byly nalezeny v různých bibliografických zdrojích podle uvedených klíčových slov.

Jednotlivé metody zastoupené v rešerši jsou tyto:

1. Reprezentace cíle a lokalizace
 - 1.1. Sledování pozadí
 - 1.2. Blob tracking
 - 1.3. Sledování obrysů
 - 1.4. Sledování založené na jádrech
 - 1.5. Sledování založené na modelech
 - 1.6. Multisenzorové sledování
 - 1.7. Pravděpodobnostní sledování
 - 1.8. Sledování učením
 - 1.9. Sledování trajektorie
 - 1.10. Sledování na základě vizuálních vlastností
2. Filtrování a asociace dat
 - 2.1. Kalmanova filtrace
 - 2.2. Částicové filtry
3. Sledování pohyblivých objektů
4. Různé další algoritmy

2 Abstrakty vybraných publikací

V následující kapitole jsou uvedeny abstrakty publikací zabývajících se problematikou sledování objektů ve videu. Publikace jsou zde řazeny abecedně podle jejich názvu.

3D Vehicle Extraction and Tracking from Multiple Viewpoints for Traffic Monitoring by using Probability Fusion Map, 2008

Zhencheng Hu, Chenhao Wang, and Keiichi Uchimura, Kumamoto University, Kumamoto, Japan

This paper presents a novel solution of vehicle occlusion and 3D measurement for traffic monitoring by data fusion from multiple stationary cameras. Comparing with single camera based conventional methods in traffic monitoring, our approach fuses video data from different viewpoints into a common probability fusion map (PFM) and extracts targets. The proposed PFM concept is efficient to handle and fuse data in order to estimate the probability of vehicle appearance, which is verified to be more reliable than single camera solution by real outdoor experiments. An AMF based shadowing modeling algorithm is also proposed in this paper in order to remove shadows on the road area and extract the proper vehicle regions.

A 2D-3D Model-Based Approach to Real-Time Visual Tracking, 2000

Éric Marchand, Patrick Bouthemy, and François Chaumette, IRISA, Rennes, France

We present an original method for tracking, in a monocular image sequence, complex objects which can be approximately modeled by a polyhedral shape. It considers two steps of global transformation, the first one operating in the 2D space and the second one in the 3D space. The first step is able to handle large displacements of the object projection in the image. It involves a 2D motion model estimated by a robust statistical method. Then, we refine the localization of the object silhouette by evaluating the 3D parameters related to the object pose by iteratively minimizing a nonlinear cost function. It aims at moving the projection of the contours of the object CAD model to the spatial intensity gradients in the image. The proposed tracking method is real-time while being reliable and robust requirements. Real tracking experiments and results embedded in a visual servoing positioning task are reported.

A Boosted Particle Filter: Multitarget Detection and Tracking, 2004

Kenji Okuma, Ali Taleghani, Nando De Freitas, James J. Little, and David G. Lowe, University of British Columbia, Vancouver, Canada

The problem of tracking a varying number of non-rigid objects has two major difficulties. First, the observation models and target distributions can be highly non-linear and non-Gaussian. Second, the presence of a large, varying number of objects creates complex interactions with overlap and ambiguities. To surmount these difficulties, we introduce a vision system that is capable of learning, detecting and tracking the objects of interest. The system is demonstrated in the context of tracking hockey players using video sequences. Our approach combines the strengths of two successful algorithms: mixture particle filters and Adaboost. The mixture particle filter [17] is ideally suited to multi-target tracking as it assigns a mixture component to each player. The crucial design issues in mixture particle filters are the choice of the proposal distribution and the

treatment of objects leaving and entering the scene. Here, we construct the proposal distribution using a mixture model that incorporates information from the dynamic models of each player and the detection hypotheses generated by Adaboost. The learned Adaboost proposal distribution allows us to quickly detect players entering the scene, while the filtering process enables us to keep track of the individual players. The result of interleaving Adaboost with mixture particle filters is a simple, yet powerful and fully automatic multiple object tracking system.

A Comparison of Multicamera Person-Tracking Algorithms, 2005

A. W. Senior, G. Potamianos, S. Chu, Z. Zhang, and A. Hampapur, IBM T. J. Watson Research Center, Yorktown Heights, USA

In this paper, we present a comparison of four novel algorithms that have been applied to the tracking of people in an indoor scenario. Tracking is carried out in 3D or 2D (ground plane) to provide position information for a variety of surveillance, HCI or meeting-support services. The algorithms, based on background subtraction, face detection, particle filter feature-matching and edge alignment of a cylindrical model are described and comparative results presented using independent test data produced and ground-truthed for the EU CHIL project.

A Fast Model-Free Morphology-Based Object Tracking Algorithm, 2002

Jonathan Owensa, and Andrew Hunterb, University of Sunderland, UK

Eric Fletcher, Durham University, UK

This paper describes the multiple object tracking component of an automated CCTV surveillance system. The system tracks objects, and alerts the operator if unusual trajectories are discovered. Objects are detected by background differencing. Low contrast levels can present problems, leading to poor object segmentation and fragmentation, particularly on older analogue surveillance networks. The model-free tracking algorithm described in this paper addresses object fragmentation, and the object merging that occurs when proximate objects segment to the same connected component.

A Method of Landmark Visual Tracking for Mobile Robot, 2008

Lijun Zhao, Ruifeng Li, Tianying Zang, Lining Sun, and Xufeng Fan, State Key Laboratory of Advanced Robotic Technology and System, Harbin, China

Landmark tracking is key factor for mobile robots localization and navigation. This paper proposes a combined approach automatically to detect and track landmark. Firstly, a landmark is initially located in the image coordinates by features recognition- SIFT (Scale Invariant Feature Transform) and matching technology-RANSAC(Random Sample Consensus). Then based on similarity distance, tracking algorithm is called, which depends on adaptive particle filter. Furthermore, re-position strategy based SIFT is also presented to catch the landmark which was lost. Finally, the experimental results show that the proposed method achieves robust and real-time tracking of a landmark and has a practical value for robot visual.

A Nonparametric Treatment for Location/Segmentation Based Visual Tracking, 2007

Le Lu, Siemens Corporate Research, USA

Gregory D. Hager, Johns Hopkins University, USA

In this paper, we address two closely related visual tracking problems: 1) localizing a target's position in low or moderate resolution videos and 2) segmenting a target's image support in moderate to high resolution videos. Both tasks are treated as an online binary classification problem using dynamic foreground/background appearance models. Our major contribution is a novel nonparametric approach that successfully maintains a temporally changing appearance model for both foreground and background. The appearance models are formulated as "bags of image patches" that approximate the true two-class appearance distributions. They are maintained using a temporaladaptive importance resampling procedure that is based on simple nonparametric statistics of the appearance patch bags. The overall framework is independent of an specific foreground/background classification process and thus offers the freedom to use different classifiers. We demonstrate the effectiveness of our approach with extensive comparative experimental results on sequences from previous visual tracking [1, 12] and video matting [4] work as well as our own data.

A Parallel Color-Based Particle Filter for Object Tracking, 2008

Henry Medeiros, Johnny Park, and Avinash Kak, Purdue University, West Lafayette, USA

Porting well known computer vision algorithms to low power, high performance computing devices such as SIMD linear processor arrays can be a challenging task. One especially useful such algorithm is the color-based particle filter, which has been applied successfully by many research groups to the problem of tracking nonrigid objects. In this paper, we propose an implementation of the color-based particle filter suitable for SIMD processors. The main focus of our work is on the parallel computation of the particle weights. This step is the major bottleneck of standard implementations of the color-based particle filter since it requires the knowledge of the histograms of the regions surrounding each hypothesized target position. We expect this approach to perform faster in an SIMD processor than an implementation in a standard desktop computer even running at much lower clock speeds.

A Probabilistic Exclusion Principle for Tracking Multiple Objects, 2000

John Maccormick, University of Oxford, UK

Andrew Blake, Microsoft Research Limited, UK

Tracking multiple targets is a challenging problem, especially when the targets are "identical", in the sense that the same model is used to describe each target. In this case, simply instantiating several independent 1-body trackers is not an adequate solution, because the independent trackers tend to coalesce onto the best-fitting target. This paper presents an observation density for tracking which solves this problem by exhibiting a probabilistic exclusion principle. Exclusion arises naturally from a systematic derivation of the observation density, without relying on heuristics. Another important contribution of the paper is the presentation of partitioned sampling, a new sampling method for multiple object tracking. Partitioned sampling avoids the high computational load associated with fully coupled trackers, while retaining the desirable properties of coupling.

A Real-time Color-based Object Tracking robust to Irregular Illumination Variations, 2001

Yong-Beom Lee, Bum-Jae You, Korea Institute of Science and Technology, Seoul, Korea

Seong-Whan Lee, Korea University, Seoul, Korea

Color-based object tracking takes great attentions since a color is an efficient and robust visual cue for characterizing one object from the other objects. Color segmentation is, however, suffered from color variations induced from irregular illumination variations and the viewing geometry of a camera. This paper proposes a reliable color modeling approach including intensity information in HSI color space using B-spline curves based on the fact that color distribution of a single-colored object even in HS (Hue-Saturation) plane is not invariant with respect to brightness variations in practical cameras. By using the approach, our color-based visual tracker is able to adapt to irregular illumination variations and abrupt changes of brightness. The approach is applied for real-time face tracking under various illumination conditions successfully in a PC-based vision system.

A Study of a Target Tracking Algorithm Using Global Nearest Neighbor Approach, 2003

Pavlina Konstantinova, Alexander Udvarev, and Tzvetan Semerdjiev, Central Laboratory for Parallel Processing, BAS, Sofia, Bulgaria

This paper compares two algorithms for Multiple Target Tracking (MTT), using Global Nearest Neighbor (GNN) and Suboptimal Nearest Neighbor (SNN) approach respectively. For both algorithms the observations are divided in clusters to reduce computational efforts. For each cluster the assignment problem is solved by using Munkres algorithm or according SNN rules. Results reveal that in some cases the GNN approach gives better solution than SNN approach. The computational time, needed for assignment problem solution using Munkres algorithm is studied and results prove that it is suitable for real time implementations.

A Survey of Maneuvering Target Tracking: Dynamic Models, 2000

X. Rong Li, and Vesselin P. Jilkov, University of New Orleans, USA

This is the first part of a series of papers that provide a comprehensive and up-to-date survey of the problems and

techniques of tracking maneuvering targets in the absence of the so-called measurement-origin uncertainty. It surveys the various mathematical models of target dynamics proposed for maneuvering target tracking, including 2D and 3D maneuver models as well as coordinate-uncoupled generic models for target dynamics. This survey emphasizes the underlying ideas and assumptions of the models. Interrelationships among the models surveyed and insight to the pros and cons of the models are provided. Some material presented here has not appeared elsewhere.

A Survey of Maneuvering Target Tracking - Part II: Ballistic Target Models, 2001

X. Rong Li, and Vesselin P. Jilkov, University of New Orleans, USA

This paper is the second part in a series that provides a comprehensive survey of the problems and techniques of tracking maneuvering targets in the absence of the so-called measurement-origin uncertainty. It surveys motion models of ballistic targets used for target tracking. Models for all three phases (i.e., boost, coast, and reentry) of motion are covered.

A Survey of Maneuvering Target Tracking - Part III: Measurement Models, 2001

X. Rong Li, and Vesselin P. Jilkov, University of New Orleans, USA

This is the third part of a series of papers that provide a comprehensive survey of the techniques for tracking maneuvering targets without addressing the so-called measurement-origin uncertainty. Part I [1] and Part II [2] deal with general target motion models and ballistic target motion models, respectively. This part surveys measurement models, including measurement model-based techniques, used in target tracking. Models in Cartesian, sensor measurement, their mixed, and other coordinates are covered. The stress is on more recent advances - topics that have received more attention recently are discussed in greater details.

A System for Video Surveillance and Monitoring, 2000

Robert T. Collins, Alan J. Lipton, Takeo Kanade, Hironobu Fujiyoshi, David Duggins, Yanghai Tsin, David Tolliver, Nobuyoshi Enomoto, and Osamu Hasegawa, Carnegie Mellon University, Pittsburgh, USA

Peter Burt, and Lambert Wixson, The Sarnoff Corporation, Princeton, USA

Under the three-year Video Surveillance and Monitoring (VSAM) project (1997–1999), the Robotics Institute at Carnegie Mellon University (CMU) and the Sarnoff Corporation developed a system for autonomous Video Surveillance and Monitoring. The technical approach uses multiple, cooperative video sensors to provide continuous coverage of people and vehicles in a cluttered environment. This final report presents an overview of the system, and of the technical accomplishments that have been achieved.

A Tutorial on Particle Filters for Online Nonlinear/Non-Gaussian Bayesian Tracking, 2002

M. Sanjeev Arulampalam, Defence Science and Technology Organisation, Adelaide, Australia

Simon Maskell, and Neil Gordon, QinetiQ, Ltd., Malvern, UK, and Cambridge University, Cambridge, UK

Tim Clapp, Astrium Ltd., Stevenage, UK

Increasingly, for many application areas, it is becoming important to include elements of nonlinearity and non-Gaussianity in order to model accurately the underlying dynamics of a physical system. Moreover, it is typically crucial to process data on-line as it arrives, both from the point of view of storage costs as well as for rapid adaptation to changing signal characteristics. In this paper, we review both optimal and suboptimal Bayesian algorithms for nonlinear/non-Gaussian tracking problems, with a focus on particle filters. Particle filters are sequential Monte Carlo methods based on point mass (or “particle”) representations of probability

densities, which can be applied to any state-space model and which generalize the traditional Kalman filtering methods. Several variants of the particle filter such as SIR, ASIR, and RPF are introduced within a generic framework of the sequential importance sampling (SIS) algorithm. These are discussed and compared with the standard EKF through an illustrative example.

Adaboost Video Tracking, 2008

Jia Jingping, and Zhang Feizhou, Peking University, China

Chai Yanmei, Tsinghua University, China

A new approach of tracking objects in image sequences is proposed, in which tracking is seen as a binary classification problem. For each incoming image frame, a likelihood image for the object is created according to the classification results of pixels by a Adaboost feature classifier. In the likelihood image the object's region turns into a blob. The scale of this blob can be determined by the local maxima of differential scale-space filter. We employ the QP_TR trust region algorithm to search for the local maxima of the multi-scale normalized Laplacian filter of the likelihood image so as to locate the object as well as determine its scale. The object's appearance change is dealt with in the update step of the feature classifier. Based on the tracking results of sequence examples, the novel method has been proven to be capable of describing the object more accurately and thus achieves much better tracking precision.

Adaptable Model-Based Tracking Using Analysis-by-Synthesis Techniques, 2007

Harald Wuest, Nanyang Technological University, Singapore

Folker Wientapper, and Didier Stricker, TU Darmstadt, Germany

In this paper we present a novel analysis-by-synthesis approach for real-time camera tracking in industrial scenarios. The camera pose estimation is based on the tracking of line features which are generated dynamically in every frame by rendering a polygonal model and extracting contours out of the rendered scene. Different methods of the line model generation are investigated. Depending on the scenario and the given 3D model either the image gradient of the frame buffer or discontinuities of the z-buffer and the normal map are used for the generation of a 2D edge map. The 3D control points on a contour are calculated by using the depth value stored in the z-buffer. By aligning the generated features with edges in the current image, the extrinsic parameters of the camera are estimated. The camera pose used for rendering is predicted by a line-based frame-to-frame tracking which takes advantage of the generated edge features. The method is validated and evaluated with the help of ground-truth data as well as real image sequences.

Adaptive background mixture models for real-time tracking, 1999

Chris Stauffer, and W. E. L Grimson, Massachusetts Institute of Technology, Cambridge, USA

A common method for real-time segmentation of moving regions in image sequences involves "background subtraction," or thresholding the error between an estimate of the image without moving objects and the current image. The numerous approaches to this problem differ in the type of background model used and the procedure used to update the model. This paper discusses modeling each pixel as a mixture of Gaussians and

using an on-line approximation to update the model. The Gaussian distributions of the adaptive mixture model are then evaluated to determine which are most likely to result from a background process. Each pixel is classified based on whether the Gaussian distribution which represents it most effectively is considered part of the background model. This results in a stable, real-time outdoor tracker which reliably deals with lighting changes, repetitive motions from clutter, and long-term scene changes. This system has been run almost continuously for 16 months, 24 hours a day, through rain and snow.

Algorithms for Cooperative Multisensor Surveillance, 2001

Robert T. Collins, and Takeo Kanade, Carnegie Mellon University, Pittsburgh, USA

Alan J. Lipton, Diamondback Vision, Inc., Reston, USA

Hironobu Fujiyoshi, Chubu University, Aichi, Japan

The Video Surveillance and Monitoring (VSAM) team at Carnegie Mellon University (CMU) has developed an end-to-end, multicamera surveillance system that allows a single human operator to monitor activities in a cluttered environment using a distributed network of active video sensors. Video understanding algorithms have been developed to automatically detect people and vehicles, seamlessly track them using a network of cooperating active sensors, determine their three-dimensional locations with respect to a geospatial site model, and present this information to a human operator who controls the system through a graphical user interface. The goal is to automatically collect and disseminate real-time information to improve the situational awareness of security providers and decision makers. The feasibility of real-time video surveillance has been demonstrated within a multicamera testbed system developed on the campus of CMU. This paper presents an overview of the issues and algorithms involved in creating this semiautonomous, multicamera surveillance system.

An Adaptive Color-Based Particle Filter, 2003

Katja Nummiaro, Katholieke Universiteit Leuven, Heverlee, Belgium

Esther Koller-Meier, and Luc Van Gool, Swiss Federal Institute of Technology, Zurich, Switzerland

Robust real-time tracking of non-rigid objects is a challenging task. Particle filtering has proven very successful for non-linear and non-Gaussian estimation problems. The article presents the integration of color distributions into particle filtering, which has typically been used in combination with edge-based image features. Color distributions are applied as they are robust to partial occlusion, are rotation and scale invariant and computationally efficient. As the color of an object can vary over time dependent on the illumination, the visual angle and the camera parameters, the target model is adapted during temporally stable image observations. An initialization based on an appearance condition is introduced since tracked objects may disappear and reappear. Comparisons with the mean shift tracker and a combination between the mean shift tracker and Kalman filtering show the advantages and limitations of the new approach.

An Algorithm for Multiple Object Trajectory Tracking, 2004

Mei Han, Wei Xu, and Hai Tao, NEC Laboratories America, Cupertino, USA

Yihong Gong, University of California, USA

Most tracking algorithms are based on the maximum a posteriori (MAP) solution of a probabilistic framework called Hidden Markov Model, where the distribution of the object state at current time instance is estimated based on current and previous observations. However, this approach is prone to errors caused by temporal distractions such as occlusion, background clutter and multi-object confusion. In this paper we propose a multiple object tracking algorithm that seeks the optimal state sequence which maximizes the joint state-observation probability. We name this algorithm trajectory tracking since it estimates the state sequence or “trajectory” instead of the current state. The algorithm is capable of tracking multiple objects whose number is unknown and varies during tracking. We introduce an observation model which is composed of the original image, the foreground mask given by background subtraction and the object detection map generated by an object detector. The image provides the object appearance information. The foreground mask enables the likelihood computation to consider the multi-object configuration in its entirety. The detection map consists of pixelwise object detection scores, which drives the tracking algorithm to perform joint inference on both the number of objects and their configurations efficiently.

An Analysis-by-Synthesis Camera Tracking Approach Based on Free-Form Surfaces, 2007

Kevin Koeser, Bogumil Bartczak, and Reinhard Koch, Christian-Albrechts-Universitat, Kiel, Germany

We propose a model-based camera pose estimation approach, which makes use of GPU-assisted analysis-by-synthesis methods on a very wide field of view (e.g. fish-eye) camera. After an initial registration, the synthesis part of the tracking is performed on graphics hardware, which simulates internal and external parameters of the camera, this way minimizing lens and perspective differences between a model view and a real camera image. We show how such a model is automatically created from a scene and analyze the sensitivity of the tracking to the model accuracy, in particular the case when we represent free-form surfaces by planar patches. We also examine accuracy and show on synthetic and on real data that the system does not suffer from drift accumulation. The wide field of view of the camera and the subdivision of our reference model into many textured free-form surfaces make the system robust against moving persons and other occlusions within the environment and provide a camera pose estimate in a fixed and known coordinate system.

An EM-like algorithm for color-histogram-based object tracking, 2004

Zoran Zivkovic, and Ben Krose, University of Amsterdam, The Netherlands

The iterative procedure called 'mean-shift' is a simple robust method for finding the position of a local mode (local maximum) of a kernel-based estimate of a density function. A new robust algorithm is given here that presents a natural extension of the 'mean-shift' procedure. The new algorithm simultaneously estimates the position of the local mode and the covariance matrix that describes the approximate shape of the local mode. We apply the new method to develop a new 5-degrees of freedom (DOF) color histogram based non-rigid object tracking algorithm.

An improved particle filtering algorithm based on observation inversion optimal sampling, 2009

Hu Zhen-tao, Pan Quan, Yang Feng, Cheng Yong-mei, Northwestern Polytechnical University, Xi'an, China

According to the effective sampling of particles and the particles impoverishment caused by re-sampling in particle filter, an improved particle filtering algorithm based on observation inversion optimal sampling was proposed. Firstly, virtual observations were generated from the latest observation, and two sampling strategies were presented. Then, the previous time particles were sampled by utilizing the function inversion relationship between observation and system state. Finally, the current time particles were generated on the basis of the previous time particles and the system one-step state transition model. By the above method, sampling particles can make full use of the latest observation information and the priori modeling information, so that they further approximate the true state. The theoretical analysis and experimental results show that the new algorithm filtering accuracy and real-time outperform obviously the standard particle filter, the extended Kalman particle filter and the unscented particle filter.

Application of Color Segmentation Using Online Learning for Target Tracking, 2008

Muhammad Asif Memon, Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), Karachi, Pakistan

Hassan Ahmed, and Shahid A. Khan, COMSATS Institute of Information Technology, Islamabad

Color segmentation techniques find extensive applications in visual tracking as the color information provides a robust reference for identifying a target. Color based tracking systems generally use histograms or static models. However, in the real world the changing surrounding conditions must be taken into account. An online learning method of color segmentation has been adapted to ensure better performance even with changing lighting conditions. A neural network, based on fuzzy Adaptive Resonance Theory (ART), is used to develop the color model that is updated with each frame by the pixels classified within the target. The categories formed by the ART network are restricted to ensure fast processing, and the performance of the system is analyzed at different thresholds for association with the color model. Further, a Kalman filter is added into the loop for predicting the target's position in the next frame and a comparison is made to investigate the improvement in performance.

Applying a New Spatial Color Histogram in Mean-Shift Based Tracking Algorithm, 2005

Dong Xu, Yimin Wang, and Jinwen An, Northwestern Polytechnical University, Xi'an, China

Due to its robustness and computational efficiency, color histogram has been successfully applied in mean-shift based tracking algorithms. However, the target-shift invariant property of the compact color feature in the tracking window would let the mean shift algorithm fall into local extrema and cause inaccuracy or even failure of target localization. Furthermore, the lack of spatial information often leads to false positives of the color based tracker when the background has a similar color style. To incorporate spatial information, in this paper, we propose a new spatial color histogram and apply it in the mean shift based tracking algorithm. To achieve more accuracy of tracking and robustness to background motions, we also propose to initialize the tracker at multiple positions under a hierarchical framework. Experimental results show the updated algorithm can not only achieve more precise tracking results, but can accommodate relative large background motions.

Bayesian Kernel Tracking, 2002

Dorin Comaniciu, Siemens Corporate Research, Princeton, USA

We present a Bayesian approach to real-time object tracking using nonparametric density estimation. The target model and candidates are represented by probability densities in the joint spatial-intensity domain. The new location and appearance of the target are jointly derived by computing the maximum likelihood estimate of the parameter vector that characterizes the transformation from the candidate to the model. This probabilistic formulation accommodates variations in the target appearance, while being robust to outliers represented by partial occlusions. In this paper we analyze the simplest parameterization represented by translation in both domains and present a gradient-based iterative solution. Various tracking sequences demonstrate the superior behavior of the method.

Better Proposal Distributions: Object Tracking Using Unscented Particle Filter, 2001

Yong Rui, and Yunqiang Chen, Microsoft Research, Redmond, USA

Tracking objects involves the modeling of non-linear non- Gaussian systems. On one hand, variants of Kalman filters are limited by their Gaussian assumptions. On the other hand, conventional particle filter, e.g., CONDENSATION, uses transition prior as the proposal distribution. The transition prior does not take into account current observation data, and many particles can therefore be wasted in low likelihood area. To overcome these difficulties, unscented particle filter (UPF) has recently been proposed in the field of filtering theory. In this paper, we introduce the UPF framework into audio and visual tracking. The UPF uses the unscented Kalman filter to generate sophisticated proposal distributions that seamlessly integrate the current observation, thus greatly improving the tracking performance. To evaluate the efficacy of the UPF framework, we apply it in two real-world tracking applications. One is the audio-based speaker localization, and the other is the visionbased human tracking. The experimental results are compared against those of the widely used CONDENSATION approach and have demonstrated superior tracking performance.

Block Matching for Object Tracking, 2003

A. Gyaourova, C. Kamath, and S.-C. Cheung, the University of California, USA

Models which describe road tra_c patterns can be helpful in detection and/or prevention of uncommon and dangerous situations. Such models can be built by the use of motion detection algorithms applied to video data. Block matching is a standard technique for encoding motion in video compression algorithms. We explored the capabilities of the block matching algorithm when applied for object tracking. The goal of our experiments is two-fold: (1) to explore the abilities of the block matching algorithm on low resolution and low frame rate video and (2) to improve the motion detection performance by the use of di_erent search techniques during the process of block matching. Our experiments showed that the block matching algorithm yields good object tracking results and can be used with high success on low resolution and low frame rate video data. We observed that different searching methods have small effect on the final results. In addition, we proposed a technique based on frame history, which successfully overcame false motion caused by small camera movements.

BraMBLe: A Bayesian Multiple-Blob Tracker, 2001

M. Isard, and J. MacCormick, Compaq Systems Research Center, Palo Alto, USA

Blob trackers have become increasingly powerful in recent years largely due to the adoption of statistical appearance models which allow effective background subtraction and robust tracking of deforming foreground objects. It has been standard, however, to treat background and foreground modelling as separate processes — background subtraction is followed by blob detection and tracking—which prevents a principled computation of image likelihoods. This paper presents two theoretical advances which address this limitation and lead to a robust multiple-person tracking system suitable for single-camera real-time surveillance applications. The first innovation is a multi-blob likelihood function which assigns directly comparable likelihoods to hypotheses containing different numbers of objects. This likelihood function has a rigorous mathematical basis: it is adapted from the theory of Bayesian correlation, but uses the assumption of a static camera to create a more specific background model while retaining a unified approach to background and foreground modelling. Second we introduce a Bayesian filter for tracking multiple objects when the number of objects present is unknown and varies over time. We show how a particle filter can be used to perform joint inference on both the number of objects present and their configurations. Finally we demonstrate that our system runs comfortably in real time on a modest workstation when the number of blobs in the scene is small.

Branching Ground Target Tracking using Sparse Manual Observations, 2004

Johan Edlund, Carl Johan Setterlind, and Niclas Bergman, Saab AB, Järfälla, Sweden

Work in the field of ground target surveillance of vehicles usually focus on elevated sensor platforms like unmanned aerial vehicles (UAV) or other aircraft equipped with advanced sensing systems. These systems yield high-resolution information, but with a limited coverage. In this work we focus on a different problem; when the data rate is very low (one detection per minute) and the sensors are ground stationed manual observers. High-resolution coverage is impossible to achieve in this scenario, and one must rely heavily on extra geographical information. The aim of this work has been to modify an existing product, the Saab Multi Sensor Tracker (MST), utilizing the Multi Hypothesis Tracking (MHT) association logic in the MST so that when the track reaches an intersection each branch in the MHT follows a different road segment. Additional branches have to be added to handle the problems of vehicles stopping or turning around at the intersections, and to handle off-road vehicles. The algorithm structure and design is detailed and simulation results using the modified MST are presented.

Calibration and Comparison of Visual Tracking on the Ground for Multi Camera Tracking, 2009

Jorge Raul Gomez, Jose J. Guerrero, and Elias Herrero-Jaraba, University of Zaragoza, Spain

Tracking is an important field in visual surveillance systems. Trackers have been applied traditionally in the image, but a new concept of tracking has been used gradually, applying the tracking on the ground map of the surrounding area. The purpose of this article is to compare both alternatives and prove that this new usage makes possible to obtain a higher performance and a minimization of the projective effects. Moreover, it provides the concept of multi-camera as a new tool for mobile object tracking in surveillance scenes, because a common reference system can be defined without increasing complexity. An automatic camera re-calibration procedure is also proposed, which avoids some practical limitations of the approach.

Color-Based Object Tracking in Multi-camera Environments, 2003

Katja Nummiaro, Katholieke Universiteit Leuven, Belgium

Esther Koller-Meier, Tomáš Svoboda, Daniel Roth, and Luc Van Gool, Swiss Federal Institute of Technology, Switzerland

This paper presents a multi-view tracker, meant to operate in smart rooms that are equipped with multiple cameras. The cameras are assumed to be calibrated. In particular, we demonstrate a virtual classroom application, where the system automatically selects the camera with the 'best' view on the face of a person moving in the room. Realtime object tracking, which is needed to achieve this, is implemented by means of color-based particle filtering. The use of multiple model histograms for the target (human head) results in robust tracking, even when the view on the target changes considerably like from the front to the back. Information is shared between the cameras, which aids robustness to the system. Once one camera has lost the target, it can be reinitialized with the help of the epipolar constraints suggested by the others. Experiments in our research environment corroborate the effectiveness of the approach.

Color-Based Probabilistic Tracking, 2002

P. Pérez, J. Vermaak, and M. Gangnet, Microsoft Research, Cambridge, UK

C. Hue Iriša, Campus de Beaulieu, Rennes, France

Color-based trackers recently proposed have been proved robust and versatile for a modest computational cost. They are especially appealing for tracking tasks where the spatial structure of the tracked objects exhibits such a dramatic variability that trackers based on a space-dependent appearance reference would break down very fast. Trackers in [3,4,5] rely on the deterministic search of a window whose color content matches a reference histogram color model. Relying on the same principle of color histogram distance, but within a probabilistic framework, we introduce a new Monte Carlo tracking technique. The use of a particle filter allows us to better handle color clutter in the background, as well as complete occlusion of the tracked entities over a few frames. This probabilistic approach is very flexible and can be extended in a number of useful ways. In particular, we introduce the following ingredients: multi-part color modeling to capture a rough spatial layout ignored by global histograms, incorporation of a background color model when relevant, and extension to multiple objects.

Decision Fusion for Object Detection and Tracking Using Mobile Cameras, 2004

Luis David López Gutiérrez, and Leopoldo Altamirano Robles, National Institute of Astrophysics Optics and Electronics, México

In this paper an approach to the automatic target detection and tracking using multisensor image sequences with the presence of camera motion is presented. The approach consists of three parts. The first part uses a motion segmentation method for target detection in the visible image sequence. The second part uses a background model for detecting objects presented in the infrared sequence, which is preprocessed to eliminate the camera motion. The third part combines the individual results of the detection systems; it extends the Joint Probabilistic Data Association (JPDA) algorithm to handle an arbitrary number of sensors. Our approach is tested using image sequences with high clutter in dynamic environments. Experimental results show that the system detects 99% of the targets in the scene, and the fusion module removes 90% of the false detections.

Effective Appearance Model and Similarity Measure for Particle Filtering and Visual Tracking, 2006

Hanzi Wang, David Suter, and Konrad Schindler, Monash University, Clayton, Australia

In this paper, we adaptively model the appearance of objects based on Mixture of Gaussians in a joint spatial-color space (the approach is called SMOG). We propose a new SMOG-based similarity measure. SMOG captures richer information than the general color histogram because it incorporates spatial layout in addition to color. This appearance model and the similarity measure are used in a framework of Bayesian probability for tracking natural objects. In the second part of the paper, we propose an Integral Gaussian Mixture (IGM) technique, as a fast way to extract the parameters of SMOG for target candidate. With IGM, the parameters of SMOG can be computed efficiently by using only simple arithmetic operations (addition, subtraction, division) and thus the computation is reduced to linear complexity. Experiments show that our method can successfully track objects despite changes in foreground appearance, clutter, occlusion, etc.; and that it outperforms several color-histogram based methods.

Effective Motion Tracking Using Known and Learned Actuation Models, 2008

Yang Gu, Carnegie Mellon University, Pittsburgh, USA

Robots need to track objects. We consider tasks where robots actuate on the target that is visually tracked. Object tracking efficiency completely depends on the accuracy of the motion model and of the sensory information. The motion model of the target becomes particularly complex in the presence of multiple agents acting on a mobile target. We assume that the tracked object is actuated by a team of agents, composing of robots and possibly humans. Robots know their own actions, and team members are collaborating according to coordination plans and communicated information. The thesis shows that using a previously known or learned action model of the single robot or team members improves the efficiency of tracking. First, we introduce and implement a novel team-driven motion tracking approach. Team-driven motion tracking is a tracking paradigm defined as a set of principles for the inclusion of a hierarchical, prior knowledge and construction of a motion model. We illustrate a possible set of behavior levels within the Segway soccer domain that correspond to the abstract motion modeling decomposition. Second, we introduce a principled approach to incorporate models of the robot-object interaction into the tracking algorithm to effectively improve the performance of the tracker. We present the integration of a single robot behavioral model in terms of skills and tactics with multiple actions into our dynamic Bayesian probabilistic tracking algorithm. Third, we extend to multiple motion tracking models corresponding to known multi-robot coordination plans or from multi-robot communication. We evaluate our resulting informed-tracking approach empirically in simulation and using a setup Segway soccer task. The input of the multiple single and multi-robot behavioral sources allow a robot to much more effectively visually track mobile targets with dynamic trajectories. Fourth, we present a parameter learning algorithm to learn actuation models. We describe the parametric system model and the parameters we need to learn in the actuation model. As in the KLD-sampling algorithm applied to tracking, we adapt the number of modeling particles and learn the unknown parameters. We successfully decrease the computation time of learning and the state estimation process by using significantly fewer particles on average. We show the effectiveness of learning using simulated experiments. The tracker that uses the learned actuation model achieves improved tracking performance. These contributions demonstrate that it is possible to effectively improve an agent's object tracking ability using tactics, plays, communication and learned action models in the presence of multiple agents acting on a mobile object. The introduced tracking algorithms are proven effective in a number of simulated experiments and setup Segway robot soccer tasks. The team-driven motion tracking framework is demonstrated empirically across a wide range of settings of increasing complexity.

Embedded Real-Time Surveillance Using Multimodal Mean Background Modeling, 2009

Senyo Apewokin, Brian Valentine, Dana Forsthoefel, Linda Wills, and Scott Wills, Georgia Institute of Technology, USA

Antonio Gentile, University of Palermo, Italy

Automated video surveillance applications require accurate separation of foreground and background image content. Cost-sensitive embedded platforms place real-time performance and efficiency demands on techniques to accomplish this task. In this chapter, we evaluate pixel-level foreground extraction techniques for a low-cost integrated surveillance system. We introduce a new adaptive background modeling technique, multimodal mean (MM), which balances accuracy, performance, and efficiency to meet embedded system requirements. Our evaluation compares several pixel-level foreground extraction techniques in terms of their computation and storage requirements, and functional accuracy for three representative video sequences. The proposed MM algorithm delivers comparable accuracy of the best alternative (mixture of Gaussians) with a 6× improvement in execution time and an 18% reduction in required storage on an eBox-2300 embedded platform.

Enhanced Importance Sampling: Unscented Auxiliary Particle Filtering for Visual Tracking, 2005

Chunhua Shen, Anton van den Hengel, Anthony Dick, and Michael J. Brooks, The University of Adelaide, Australia

The particle filter has attracted considerable attention in visual tracking due to its relaxation of the linear and Gaussian restrictions in the state space model. It is thus more flexible than the Kalman filter. However, the conventional particle filter uses system transition as the proposal distribution, leading to poor sampling efficiency and poor performance in visual tracking. It is not a trivial task to design satisfactory proposal distributions for the particle filter. In this paper, we introduce an improved particle filtering framework into visual tracking, which combines the unscented Kalman filter and the auxiliary particle filter. The efficient unscented auxiliary particle filter (UAPF) uses the unscented transformation to predict one-step ahead likelihood and produces more reasonable proposal distributions, thus reducing the number of particles required and substantially improving the tracking performance. Experiments on real video sequences demonstrate that the UAPF is computationally efficient and outperforms the conventional particle filter and the auxiliary particle filter.

Evaluation and Improvements of a Real-Time Background Subtraction Method, 2005

Donatello Conte, Pasquale Foggia, Michele Petretta, Francesco Tufano, and Mario Vento, Università di Salerno, Italy

In a video surveillance system, moving object detection is the most challenging problem especially if the system is applied in complex environments with variable lighting, dynamic and articulate scenes, etc.. Furthermore, a video surveillance system is a real-time application, so discouraging the use of good, but computationally expensive, solutions. This paper presents a set of improvements of a basic background subtraction algorithm that are suitable for video surveillance applications. Besides we present a new evaluation scheme never used in the context of moving object detection algorithms.

Fast Multiple Object Tracking via a Hierarchical Particle Filter, 2005

Changjiang Yang, Ramani Duraiswami, and Larry Davis, University of Maryland, USA

A very efficient and robust visual object tracking algorithm based on the particle filter is presented. The method characterizes the tracked objects using color and edge orientation histogram features. While the use of more features and samples can improve the robustness, the computational load required by the particle filter increases. To accelerate the algorithm while retaining robustness we adopt several enhancements in the algorithm. The first is the use of integral images for efficiently computing the color features and edge orientation histograms, which allows a large amount of particles and a better description of the targets. Next, the observation likelihood based on multiple features is computed in a coarse-to-fine manner, which allows the computation to quickly focus on the more promising regions. Quasi-random sampling of the particles allows the filter to achieve a higher convergence rate. The resulting tracking algorithm maintains multiple hypotheses and offers robustness against clutter or short period occlusions. Experimental results demonstrate the efficiency and effectiveness of the algorithm for single and multiple object tracking.

Fast Object Tracking Using Adaptive Block Matching, 2005

Karthik Hariharakrishnan, Multimedia Group, Motorola, Inc., Bangalore, India

Dan Schonfeld, University of Illinois at Chicago, Chicago, USA

We propose a fast object tracking algorithm that predicts the object contour using motion vector information. The segmentation step common in region-based tracking methods is avoided, except for the initialization of the object. Tracking is achieved by predicting the object boundary using block motion vectors followed by updating the contour using occlusions/disocclusion detection. An adaptive block-based approach has been used for estimating motion between frames. An efficient modulation scheme is used to control the gap between frames used for motion estimation. The algorithm for detecting disocclusion proceeds in two steps. First, uncovered regions are estimated from the displaced frame difference. These uncovered regions are classified into actual disocclusions and false alarms by observing the motion characteristics of uncovered regions. Occlusion and disocclusion are considered as dual events and this relationship is explained in detail. The algorithm for detecting occlusion is developed by modifying the disocclusion detection algorithm in accordance with the duality principle. The overall tracking algorithm is computationally superior to existing region-based methods for object tracking. The immediate applications of the proposed tracking algorithm are video compression using MPEG-4 and content retrieval based on standards like H.264. Preliminary simulation results demonstrate the performance of the proposed algorithm.

Improving Real-Time Performance of Computer Vision Applications, 2009

Changsong Shen, James J. Little, and Sidney Fels, University of British Columbia, Vancouver, Canada

Meeting constraints for real-time performance is a main issue for computer vision, especially for embedded computer vision systems. This chapter presents our progress on our open vision library (OpenVL), a novel software architecture to address efficiency through facilitating hardware acceleration, reusability, and scalability for computer vision systems. A logical image understanding pipeline is introduced to allow parallel processing. We also discuss progress on our middleware—vision library utility toolkit (VLUT)—that enables applications to operate transparently over a heterogeneous collection of hardware implementations. OpenVL works as a state

machine, with an event-driven mechanism to provide users with application-level interaction. Various explicit or implicit synchronization and communication methods are supported among distributed processes in the logical pipelines. The intent of OpenVL is to allow users to quickly and easily recover useful information from multiple scenes, in a cross-platform, cross-language manner across various software environments and hardware platforms. To validate the critical underlying concepts of OpenVL, a human tracking system and a local positioning system are implemented and described. The novel architecture separates the specification of algorithmic details from the underlying implementation, allowing for different components to be implemented on an embedded system without recompiling code.

Incremental Density Approximation and Kernel-Based Bayesian Filtering for Object Tracking, 2004

Bohyung Han, and Larry Davis, University of Maryland, USA

Dorin Comaniciu, and Ying Zhu, Siemens Corporate Research, Princeton, USA

Statistical density estimation techniques are used in many computer vision applications such as object tracking, background subtraction, motion estimation and segmentation. The particle filter (Condensation) algorithm provides a general framework for estimating the probability density functions (pdf) of general non-linear and non-Gaussian systems. However, since this algorithm is based on a Monte Carlo approach, where the density is represented by a set of random samples, the number of samples is problematic, especially for high dimensional problems. In this paper, we propose an alternative to the classical particle filter in which the underlying pdf is represented with a semi-parametric method based on a mode finding algorithm using mean-shift. A mode propagation technique is designed for this new representation for tracking applications. A quasi-random sampling method in the measurement stage is used to improve performance, and sequential density approximation for the measurements distribution is performed for efficient computation. We apply our algorithm to a high dimensional color-based tracking problem, and demonstrate its performance by showing competitive results with other trackers.

Incremental Learning for Robust Visual Tracking, 2007

David A. Ross, University of Toronto, Canada

Jongwoo Lim, and Ming-Hsuan Yang, Honda Research Institute, California, USA

Ruei-Sung Lin, Motorola Labs, Illinois, USA

Visual tracking, in essence, deals with nonstationary image streams that change over time. While most existing algorithms are able to track objects well in controlled environments, they usually fail in the presence of significant variation of the object's appearance or surrounding illumination. One reason for such failures is that many algorithms employ fixed appearance models of the target. Such models are trained using only appearance data available before tracking begins, which in practice limits the range of appearances that are modeled, and ignores the large volume of information (such as shape changes or specific lighting conditions) that becomes available during tracking. In this paper, we present a tracking method that incrementally learns a low-dimensional subspace representation, efficiently adapting online to changes in the appearance of the target. The model update, based on incremental algorithms for principal component analysis, includes two important features: a method for correctly updating the sample mean, and a forgetting factor to ensure less modeling power is expended fitting older observations. Both of these features contribute measurably to improving overall tracking performance. Numerous experiments demonstrate the effectiveness of the proposed tracking algorithm in indoor and outdoor environments where the target objects undergo large changes in pose, scale, and illumination.

Intelligent Motion Tracking by Combining Specialized Algorithms, 2009

Matthias Weber, FGAN e.V., FKIE, Wachtberg-Werthhoven, Germany

Motion Capture is a widely accepted approach to capture natural human motion, usually utilizing markers to track certain anthropological points on the participant's body. Unfortunately, these markers do not carry any identification information. Furthermore, marker data can be noisy. To address these problems this work suggests a hybrid approach, i.e. an approach using several experts to solve easier, less complex subproblems. Currently, the presented hybrid approach is built upon three methods, two for identification and one for tracking purposes. For identification of an initial posture, a PCA-based technique for aligning a skeleton model as well as a tree-based optimization comparing anthropometric and tracking data are introduced. To complement the hybrid computation pipeline a neural network algorithm based on selforganizing maps tracks the markers on subsequent frames.

Inverse Composition for Multi-kernel Tracking, 2006

Remi Megret, Mounia Mikram, and Yannick Berthoumiou, Université Bordeaux, Talence, France

Existing multi-kernel tracking methods are based on a forwards additive motion model formulation. However this approach suffers from the need to estimate an update matrix for each iteration. This paper presents a general framework that extends the existing approach and that allows to introduce a new inverse compositional formulation which shifts the computation of the update matrix to a one time initialisation step. The proposed approach thus reduces the computational complexity of each iteration, compared to the existing forwards approach. The approaches are compared both in terms of algorithmic complexity and quality of the estimation.

JPDAF Based HMM for Real-Time Contour Tracking, 2001

Yunqiang Chen, and Thomas S. Huang, University of Illinois, USA

Yong Rui, Microsoft Research, Redmond, USA

Tracking objects using multiple cues yields more robust results. The well-known hidden Markov model (HMM) provides a powerful framework to incorporate multiple cues by expanding its observation. However, a plain HMM does not capture the inter-correlation between measurements of neighboring states when computing the transition probabilities. This can seriously damage the tracking performance. To overcome this difficulty, in this paper, we propose a new HMM framework targeted at contour-based object tracking. A joint probability data association filter (JPDAF) is used to compute the HMM's transition probabilities, taking into account the intercorrelated neighboring measurements. To ensure real-time performance, we have further developed an efficient method to calculate the data association probability via dynamic programming, which allows the proposed JPDAF-HMM to run comfortably at 30 frames/sec. This new tracking framework not only can easily incorporate various image cues (e.g., edge intensity, foreground region color and background region color), but also offers an on-line learning process to adapt to changes in the scene. To evaluate its tracking performance, we have applied the proposed JPDAF-HMM in various realworld video sequences. We report promising tracking results in complex environments.

Kalman filter for vision tracking, 2005

Erik Cuevas^{1,2}, Daniel Zaldivar^{1,2}, and Raul Rojas¹

¹Freie Universität Berlin, Berlin, Germany

²Universidad de Guadalajara, Guadalajara, Mexico

The Kalman filter has been used successfully in different prediction applications or state determination of a system. One important field in computer vision is the object tracking. Different movement conditions and occlusions can hinder the vision tracking of an object. In this report we present the use of the Kalman filter in the vision tracking. We consider the capacity of the Kalman filter to allow small occlusions and also the use of the the extended Kalman filter (EKF) to model complex movements of objects.

Kernel-Based Object Tracking, 2000

Dorin Comaniciu, Visvanathan Ramesh, Siemens Corporate Research, Princeton, USA

Peter Meer, Rutgers University, USA

A new approach toward target representation and localization, the central component in visual tracking of non-rigid objects, is proposed. The feature histogram based target representations are regularized by spatial masking with an isotropic kernel. The masking induces spatially-smooth similarity functions suitable for gradient-based optimization, hence, the target localization problem can be formulated using the basin of attraction of the local maxima. We employ a metric derived from the Bhattacharyya coefficient as similarity measure, and use the mean shift procedure to perform the optimization. In the presented tracking examples the new method successfully coped with camera motion, partial occlusions, clutter, and target scale variations. Integration with motion filters and data association techniques is also discussed. We describe only few of the potential applications: exploitation of background information, Kalman tracking using motion models, and face tracking.

Learning to Detect Natural Image Boundaries Using Local Brightness, Color, and Texture Cues, 2004

David R. Martin, Boston College, Chestnut Hill, USA

Charless C. Fowlkes, and Jitendra Malik, University of California, Berkeley, USA

The goal of this work is to accurately detect and localize boundaries in natural scenes using local image measurements. We formulate features that respond to characteristic changes in brightness, color, and texture associated with natural boundaries. In order to combine the information from these features in an optimal way, we train a classifier using human labeled images as grand truth. The output of this classifier provides the posterior probability of a boundary at each image location and orientation. We present precision-recall curves showing that the resulting detector significantly outperforms existing approaches. Our two main results are 1) that cue combination can be performed adequately with a simple linear model and 2) that a proper, explicit treatment of texture is required to detect boundaries in natural images.

Likelihood-based object detection and object tracking using color histograms and EM, 2002

Paul Withagen^{1,2}, and Klammer Schutte^{1,2}

¹ TNO Physics and Electronics Laboratory, The Hague, The Netherlands

² Frans Groen IAS group, University of Amsterdam, The Netherlands

The topic of this paper is the integration of Expectation Maximization (EM) background modeling and template matching using color histograms as templates to improve person tracking for surveillance applications. The tracked objects are humans, which are not rigid bodies. As such shape deformations of the objects must be allowed. For each frame, the decision has to be made which pixels belong to an object, and which do not. The integration of detection and tracking is done using a likelihood-based framework. This way the classification of pixels between background and object can be based on comparing likelihoods rather than separate thresholds. A demonstration of the proposed algorithm will be given.

Maneuvering target tracking by using particle filter, 2001

Norikazu Ikoma, and Hiroshi Maeda, Kyushu Institute of Technology, Kita-Kyushu, Japan

Naoyuki Ichimura, Electrotechnical Laboratory, Tsukuba, Ibaraki, Japan

Tomoyuki Higuchi, The Institute of Statistical Mathematics, Minato-ku Tokyo, Japan

The aim of this research is to track a maneuvering target, e.g. a ship, an aircraft, and so on. We use a state-space representation to model this situation. The dynamics of the target is represented by a system model, firstly in continuous time, though a discretized system model is actually to be used in practice. The position of the target is measured by radar, and this process is described by a nonlinear observation model in polar coordinates. To follow abrupt changes in the target's motion due to sudden operations of the acceleration pedal, braking and steering, we propose the use of heavy-tailed non-Gaussian distribution for the system noise. Consequently, the model we use is a nonlinear non-Gaussian state-space model. A particle filter is used to estimate the target state of the nonlinear non-Gaussian model. The usefulness of the method is shown by simulation.

MCMC-Based Particle Filtering for Tracking a Variable Number of Interacting Targets, 2005

Zia Khan, Tucker Balch, and Frank Dellaert, Georgia Institute of Technology, USA

We describe a particle filter that effectively deals with interacting targets - targets that are influenced by the proximity and/or behavior of other targets. The particle filter includes a Markov random field (MRF) motion prior that helps maintain the identity of targets throughout an interaction, significantly reducing tracker failures. We show that this MRF prior can be easily implemented by including an additional interaction factor in the importance weights of the particle filter. However, the computational requirements of the resulting multi-target filter render it unusable for large numbers of targets. Consequently, we replace the traditional importance sampling step in the particle filter with a novel Markov chain Monte Carlo (MCMC) sampling step to obtain a more efficient MCMC-based multi-target filter. We also show how to extend this MCMC-based filter to address a variable number of interacting targets. Finally, we present both qualitative and quantitative experimental results, demonstrating that the resulting particle filters deal efficiently and effectively with complicated target interactions.

MCMC Data Association and Sparse Factorization Updating for Real Time Multitarget Tracking with Merged and Multiple Measurements, 2006

Zia Khan, Tucker Balch, and Frank Dellaert, Georgia Institute of Technology, USA

In several multitarget tracking applications a target may return more than one measurement per target, and interacting targets may return multiple merged measurements between targets. Existing algorithms for tracking and data association, initially applied to radar tracking, do not adequately address these types of measurements. Here, we introduce a probabilistic model for interacting targets that addresses both types of measurements simultaneously. We provide an algorithm for approximate inference in this model using a Markov chain Monte Carlo (MCMC) based auxiliary variable particle filter. We Rao-Blackwellize the Markov chain to eliminate sampling over the continuous state space of the targets. A major contribution of this work is the use of sparse least squares updating and downdating techniques, which significantly reduce the computational cost per iteration of the Markov chain. Also, when combined with a simple heuristic, they enable the algorithm to correctly focus computation on interacting targets. We include experimental results on a challenging simulation sequence. We test the accuracy of the algorithm using two sensor modalities, video and laser range data. We also show the algorithm exhibits real time performance on a conventional PC.

Mixed Coordinate Tracking of Generalized Maneuvering Targets Using Acceleration and Jerk Models, 2000

Pravas R. Mahapatra, Indian Institute of Science, Bangalore, India

Kishore Mehrotra, Christchurch, New Zealand

In a recent paper the authors introduced an all-Cartesian formulation of a jerk model for tracking highly maneuvering targets. Here a more complex but realistic case is considered, where target motion modeling and tracking are carried out in the 3-D Cartesian frame using measurements obtained in a spherical system. The transformation of the measurements into the Cartesian system results in nonlinear measurement equations. We solve the problem using an extended Kalman filter (EKF) approach, and also treat the earlier acceleration model similarly for comparison of results.

Monte Carlo Filtering for Multi-Target Tracking and Data Association, 2005

Jaco Vermaak, Simon J. Godsill, Cambridge University, UK

Patrick P'erez, IRISA/INRIA Rennes, France

In this paper we present Monte Carlo methods for multi-target tracking and data association. The methods are applicable to general non-linear and non-Gaussian models for the target dynamics and measurement likelihood. We provide efficient solutions to two very pertinent problems: the data association problem that arises due to unlabelled measurements in the presence of clutter, and the curse of dimensionality that arises due to the increased size of the state-space associated with multiple targets. We develop a number of algorithms to achieve this. The first, which we will refer to as the Monte Carlo Joint Probabilistic Data Association Filter (MC-JPDAF), is a generalisation of the strategy proposed in [1], [2]. As is the case for the JPDAF, the distributions of interest are the marginal filtering distributions for each of the targets, but these are

approximated with particles rather than Gaussians. We also develop two extensions to the standard particle filtering methodology for tracking multiple targets. The first, which we will refer to as the Sequential Sampling Particle Filter (SSPF), samples the individual targets sequentially by utilising a factorisation of the importance weights. The second, which we will refer to as the Independent Partition Particle Filter (IPPF), assumes the associations to be independent over the individual targets, leading to an efficient componentwise sampling strategy to construct new particles. We evaluate and compare the proposed methods on a challenging synthetic tracking problem.

Moving Object Tracking in Video, 2000

Yiwei Wang, The Pennsylvania State University, USA

John F. Doherty, National Institute of Standards and Technology, Gaithersburg, USA

The advance of technology makes video acquisition devices better and less costly, thereby increasing the number of applications that can effectively utilize digital video. Compared to still images, video sequences provide more information about how objects and scenarios change over time. However, video needs more space for storage and wider bandwidth for transmission. Hence is raised the topic of video compression. The MPEG 4 compression standard suggests the usage of object planes. If the object planes are segmented correctly and the motion parameters are derived for each object plane accordingly, a better compression ratio can be expected. Therefore, to take full advantage of the MPEG 4 standard, algorithms for tracking objects are needed. It is also obvious that there is great interest in moving object tracking algorithms in the fields of reconnaissance, robot technology, etc. So, we propose an algorithm to track moving objects in video sequences. The algorithm first separates the moving objects from the background in each frame. Then, four sets of variables are computed based on the positions, the sizes, the grayscale distributions and the presence of textures of the objects. A rule-based method is developed to track the objects between frames, based on the values of the variables. Preliminary experimental results show that the algorithm performs well. The tests also show that the algorithm obtains success in indicating new tracks (object starts moving), ceased tracks (object stops moving) and possible collisions (objects move together).

Moving Vehicle Tracking Based on SIFT Active Particle Choosing, 2009

Tao Gao, Zheng-guang Liu, and Jun Zhang, Tianjin University, China

Wen-chun Gao, Honeywell, China

For particle filtering tracking method, particle choosing is random to some degree according to the dynamics equation, which may cause inaccurate tracking results. To compensate, an improved particle filtering tracking method is presented. A moving vehicle is detected by redundant discrete wavelet transforms method (RDWT), and then the key points are obtained by scale invariant feature transform. The matching key points in the follow-up frames obtained by SIFT method are used as the initial particles to improve the tracking performance. Experimental results show that more particles centralize in the region of motion area by the presented method than traditional particle filtering, and tracking results of moving vehicles are more accurate. The method has been adopted by Tianjin traffic bureau of China, and has a certain actual application prospect.

Multi-object trajectory tracking, 2007

Mei Han, Wei Xu, and Hai Tao, NEC Laboratories America, Cupertino, USA

Yihong Gong, University of California, USA

The majority of existing tracking algorithms are based on the maximum a posteriori solution of a probabilistic framework using a Hidden Markov Model, where the distribution of the object state at the current time instance is estimated based on current and previous observations. However, this approach is prone to errors caused by distractions such as occlusions, background clutters and multi-object confusions. In this paper, we propose a multiple object tracking algorithm that seeks the optimal state sequence that maximizes the joint multi-object state-observation probability. We call this algorithm trajectory tracking since it estimates the state sequence or “trajectory” instead of the current state. The algorithm is capable of tracking unknown time-varying number of multiple objects. We also introduce a novel observation model which is composed of the original image, the foreground mask given by background subtraction and the object detection map generated by an object detector. The image provides the object appearance information. The foreground mask enables the likelihood computation to consider the multi-object configuration in its entirety. The detection map consists of pixel-wise object detection scores, which drives the tracking algorithm to perform joint inference on both the number of objects and their configurations efficiently. The proposed algorithm has been implemented and tested extensively in a complete CCTV video surveillance system to monitor entries and detect tailgating and piggybacking violations at access points for over six months. The system achieved 98.3% precision in event classification. The violation detection rate is 90.4% and the detection precision is 85.2%. The results clearly demonstrate the advantages of the proposed detection based trajectory tracking framework.

Multiple Collaborative Kernel Tracking, 2007

Zhimin Fan, Ming Yang, and Ying Wu, Northwestern University, Evanston, USA

Those motion parameters that cannot be recovered from image measurements are unobservable in the visual dynamic system. This paper studies this important issue of singularity in the context of kernel-based tracking and presents a novel approach that is based on a motion field representation which employs redundant but sparsely correlated local motion parameters instead of compact but uncorrelated global ones. This approach makes it easy to design fully observable kernel-based motion estimators. This paper shows that these highdimensional motion fields can be estimated efficiently by the collaboration among a set of simpler local kernel-based motion estimators, which makes the new approach very practical.

Multiple Hypothesis Tracking For Multiple Target Tracking, 2004

Samuel S. Blackman, Raytheon Co., El Segundo, USA

Multiple hypothesis tracking (MHT) is generally accepted as the preferred method for solving the data association problem in modern multiple target tracking (MTT) systems. This paper summarizes the motivations for MHT, the basic principles behind MHT and the alternative implementations in common use. It discusses the manner in which the multiple data association hypotheses formed by MHT can be combined with multiple filter models, such as used by the interacting multiple model (IMM) method. An overview of the studies that show the advantages of MHT over the conventional single hypothesis approach is given. Important current applications and areas of future research and development for MHT are discussed.

Multiple Kernel Tracking with SSD, 2004

Gregory D. Hager, Maneesh Dewan, and Charles V. Stewart, Johns Hopkins University, Baltimore, USA

Kernel-based objective functions optimized using the mean shift algorithm have been demonstrated as an effective means of tracking in video sequences. The resulting algorithms combine the robustness and invariance properties afforded by traditional density-based measures of image similarity, while connecting these techniques to continuous optimization algorithms. This paper demonstrates a connection between kernel-based algorithms and more traditional template tracking methods. There is a well known equivalence between the kernel-based objective function and an SSD-like measure on kernel-modulated histograms. It is shown that under suitable conditions, the SSD-like measure can be optimized using Newton-style iterations. This method of optimization is more efficient (requires fewer steps to converge) than mean shift and makes fewer assumptions on the form of the underlying kernel structure. In addition, the methods naturally extend to objective functions optimizing more elaborate parametric motion models based on multiple spatially distributed kernels. We demonstrate multi-kernel methods on a variety of examples ranging from tracking of unstructured objects in image sequences to stereo tracking of structured objects to compute full 3D spatial location.

Multiple Target Tracking For Mobile Robots Using the JPDAF Algorithm, 2007

Aliakbar Gorji, Saeed Shiry, and Mohammad Bagher Menhaj, Amirkabir University of Technology, Tehran, Iran

Mobile robot localization is taken into account as one of the most important topics in robotics. In this paper, the localization problem is extended to the cases in which estimating the position of multiple robots is considered. To do so, the Joint Probabilistic Data Association Filter (JPDAF) approach is applied for tracking the position of multiple robots. To characterize the motion of each robot, two models are used. First, a simple near constant velocity model is considered and then a variable velocity model is applied for tracking. This improves the performance when the robots change their velocity and conduct maneuvering movements. This issue gives an advantage to explore the movement of the maneuvering objects which is common in many robotics problems such as soccer or rescue robots. Simulation results show the efficiency of the JPDAF algorithm in tracking multiple mobile robots with maneuvering movements.

Multiple Target Tracking Using Spatio-Temporal Markov Chain Monte Carlo Data Association, 2007

Qian Yu, and Gerard Medioni, University of Southern California, Los Angeles, USA

Isaac Cohen, Honeywell, Minneapolis, USA

We propose a framework for general multiple target tracking, where the input is a set of candidate regions in each frame, as obtained from a state of the art background learning, and the goal is to recover trajectories of targets over time from noisy observations. Due to occlusions by targets and static objects, noisy segmentation and false alarms, one foreground region may not correspond to one target faithfully. Therefore the one-to-one assumption used in most data association algorithms is not always satisfied. Our method overcomes the one-to-one assumption by formulating the visual tracking problem in terms of finding the best spatial and temporal association of observations, which maximizes the consistency of both motion and appearance of trajectories. To

avoid enumerating all possible solutions, we take a Data Driven Markov Chain Monte Carlo (DD-MCMC) approach to sample the solution space efficiently. The sampling is driven by an informed proposal scheme controlled by a joint probability model combining motion and appearance. To make sure the Markov chain to converge to a desired distribution, we propose an automatic approach to determine the parameters in the target distribution. Comparative experiments with quantitative evaluations are provided.

Multiple Kernel Tracking with SSD, 2004

Gregory D. Hager, Maneesh Dewan, and Charles V. Stewart, Johns Hopkins, Baltimore, USA

Kernel-based objective functions optimized using the mean shift algorithm have been demonstrated as an effective means of tracking in video sequences. The resulting algorithms combine the robustness and invariance properties afforded by traditional density-based measures of image similarity, while connecting these techniques to continuous optimization algorithms. This paper demonstrates a connection between kernelbased algorithms and more traditional template tracking methods. There is a well known equivalence between the kernel-based objective function and an SSD-like measure on kernel-modulated histograms. It is shown that under suitable conditions, the SSD-like measure can be optimized using Newton-style iterations. This method of optimization is more efficient (requires fewer steps to converge) than mean shift and makes fewer assumptions on the form of the underlying kernel structure. In addition, the methods naturally extend to objective functions optimizing more elaborate parametric motion models based on multiple spatially distributed kernels. We demonstrate multi-kernel methods on a variety of examples ranging from tracking of unstructured objects in image sequences to stereo tracking of structured objects to compute full 3D spatial location.

Multiple object detection and tracking with pseudo-particle filter, 2009

Baolong GUO, and Wei SUN, Xidian University, Xi'an, China

To tackle the divergence of the classical particle filter method for multiple object tracking in image sequences, a new particle filter, called pseudoparticle filter (PPF), is proposed. The PPF invokes subset particles of generic particle filters to form a continuous estimate of the posterior density function of the objects. After sampling-importance resampling (SIR), the subset particles converge to the observations. It is proved that, using an appropriate kernel function of the mean shift algorithm, we can get the subset particles of the observations and the fixed points of clustering results as the state of the objects. A multiple object data association and state estimation technique is proposed to resolve the subset particles correspondence ambiguities that arise when multiple objects are present. Experimental results demonstrate the efficiency and effectiveness of the algorithm for single and multiple object tracking.

Multiple object tracking with kernel particle filter, 2005

Cheng Chang, Rashid Ansari, and Ashfaq Khokhar, University of Illinois at Chicago, USA

A new particle filter, Kernel Particle Filter (KPF), is proposed for visual tracking for multiple objects in image sequences. The KPF invokes kernels to form a continuous estimate of the posterior density function and allocates particles based on the gradient derived from the kernel density estimate. A data association technique is also proposed to resolve the motion correspondence ambiguities that arise when multiple objects are present.

The data association technique introduces minimal amount of computation by making use of the intermediate results obtained in particle allocation. We show that KPF performs robust multiple object tracking with improved sampling efficiency.

Multi-Target Tracking - Linking Identities using Bayesian Network Inference, 2006

Peter Nillius, Josephine Sullivan, and Stefan Carlsson, Royal Institute of Technology, Stockholm, Sweden

Multi-target tracking requires locating the targets and labeling their identities. The latter is a challenge when many targets, with indistinct appearances, frequently occlude one another, as in football and surveillance tracking. We present an approach to solving this labeling problem. When isolated, a target can be tracked and its identity maintained. While, if targets interact this is not always the case. This paper assumes a track graph exists, denoting when targets are isolated and describing how they interact. Measures of similarity between isolated tracks are defined. The goal is to associate the identities of the isolated tracks, by exploiting the graph constraints and similarity measures. We formulate this as a Bayesian network inference problem, allowing us to use standard message propagation to find the most probable set of paths in an efficient way. The high complexity inevitable in large problems is gracefully reduced by removing dependency links between tracks. We apply the method to a 10 min sequence of an international football game and compare results to ground truth.

New Models For Real-Time Tracking Using Particle Filtering, 2007

Ng Ka Ki, and Edward J. Delp, Purdue University, West Lafayette, USA

This paper presents new methods for efficient object tracking in video sequences using multiple features and particle filtering. A histogram-based framework is used to describe the features. Histograms are useful because have the property that they allow changes in the object appearance while the histograms remain the same. Particle filtering is used because it is very robust for non-linear and non-Gaussian dynamic state estimation problems and performs well when clutter and occlusions are present. Color histogram based particle filtering is the most common method used for object tracking. However, a single feature tracker loses track easily and can track the wrong object. One popular remedy for this problem is using multiple features. It has been shown that using multiple features for tracking provides more accurate results while increasing the computational complexity.

In this paper we address these problems by describing an efficient method for histogram computation. For better tracking performance we also introduce a new observation likelihood model with dynamic parameter setting. Experiments show our proposed method is more accurate and more efficient than the traditional color histogram based particle filtering.

Off-Line and Real-Time Methods for ML-PDA Target Validation, 2007

Wayne R. Blanding, Peter K. Willett, and Yaakov Bar-Shalom, University of Connecticut, USA

We present two procedures for validating targets whose track estimates are obtained using the Maximum Likelihood Probabilistic Data Association (ML-PDA) algorithm. The ML-PDA, developer for Very Low Observable (VLO) target tracking, always provides a track estimate that must then be tested for target existence

by comparing the value of the Log Likelihood Ratio (LLR) at the track estimate to a threshold. Using extreme value theory, we show that in the absence of a target the LLR at the track estimate obeys approximately a Gumbel distribution rather than the Gaussian distribution previously ascribed to it in the literature. The off-line target validation procedure relies on extensive offline simulations to obtain a set of target validation thresholds that are then used by the tracking system. The real-time procedure uses the data set that produced the track estimate to also determine the target validation threshold. The performance of these two procedures is investigated through simulation of two active sonar tracking scenarios by comparing the false true target/track acceptance probabilities. These techniques have potential for use in a broader class of maximum likelihood estimation problems with similar structure.

On-Line Kernel-Based Tracking in Joint Feature-Spatial Spaces, 2004

Changjiang Yang, Ramani Duraiswami, Ahmed Elgammal, and Larry Davis, University of Maryland, USA

We will demonstrate an object tracking algorithm that uses a novel simple symmetric similarity function between spatially-smoothed kernel-density estimates of the model and target distributions. The similarity measure is based on the expectation of the density estimates over the model or target images. The density is estimated using radial-basis kernel functions which measure the affinity between points and provide a better outlier rejection property. The meanshift algorithm is used to track objects by iteratively maximizing this similarity function. To alleviate the quadratic complexity of the density estimation, we employ Gaussian kernels and the fast Gauss transform to reduce the computations to linear order. This leads to a very efficient and robust nonparametric tracking algorithm. More details can be found in [2]. The system processes online video stream on a P4 1.4GHz and achieves 30 frames per second using an ordinary webcam.

Object Detection and Tracking Using a Likelihood Based Approach, 2002

Paul Withagen, and Klamer Schutte TNO Physics and Electronics Laboratory, Hague, The Netherlands

Frans Groen, IAS group, University of Amsterdam, Amsterdam, The Netherlands

Many surveillance algorithms use both background modeling to detect moving objects and object tracking to analyze the motion patterns of the objects detected. In our case, Expectation Maximization (EM) is used to model the background and detect moving objects. Tracking is based on the objects color histogram. Using EM we can calculate the probability that a pixel value belongs to the background. Simultaneously, we use the color histogram of an object as a feature for tracking the object, which we use to calculate the probability that the pixel belongs to the object. In this paper we report integration between background modeling using EM and object tracking using color histograms. The classification between background objects will be based on probabilities. We will show the advantages for both the object detection and tracking part.

Object tracking: A survey, 2006

[Alper Yilmaz](#), Ohio State University, USA

[Omar Javed](#), and [Mubarak Shah](#), University of Central Florida, USA

The goal of this article is to review the state-of-the-art tracking methods, classify them into different categories,

and identify new trends. Object tracking, in general, is a challenging problem. Difficulties in tracking objects can arise due to abrupt object motion, changing appearance patterns of both the object and the scene, nonrigid object structures, object-to-object and object-to-scene occlusions, and camera motion. Tracking is usually performed in the context of higher-level applications that require the location and/or shape of the object in every frame. Typically, assumptions are made to constrain the tracking problem in the context of a particular application. In this survey, we categorize the tracking methods on the basis of the object and motion representations used, provide detailed descriptions of representative methods in each category, and examine their pros and cons. Moreover, we discuss the important issues related to tracking including the use of appropriate image features, selection of motion models, and detection of objects.

Object tracking system using colour histograms, 2001

J. Vergés-Llahí, and A. Sanfeliu, Institut de Robòtica i Informàtica Industrial (UPC-CSIC), Spain

J. Aranda, Automàtica i Informàtica Industrial (UPC), Spain

A pan-tilt structure has been endowed with the capability of doing the visual tracking of a moving target. Moving objects in the field of view of the camera are detected and the more relevant region colour feature is selected as the pattern to follow. Colour histogram is used as reliable feature to model object appearance and its adaptation handles with illumination changes.

Object Tracking Using Grayscale Appearance Models and Swarm Based Particle Filter, 2008

Bogdan Kwolek, Rzeszów University of Technology, Poland

We propose a hybrid tracking algorithm consisting of two trackers built on grayscale appearance models. In a first tracker we employ an object template that consists of several grayscale image patches. Every patch votes for the possible positions of the object undergoing tracking. A grayscale appearance model that is learned online is used in a supplementing tracker. A particle swarm optimization algorithm is utilized to shift particles toward more promising regions in the probability density function. Experimental results show that the hybrid tracker outperforms each of the trackers.

Online target tracking and sensor registration using sequential Monte Carlo methods, 2006

Jack Li, William Ng, and Simon Godsill, Cambridge University, UK

In tracking applications, the target state (e.g., position, velocity) can be estimated by processing the measurements collected from all deployed sensors at a central node. The estimation performance significantly relies on the accuracy of the sensor positions/rotations when data fusion is conducted. Since in practice precise knowledge of this

sensor information is seldom available, in this paper we propose a Sequential Monte Carlo (SMC) approach to jointly estimate the target state and resolve the sensor position uncertainty.

Online updating appearance generative mixture model for meanshift tracking, 2008

Jilin Tu, and Thomas Huang, University of Illinois at Urbana and Champaign, USA

Hai Tao, University of California, USA

This paper proposes an appearance generative mixture model based on key frames for meanshift tracking. Meanshift tracking algorithm tracks an object by maximizing the similarity between the histogram in tracking window and a static histogram acquired at the beginning of tracking. The tracking therefore could fail if the appearance of the object varies substantially. In this paper, we assume the key appearances of the object can be acquired before tracking and the manifold of the object appearance can be approximated by piece-wise linear combination of these key appearances in histogram space. The generative process is described by a Bayesian graphical model. An Online EM algorithm is proposed to estimate the model parameters from the observed histogram in the tracking window and to update the appearance histogram. We applied this approach to track human head motion and to infer the head pose simultaneously in videos. Experiments verify that our online histogram generative model constrained by key appearance histograms alleviates the drifting problem often encountered in tracking with online updating, that the enhanced meanshift algorithm is capable of tracking object of varying appearances more robustly and accurately, and that our tracking algorithm can infer additional information such as the object poses.

Optimised Particle Filter Approaches to Object Tracking in Video Sequences, 2009

Artur Loza, University of Bristol, UK

Fanglin Wang, Shanghai Jiao Tong University, China

Miguel A. Patricio, Jesus Garcia, and Jose M. Molina, Universidad Carlos III de Madrid, Spain

In this paper, the ways of optimising a Particle Filter video tracking algorithm are investigated. The optimisation scheme discussed in this work is based on hybridising a Particle Filter tracker with a deterministic mode search technique applied to the particle distribution. Within this scheme, an extension of the recently introduced structural similarity tracker is proposed and compared with the approach based on separate and combined colour and mean-shift tracker. The new approach is especially applicable to real-world video surveillance scenarios, in which the presence of multiple targets and complex background pose a non-trivial challenge to automated trackers. The preliminary results indicate that a considerable improvement in tracking is achieved by applying the optimisation scheme, at the price of a moderate computational complexity increase of the algorithm.

Particle Filter Based Object Tracking with Discriminative Feature Extraction and Fusion, 2008

Yao Shen, Parthasarathy Guturu, and Bill P. Buckles, University of North Texas, USA

Thyagaraju Damarla, Army Research Lab, Adelphi, USA

This paper presents an object tracking algorithm based on the unscented particle filtering (UPF) approach. In this algorithm, occlusion tolerant features are first obtained for the images of the object in the consecutive frames based on the color, texture and shape (edge) information, and then a variant of the Fisher's linear discriminant function approach is applied for reducing the dimensionality of the feature space. Similarities of the two images in each feature dimension are computed by matching the histograms of the quantized feature values, and finally these similarity values are aggregated into an over all similarity measure by a novel feature

fusion technique embedded in the UPF framework. Results of experimentation with two different data sets indicate that our algorithm is both efficacious in handling severe occlusions (almost as high as 80%) and efficient with respect to tracking accuracy.

Particle Filtering, 2009

Michael Johannes, Columbia University, USA

Nicholas Polson, University of Chicago, USA

This chapter provides an overview of particle filters. Particle filters generate approximations to filtering distributions and are commonly used in non-linear and/or non-Gaussian state space models. We discuss general concepts associated with particle filtering, provide an overview of the main particle filtering algorithms, and provide an empirical example of filtering volatility from noisy asset price data.

Probabilistic Multiple Cue Integration for Particle Filter Based Tracking, 2003

Chunhua Shen, Anton van den Hengel, and Anthony Dick, University of Adelaide, Australia

Robust visual tracking has become an important topic in the field of computer vision. The integration of cues such as color, edge strength and motion has proved to be a promising approach to robust visual tracking in situations where no single cue is suitable. In this paper, an algorithm is presented which integrates multiple cues in a probabilistic manner. Specifically the likelihood of each cue is calculated and weighted before Bayes' rule is applied to obtain the resultant posterior. This posterior is generally not well represented analytically, and is therefore represented as a set of weighted particles, which is updated at each frame by a particle filter. This paper demonstrates how the combination of multiple cue integration and particle filtering results in a robust tracking method. We also demonstrate how each cue's weight can be adapted on-line during the tracking procedure.

Probabilistic Tracking in Joint Feature-Spatial Spaces, 2003

Ahmed Elgammal, Rutgers University, Piscataway, USA

Ramani Duraiswami, and Larry S. Davis, University of Maryland, USA

In this paper we present a probabilistic framework for tracking regions based on their appearance. We exploit the feature-spatial distribution of a region representing an object as a probabilistic constraint to track that region over time. The tracking is achieved by maximizing a similaritybased objective function over transformation space given a nonparametric representation of the joint feature-spatial distribution. Such a representation imposes a probabilistic constraint on the region feature distribution coupled with the region structure which yields an appearance tracker that is robust to small local deformations and partial occlusion. We present the approach for the general form of joint feature-spatial distributions and apply it to tracking with different types of image features including row intensity, color and image gradient.

Real-Time Infrared Object Tracking Based on Mean Shift, 2004

Cheng Jian, and Yang Jie, Shanghai Jiaotong University, China

The mean shift algorithm is an efficient method for tracking object in the color image sequence. However, in the infrared object-tracking scenario, there is a singular feature space, i.e. the grey space, for representing the infrared object. Due to the lack of the information for the object representation, the object tracking based on the mean shift algorithm may be lost in the infrared sequence. To overcome this disadvantage, we propose a new scheme that is to construct a cascade grey space. The experimental results performed on two different infrared image sequences show our new scheme is efficient and robust for the infrared object tracking.

Real-Time Kernel-Based Tracking in Joint Feature-Spatial Spaces, 2004

Changjiang Yang, Ramani Duraiswami, Ahmed Elgammal, and Larry Davis, University of Maryland, USA

An object tracking algorithm that uses a novel simple symmetric similarity function between spatially-smoothed kernel-density estimates of the model and target distributions is proposed and tested. The similarity measure is based on the expectation of the density estimates over the model or target images. The density is estimated using radial-basis kernel functions which measure the affinity between points and provide a better outlier rejection property. The mean-shift algorithm is used to track objects by iteratively maximizing this similarity function. To alleviate the quadratic complexity of the density estimation, we employ Gaussian kernels and the fast Gauss transform to reduce the computations to linear order. This leads to a very efficient and robust nonparametric tracking algorithm. The proposed algorithm is tested with several image sequences and shown to achieve robust and reliable real-time tracking.

Real Time Object Tracking in a Video Sequence Using a Fixed Point DSP, 2008

Syed Aamir Ali Shah, Tahir Jamil Khattak, Muhammad Farooq, Yahya M. Khawaja, Abdul Bais, Asim Anees, and Muhammad U.K. Khan, University of Engineering and Technology, Peshawar, Pakistan

In this paper we propose implementation of a viable algorithm for real time tracking of objects in a video sequence on a Digital Signal Processor (DSP). Three different tracking algorithms are simulated and on the basis of simulation results, the best algorithm is proposed for hardware implementation. The selected algorithm tracks objects by minimizing the error iteratively. A modification of the selected algorithm is suggested that suits the hardware implementation. The algorithm is tested on different video sequences, both synthetic and real, which demonstrates its performance.

Real-Time Tracking Using Trust-Region Methods, 2003

Tyng-Luh Liu, Hwann-Tzong Chen, Academia Sinica, Taipei, Taiwan

Optimization methods based on iterative schemes can be divided into two classes: line-search methods and trust-region methods. While line-search techniques are commonly found in various vision applications, not much attention is paid to trust-region ones. Motivated by the fact that line-search methods can be considered as

special cases of trust-region methods, we propose to establish a trust-region framework for real-time tracking. Our approach is characterized by three key contributions. First, since a trust-region tracking system is more effective, it often yields better performances than the outcomes of other trackers that rely on iterative optimization to perform tracking, e.g., a line-search based mean-shift tracker. Second, we have formulated a representation model that uses two coupled weighting schemes derived from the covariance ellipse to integrate an object's color probability distribution and edge density information. As a result, the system can address rotation and non-uniform scaling in a continuous space, rather than working on some presumably possible discrete values of rotation angle and scale. Third, the framework is very flexible in that a variety of distance functions can be adapted easily. Experimental results and comparative studies are provided to demonstrate the efficiency of the proposed method.

Restrictive Estimation in Tracking Problems, 2009

Andrey Makshanov, SPIIRAS, St. Petersburg, Russia

This report presents a model for tracking manoeuvring objects based on recurrent restrictive estimation and prediction procedures. One of the principal problems in statistical estimation is how to take into account various forms of prior information on unknown parameters. The proposed mathematical techniques make it possible to introduce into recurrent estimation, tracking and prediction procedures a large amount of prior information of different kinds.

Robust kernel-based tracking using optimal kontrol, 2006

Wei Qu, and Dan Schonfeld, University of Illinois, USA

Although more efficient in computation compared to other tracking approaches such as particle filtering, the kernel-based tracking suffers from the “singularity” problem which makes the tracking unstable and even completely fail. In this paper, we propose a novel framework to handle this problem by enhancing the tracker's observability. In particular, we formulate object tracking as an inverse problem, thus unifying the existing kernel-based tracking approaches into a consistent theoretical framework. By exploiting the observability theory, we explicitly give the criterion for kernel design and constraint selection. Moreover, we extend the kernel-based approach by including the state dynamics and thus form a state-space model. The use of observability theory is also extended for dynamics estimation and evaluation. We rely on an optimal observer for state estimation as a solution to video tracking. The performance of the proposed approach has been demonstrated on both synthetic and real-world video data and compared to other kernel-based tracking approaches.

Robust Model-based 3D Object Recognition by Combining Feature Matching with Tracking, 2003

Sungho Kim, Inso Kweon, and Incheol Kim, Advanced Institute of Science and Technology, Agency for Defense Development, Korea

We propose a vision based 3D object recognition and tracking system, which provides high level scene descriptions such as object identification and 3D pose information. The system is composed of object recognition part and real-time tracking part. In object recognition, we propose a feature which is robust to scale,

rotation, illumination change and background clutter. A probabilistic voting scheme maximizes the conditional probability defined by the features in correspondence to recognize an object of interest. As a result of object recognition, we obtain the homography between the model image and the input scene. In tracking, a Lie group formalism is used to cast the motion computation problem into simple geometric terms so that tracking becomes a simple optimization problem. An initial object pose is estimated using correspondences between the model image and the 3D CAD model which are predefined and the homography which relates the model image to the input scene. Results from the experiments show the robustness of the proposed system.

Robust Object Tracking, 1995

Martin Armstrong, and Andrew Zisserman, University of Oxford, UK

We describe an object tracker robust to a number of ambient conditions which often severely degrade performance, for example partial occlusion. The robustness is achieved by describing the object as a set of related geometric primitives (lines, conics, etc.), and using redundant measurements to facilitate the detection of outliers. This improves the overall tracking performance. Results are given for frame rate tracking on image sequences.

Robust Online Appearance Models for Visual Tracking, 2001

Allan D. Jepson, David J. Fleet, and Thomas F. El-Maraghi, University of Toronto, Canada

We propose a framework for learning robust, adaptive, appearance models to be used for motion-based tracking of natural objects. The approach involves a mixture of stable image structure, learned over long time courses, along with 2-frame motion information and an outlier process. An online EM-algorithm is used to adapt the appearance model parameters over time. An implementation of this approach is developed for an appearance model based on the filter responses from a steerable pyramid. This model is used in a motion-based tracking algorithm to provide robustness in the face of image outliers, such as those caused by occlusions. It also provides the ability to adapt to natural changes in appearance, such as those due to facial expressions or variations in 3D pose. We show experimental results on a variety of natural image sequences of people moving within cluttered environments.

Robust Online Appearance Models for Visual Tracking, 2003

Allan D. Jepson, David J. Fleet, and Thomas F. El-Maraghi, University of Toronto, Canada

We propose a framework for learning robust, adaptive, appearance models to be used for motion-based tracking of natural objects. The model adapts to slowly changing appearance, and it maintains a natural measure of the stability of the observed image structure during tracking. By identifying stable properties of appearance, we can weight them more heavily for motion estimation, while less stable properties can be proportionately downweighted. The appearance model involves a mixture of stable image structure, learned over long time courses, along with two-frame motion information and an outlier process. An online EM-algorithm is used to adapt the appearance model parameters over time. An implementation of this approach is developed for an appearance model based on the filter responses from a steerable pyramid. This model is used in a motion-based tracking algorithm to provide robustness in the face of image outliers, such as those caused by occlusions, while adapting to natural changes in appearance such as those due to facial expressions or variations in 3D pose.

Robust Real-time 3D Trajectory Tracking Algorithms for Visual Tracking Using Weak Perspective Projection, 2001

Wei Guan Yau, Li-Chen Fu, and David Liu, National Taiwan University, Taipei, Taiwan

In this paper, motion estimation algorithms for the most general tracking situation are developed. The proposed motion estimation algorithms are used to predict the location of target and then to generate a feasible control input so as to keep the target stationary in the center of image. The work differs from the previous algorithm of motion estimation in that it is capable to decouple the estimation of motion from the estimation of structure. The weak perspective projection is used to solve this problem. The modified optical flow is first calculated and then fed to motion estimation algorithms so as to generate an appropriate camera motion that achieve tracking. The important contribution of this work is that simple, numerically stable, none computation intensive, and correspondence-free 3D motion estimation algorithms are derived. A visual tracking system can be easily implemented and run in real-time due to the simplicity of the proposed algorithms and thus increases their efficiency.

Robust Tracking Algorithm Based on Color and Edge Distribution for Real-time Video Based Motion Capture Systems, 2002

Yoshiaki Kazawa, Yoshihiro Okadal, and Koichi Ijima, Kyushu University, Japan

This paper describes a robust tracking algorithm for real-time, video based motion capture systems. Conventional motion capture systems are unable to capture motion data in real time because they use many video cameras and take a long time to deal with many images. To deal with problem, the authors have proposed in their earlier work [I] a real-time motion capture system using one video camera. It takes a video image of the upper part of the body of a person, and generates upper body motion data, e.g., x, y, z position of hands and a face rotation in real time and it employs a very simple tracking algorithm, but it suffers from occlusion problem. In this paper, the authors propose a more robust tracking algorithm that solves the occlusion problem. This paper mainly describes this algorithm, and delineates its usefulness by showing its application and experimental results.

Robust Visual Tracking Based on An Effective Appearance Model, 2008

Xi Liy, Weiming Huy, and Xiaoqin Zhangy, National Laboratory of Pattern Recognition, CASIA, Beijing, China

Zhongfei Zhangz, State University of New York, Binghamton, USA

Most existing appearance models for visual tracking usually construct a pixel-based representation of object appearance so that they are incapable of fully capturing both global and local spatial layout information of object appearance. In order to address this problem, we propose a novel spatial Log-Euclidean appearance model (referred as SLAM) under the recently introduced Log-Euclidean Riemannian metric [23]. SLAM is capable of capturing both the global and local spatial layout information of object appearance by constructing a block-based Log-Euclidean eigenspace representation. Specifically, the process of learning the proposed SLAM consists of five steps-appearance block division, online Log-Euclidean eigenspace learning, local spatial

weighting, global spatial weighting, and likelihood evaluation. Furthermore, a novel online Log-Euclidean Riemannian subspace learning algorithm (IRSL) [14] is applied to incrementally update the proposed SLAM. Tracking is then led by the Bayesian state inference framework in which a particle filter is used for propagating sample distributions over the time. Theoretic analysis and experimental evaluations demonstrate the promise and effectiveness of the proposed SLAM.

Robust Visual Tracking by Integrating Multiple Cues based on Co-inference Learning, 2004

Ying Wu, Northwestern University, Evanston, USA

Thomas S. Huang, University of Illinois at Urbana-Champaign, Urbana, USA

Visual tracking can be treated as a parameter estimation problem that infers target states based on image observations from video sequences. A richer target representation would incur better chances of successful tracking in cluttered and dynamic environments, and thus enhance the robustness. Richer representations can be constructed by either specifying a detailed model of a single cue or combining a set of rough models of multiple cues. Both approaches increase the dimensionality of the state space, which results in a dramatic increase of computation. To investigate the integration of rough models from multiple cues and to explore computationally efficient algorithms, this paper formulates the problem of multiple cue integration and tracking in a probabilistic framework based on a factorized graphical model. Structured variational analysis of such a graphical model factorizes different modalities and suggests a co-inference process among these modalities. Based on the importance sampling technique, a sequential Monte Carlo algorithm is proposed to provide an efficient simulation and approximation of the co-inferencing of multiple cues. This algorithm runs in real-time at around 30Hz. Our extensive experiments show that the proposed algorithm performs robustly in a large variety of tracking scenarios. The approach presented in this paper has the potential to solve other problems including sensor fusion problems.

Robust Visual Tracking for Multiple Targets, 2006

Yizheng Cai, Nando de Freitas, and James J. Little, University of British Columbia, Vancouver, Canada

We address the problem of robust multi-target tracking within the application of hockey player tracking. The particle filter technique is adopted and modified to fit into the multi-target tracking framework. A rectification technique is employed to find the correspondence between the video frame coordinates and the standard hockey rink coordinates so that the system can compensate for camera motion and improve the dynamics of the players. A global nearest neighbor data association algorithm is introduced to assign boosting detections to the existing tracks for the proposal distribution in particle filters. The mean-shift algorithm is embedded into the particle filter framework to stabilize the trajectories of the targets for robust tracking during mutual occlusion. Experimental results show that our system is able to automatically and robustly track a variable number of targets and correctly maintain their identities regardless of background clutter, camera motion and frequent mutual occlusion between targets.

Segmentation-based object tracking using image warping and Kalman filtering, 2002

Yu Huang, and Thomas S. Huang, Beckman Institute, UIUC, Urbana, USA

Heinrich Niemann, University of Erlangen-Nuremberg, Germany

We propose a segmentation-based method of object tracking using image warping and Kalman filtering. The object region is defined to include a group of patches, which are obtained by a watershed algorithm. In a robust M-estimator framework, we estimate dominant motion of the object region. A linear Kalman filter is employed to predict the estimated affine motion parameters based on a second order kinematic model. Image (affine) warping is performed to predict the object region in the next frame. Warping error of each watershed segment (patch) and its rate of overlapping with the predicted region are utilized for classification of watershed segments near the object border. Applications of head and hand tracking using this method demonstrate its performance.

Sequential Monte Carlo Methods for Multi-Object Tracking, 2003

Martin Spengler

This document provides an overview over literature relevant to (multi-) object tracking based on sequential Monte Carlo methods. Besides milestones like [IB98a] (CONDENSATION) or [DdFG02] (sequential Monte Carlo methods), there are also some less fundamental articles, presenting some original ideas or extend the basic algorithms in a remarkable way. The reviewed articles are grouped in two major categories: single-object tracking and multi-object tracking. A third section contains various other tracking-related articles which do not necessarily use sequential Monte Carlo methods for tracking. This third section also contains some references to introductory material and tutorials.

Sequential Monte Carlo Methods for multiple Target Tracking and Data Fusion, 2002

Carine Hue, Irisa/Université de Rennes, Rennes, France

Jean-Pierre Le Cadre, Irisa/CNRS, Rennes, France

Patrick Pérez, Microsoft Research, Cambridge, UK

The classical particle filter deals with the estimation of one state process conditioned on a realization of one observation process. We extend it here to the estimation of multiple state processes given realizations of several kinds of observation processes. The new algorithm is used to track with success multiple targets in a bearings-only context, whereas a JPDAF diverges. Making use of the ability of the particle filter to mix different types of observations, we then investigate how to join passive and active measurements for improved tracking.

Simultaneous Localization, Mapping and Moving Object Tracking, 2004

Chieh-Chih Wang, Carnegie Mellon University, Pittsburgh, USA

LOCALIZATION, mapping and moving object tracking serve as the basis for scene understanding, which is a key prerequisite for making a robot truly autonomous. Simultaneous localization, mapping and moving object tracking (SLAMMOT) involves not only simultaneous localization and mapping (SLAM) in dynamic

environments but also detecting and tracking these dynamic objects. It is believed by many that a solution to the SLAM problem would open up a vast range of potential applications for autonomous robots. Accordingly, a solution to the SLAMMOT problem would expand robotic applications in proximity to human beings where robots work not only for people but also with people. This thesis establishes a new discipline at the intersection of SLAM and moving object tracking. Its contributions are two-fold: theoretical and practical. From a theoretical perspective, we establish a mathematical framework to integrate SLAM and moving object tracking, which provides a solid basis for understanding and solving the whole problem. We describe two solutions: SLAM with generic objects (GO), and SLAM with detection and tracking of moving objects (DATMO). SLAM with GO calculates a joint posterior over all generic objects and the robot. Such an approach is similar to existing SLAM algorithms, but with additional structure to allow for motion modelling of the generic objects. Unfortunately, it is computationally demanding and infeasible. Consequently, we provide the second solution, SLAM with DATMO, in which the estimation problem is decomposed into two separate estimators. By maintaining separate posteriors for the stationary objects and the moving objects, the resulting estimation problems are much lower dimensional than SLAM with GO. From a practical perspective, we develop algorithms for dealing with the implementation issues on perception modelling, motion modelling and data association. Regarding perception modelling, a hierarchical object based representation is presented to integrate existing feature-based, grid-based and direct methods. The sampling- and correlationbased range image matching algorithm is developed to tackle the problems arising from uncertain, sparse and featureless measurements. With regard to motion modelling, we describe a move-stop hypothesis tracking algorithm to tackle the difficulties of tracking ground moving objects. Kinematic information from motion modelling as well as geometric information from perception modelling is used to aid data association at different levels. By following the theoretical guidelines and implementing the described algorithms, we are able to demonstrate the feasibility of SLAMMOT using data collected from the Navlab8 and Navlab11 vehicles at high speeds in crowded urban environments.

Smart camera approach to real-time tracking, 2005

Sven Fleck, Sven Lanwer, and Wolfgang Straßer, University of Tübingen, Germany

Tracking applications using distributed sensor networks are emerging today, both in the field of surveillance (airports, train stations, museums, public spots) and industrial vision (visual servoing, factory automation). Traditional centralized approaches offer several drawbacks, due to limited communication bandwidth, computational requirements and thus also limited spatial camera resolution and framerate. In this paper we present a network-enabled Smart Camera for probabilistic tracking. It is capable of tracking objects in real-time and offers a very bandwidth-conservative approach, as it only transmits the tracking results which are on a higher level of abstraction.

Spatiograms Versus Histograms for Region-Based Tracking, 2005

Stanley T. Birchfield, and Sriram Rangarajan, Clemson University, USA

We introduce the concept of a spatiogram, which is a generalization of a histogram that includes potentially higher order moments. A histogram is a zeroth-order spatiogram, while second-order spatiograms contain spatial means and covariances for each histogram bin. This spatial information still allows quite general transformations, as in a histogram, but captures a richer description of the target to increase robustness in tracking. We show how to use spatiograms in kernel-based trackers, deriving a mean shift procedure in which individual pixels vote not only for the amount of shift but also for its direction. Experiments show improved tracking results compared with histograms, using both mean shift and exhaustive local search.

Support Vector Tracking, 2004

Shai Avidan, MobilEye Vision Technologies LTD, Jerusalem, Israel

Support Vector Tracking (SVT) integrates the Support Vector Machine (SVM) classifier into an optic-flow-based tracker. Instead of minimizing an intensity difference function between successive frames, SVT maximizes the SVM classification score. To account for large motions between successive frames, we build pyramids from the support vectors and use a coarse-to-fine approach in the classification stage. We show results of using SVT for vehicle tracking in image sequences.

Statistical Learning and Pattern Analysis for Image and Video Processing, 2009

Nanning Zheng Xi'an, Jiaotong University, China

This book provides a comprehensive overview of theories, methodologies, and recent developments in the field of statistical learning and statistical analysis for visual pattern modeling and computing. We had three objectives in selecting topics to cover. We wish to 1) describe a solid theoretical foundation, 2) provide a comprehensive summary of the latest advances of recent years, and 3) present typical issues to be considered in making a real system for visual information processing.

We have tried to achieve a balance between these three objectives. The rest of this book is organized as follows:

Chapter 1 is devoted to constructing the theoretic basis for pattern analysis and statistical learning. The fundamentals of statistical pattern recognition and statistical learning are presented via introducing the general framework of a statistical pattern recognition system. We also discuss pattern representation and classification, two important components of such a system, as well as concepts involved in three main approaches to statistical learning: supervised learning, semistatistical learning, and unsupervised learning. This introduction leads to the development of three parts of the whole book. In the first part, we focus on the unsupervised learning of visual pattern representational models for objects in images, which covers through Chapters 2 to 5. Usually, what a vision algorithm can accomplish depends crucially on how much it knows about content of the visual scenes. This knowledge can be mathematically represented by simple but general models that can realistically characterize visual patterns in the ensemble of visual data. Representation and computation are thus

two principal problems in visual computing. We provide a comprehensive survey of recent advances in statistical learning and pattern analysis with respect to these two problems. Chapter 2 discusses cluster analysis and perceptual grouping algorithms used in unsupervised visual pattern analysis. The systematic approaches for deriving these models are also illustrated step by step. Chapters 3 through 5 focus on representing and learning visual patterns in both spatial and temporal domains. Chapter 3 describes component analysis approaches, which are used to find hidden components via visual data analysis techniques. Chapter 4 discusses the manifold learning perspective on visual pattern representation, dimensionality reduction, and classification problems. Chapter 5 presents a review of recent advances in the adaptive wavelet transform for image and video coding. In the second part, we introduce the supervised learning of visual patterns in images, which is covered in Chapter 6. We focus on supervised statistical pattern analysis and introduce concepts and major techniques in feature extraction and selection as well as classifier design. Especially, we introduce statistical machine learning techniques by examining the support vector machine and AdaBoost classifier. In the third part, we focus on the visual pattern analysis in video. In this part, we discuss methodologies for building intelligent video analysis systems such as object detection, tracking, and recognition in video. Chapter 7 focuses on the critical aspects of motion analysis, including statistical optical flow, model-based motion analysis, and joint motion estimation

and segmentation. For the object-level motion analysis, we first introduce the sequential Bayesian estimation framework in Chapter 8, which acts as the theoretic basis for visual tracking, and then present approaches to constructing a representation model of specific objects. In Chapter 9, we present a probabilistic fusion framework for robust tracking. Chapters 10 and 11 offer a multitarget tracking in video (MTTV) formulation that exploits a Markov network whose solution is arrived at using Monte Carlo-based belief propagation. Using this approach, problems including occlusion and various number of objects in MTTV are addressed. Finally, in Chapter 12, we make an in-depth discussion of visual data processing in the cognitive process. A new scheme of association memory and new architecture of artificial intelligent system with attractors of chaos are also addressed. We argue that to make a breakthrough in current research on intelligent visual data processing, people should pay great attention to the mechanism of cognition and selective attention.

Swarming Particles with Multi-feature Model for Free-Selected Object Tracking, 2008

Yuhua Zheng, Institute of Technology, Hoboken, USA

Yan Meng, Stevens Institute of Technology, Hoboken, USA

This paper presents a new object tracking algorithm that embeds swarming particles into generic particle filter framework to achieve more robustness and flexibility. Firstly a group of particles associated with potential solutions are initialized in a high-dimensional space. Then particle swarm optimization (PSO) is used to drive particles flying. The object is tracked when the particles reach convergence. This PSO-based algorithm contains resample, similarity measure, and integration together such that the degeneracy problem of particle filter can be avoided. Furthermore, a multiple feature model is proposed for object description to enhance the tracking accuracy and efficiency. The proposed algorithm is independent with specific objects and can be used for any free-selected object tracking. Some experimental results demonstrate efficiency and robustness of the algorithm.

Target Tracking with Distributed Sensors: The Focus of Attention Problem, 2003

Volkan Isler, John Spletzer, Sanjeev Khanna, and C.J. Taylor, University of Pennsylvania, Philadelphia, USA

In this paper, we investigate data fusion techniques for target tracking using distributed sensors. Specifically, we are interested in how pairs of bearing or range sensors can be best assigned to targets in order to minimize the expected error in the estimates. We refer to this as the focus of attention (FOA) problem. In its general form, FOA is NP-hard and not well approximable. However, for specific geometries we obtain significant approximation results: a 2-approximation algorithm for stereo cameras on a line, a PTAS for then the cameras are equidistant, and a 1.42 approximation for equally spaced range sensors on a circle. In addition to constrained geometries, we further investigate the problem for general sensor placement. By reposing as a maximization problem - where the goal is to maximize the number of tracks with bounded error - we are able to leverage results from maximum set-packing to render the problem approximable. We demonstrate these in simulation for a target tracking task, and for localizing a team of mobile agents in a sensor network. These results provide insights into sensor/target assignment strategies, as well as sensor placement in a distributed network.

The development of motion tracking algorithms for low cost inertial measurement units, 2008

Giuseppe Torre, and Mikael Fernstrom, University of Limerick, Ireland

Javier Torres, Cork University, Ireland

In this paper, we describe an algorithm for the numerical evaluation of the orientation of an object to which a cluster of accelerometers, gyroscopes and magnetometers has been attached. The algorithm is implemented through a set of Max/Msp and pd new externals. Through the successful implementation of the algorithm, we introduce Pointing at, a new gesture device for the control of sound in a 3D environment. This work has been at the core of the Celeritas Project, an interdisciplinary research project on motion tracking technology and multimedia live performances between the Tyndall Institute of Cork and the Interaction Design Centre of Limerick.

Tracking Across Multiple Cameras With Disjoint Views, 2003

Omar Javed, Zeeshan Rasheed, Khurram Shafique, and Mubarak Shah, University of Central Florida, USA

Conventional tracking approaches assume proximity in space, time and appearance of objects in successive observations. However, observations of objects are often widely separated in time and space when viewed from multiple non-overlapping cameras. To address this problem, we present a novel approach for establishing object correspondence across non-overlapping cameras. Our multi-camera tracking algorithm exploits the redundancy in paths that people and cars tend to follow, e.g. roads, walk-ways or corridors, by using motion trends and appearance of objects, to establish correspondence. Our system does not require any inter-camera calibration, instead the system learns the camera topology and path probabilities of objects using Parzen windows, during a training phase. Once the training is complete, correspondences are assigned using the maximum a posteriori (MAP) estimation framework. The learned parameters are updated with changing trajectory patterns. Experiments with real world videos are reported, which validate the proposed approach.

Tracking Complex Objects Using Graphical Object Models, 2007

Leonid Sigal, and Michael Black, Brown University, Providence, USA

Dorin Comaniciu, and Ying Zhu Siemens Corporate Research, Princeton, USA

We present a probabilistic framework for component-based automatic detection and tracking of objects in video. We represent objects as spatio-temporal two-layer graphical models, where each node corresponds to an object or component of an object at a given time, and the edges correspond to learned spatial and temporal constraints. Object detection and tracking is formulated as inference over a directed loopy graph, and is solved with non-parametric belief propagation. This type of object model allows object-detection to make use of temporal consistency (over an arbitrarily sized temporal window), and facilitates robust tracking of the object. The two layer structure of the graphical model allows inference over the entire object as well as individual components. AdaBoost detectors are used to define the likelihood and form proposal distributions for components. Proposal distributions provide ‘bottom-up’ information that is incorporated into the inference process, enabling automatic object detection and tracking. We illustrate our method by detecting and tracking two classes of objects, vehicles and pedestrians, in video sequences collected using a single grayscale uncalibrated car-mounted moving camera.

Tracking Moving Objects in Vides Using Enhanced Mean Shift and Region-Based Motion Field, 2007

Tiesheng Wang, Shanghai Jiao Tong University, China

Irene Y. H. Gu, Mats Viberg, Zhongping Cao, and Nuan Song, Chalmers University of Technology, Sweden

In this paper, we propose a scheme for moving object tracking from videos by combining mean shift and motion field statistics. For mean shift, we employ an enhanced spatialrange mean shift that enables a reduced number of oversegmentation. For motion statistics, we combine the optical flow and high-order moment to generate motion regions that are associated with moving objects (or object parts). Experiments have been conducted on several indoor and outdoor (color/gray-scale) image sequences ranging from simple to median complexity. To evaluate the performance, free objective criteria are applied in addition to the visual inspection. The results show that the proposed method is promising for moving object tracking in video, with an averaging detection rate of 95%. Further, the proposed scheme is compared with that using the conventional mean shift for the tracking, indicating a significantly reduction in false alarm ($\approx 30\%$).

Tracking Multiple Objects Using Particle Filters and Digital Elevation Maps, 2009

Radu Danescu, Florin Oniga, and Sergiu Nedevschi, Technical University of Cluj-Napoca, Cluj-Napoca, Romania

Marc-Michael Meinecke, Volkswagen AG, Germany

Tracking multiple objects has always been a challenge, and is a crucial problem in the field of driving assistance systems. The particle filter-based trackers have the theoretical possibility of tracking multiple hypotheses, but in practice the particles will cluster around the stronger one. This paper proposes a two-level approach to the multiple object tracking problem. One particle filter-based tracker will search the whole state space for new hypotheses, and when a hypothesis becomes strong enough, it will be passed to an individual object tracker, which will track it until the object is lost. The initialization tracker and the individual object trackers use the same state models and the same measurement technique, based on stereovision-generated elevation maps, and differ only in their use of the estimation results. The proposed solution is a simple and robust one, adaptable to different types of object models and to different types of sensors.

Tracking of vehicle trajectory by combining a camera and a laser rangefinder, 2008

Y. Goyat, LCPC, Bouguenais, France,

T. Chateau, and L. Trassoudaine, LASMEA, Aubière, France

This article presents a probabilistic method for vehicle tracking using a sensor composed of both a camera and a laser rangefinder. Two main contributions will be set forth in this paper. The first involves the definition of an original likelihood function based on the projection of simplified 3D vehicle models. We will also propose an efficient approach to compute this function using a line-based integral image. The second contribution focuses on a sampling algorithm designed to handle several sources. The resulting modified particle filter is capable of naturally merging several observation functions in a straightforward manner. Many trajectories of a vehicle equipped with a kinematic GPS1 have been measured on actual field sites, with a video system specially

developed for the project. This field input has made it possible to experimentally validate the result obtained from the algorithm. The ultimate goal of this research is to derive a better understanding of driver behavior in order to assist road managers in their effort to ensure network safety.

Tracking with Multiple Cameras for Video Surveillance, 2008

M.K. Bhuyan, and Abbas Bigdeli, National ICTQueensland Research Laboratory, Brisbane, Australia.

Brian C. Lovell, The University of Queensland, Brisbane, Australia

The large shape variability and partial occlusions challenge most object detection and tracking methods for nonrigid targets such as pedestrians. Single camera tracking is limited in the scope of its applications because of the limited field of view (FOV) of a camera. This initiates the need for a multiple-camera system for completely monitoring and tracking a target, especially in the presence of occlusion. When the object is viewed with multiple cameras, there is a fair chance that it is not occluded simultaneously in all the cameras. In this paper, we developed a method for the fusion of tracks obtained from two cameras placed at two different positions. First, the object to be tracked is identified on the basis of shape information measured by MPEG-7 ART shape descriptor. After this, single camera tracking is performed by the unscented Kalman filter approach and finally the tracks from the two cameras are fused. A sensor network model is proposed to deal with the situations in which the target moves out of the field of view of a camera and reenters after sometime. Experimental results obtained demonstrate the effectiveness of our proposed scheme for tracking objects under occlusion.

Updating Background Image for Motion Tracking Using Particle Filter, 2009

Yuji Iwahori, Wataru Kurahashi, Chubu University, Kasugai, Japan

Shinji Fukui, Aichi University of Education, Hirosawa, Japan

Robert J. Woodham, University of British Columbia, Vancouver, Canada

Particle filtering based motion tracking needs the extraction of the region of moving object to assign particles for moving object. To extract the moving object, a background subtraction is often used. However, it is difficult to extract the moving object when illumination changes during motion. Updating background image using RANSAC has been proposed to solve this problem, but it is still difficult for RANSAC to update the background image with high accuracy when many exception values are included in the data for updating background. In addition, another constraint includes such that the first background image is necessary for updating background image to extract the moving object. This paper proposes an extended new approach to update the background image with high accuracy using the data which excepts the exception values based on the tracking result with particle filtering. PSA (Pixel State Analysis) is further introduced to distribute particles before updating the first background, which can assign particles without preparing background image in advance.

Vehicle Segmentation and Tracking from a Low-Angle Off-Axis Camera, 2005

Neeraj K. Kanhere, Shrinivas J. Pundlik, and Stanley T. Birchfield, Clemson University, USA

We present a novel method for visually monitoring a highway when the camera is relatively low to the ground and on the side of the road. In such a case, occlusion and the perspective effects due to the heights of the vehicles cannot be ignored. Features are detected and tracked throughout the image sequence, and then grouped together using a multilevel homography, which is an extension of the standard homography to the low-angle situation. We derive a concept called the relative height constraint that makes it possible to estimate the 3D height of feature points on the vehicles from a single camera, a key part of the technique. Experimental results on several different highways demonstrate the system's ability to successfully segment and track vehicles at low angles, even in the presence of severe occlusion and significant perspective changes.

Vision-Based Multiple Interacting Targets Tracking via On-Line Supervised Learning, 2008

Xuan Song, Jinshi Cui, Hongbin Zha, and Huijing Zhao, Peking University, China

Successful multi-target tracking requires locating the targets and labeling their identities. This mission becomes significantly more challenging when many targets frequently interact with each other (present partial or complete occlusions). This paper presents an on-line supervised learning based method for tracking multiple interacting targets. When the targets do not interact with each other, multiple independent trackers are employed for training a classifier for each target. When the targets are in close proximity or present occlusions, the learned classifiers are used to assist in tracking. The tracking and learning supplement each other in the proposed method, which not only deals with tough problems encountered in multi-target tracking, but also ensures the entire process to be completely on-line. Various evaluations have demonstrated that this method performs better than previous methods when the interactions occur, and can maintain the correct tracking under various complex tracking situations, including crossovers, collisions and occlusions.

Visual-model-based, real-time 3D pose tracking for autonomous navigation: methodology and experiments, 2008

Hans de Ruiter, and Beno Benhabib, University of Toronto, Canada

This paper presents a novel 3D-model-based computer-vision method for tracking the full six degree-of-freedom (dof) pose (position and orientation) of a rigid body, in real-time. The methodology has been targeted for autonomous navigation tasks, such as interception of or rendezvous with mobile targets. Tracking an object's complete six-dof pose makes the proposed algorithm useful even when targets are not restricted to planar motion (e.g., flying or rough-terrain navigation). Tracking is achieved via a combination of textured model projection and optical flow. The main contribution of our work is the novel combination of optical flow with z-buffer depth information that is produced during model projection. This allows us to achieve six-dof tracking with a single camera. A localized illumination normalization filter also has been developed in order to improve robustness to shading. Real-time operation is achieved using GPU-based filters and a new data-reduction algorithm based on colour-gradient redundancy, which was developed within the framework of our project. Colour-gradient redundancy is an important property of colour images, namely, that the gradients of all colour channels are generally aligned. Exploiting this property provides a threefold increase in speed. A processing rate of approximately 80 to 100 fps has been obtained in our work when utilizing synthetic and real target-motion sequences. Sub-pixel accuracies were obtained in tests performed under different lighting conditions.

3 Seznam dalších publikací

V následující kapitole se nachází soupis dalších článků, knih a jiných relevantních zdrojů zabývajících se video trackingem. Klíčová slova zvolená jako kritérium pro vyhledávání: video tracking, video frames, frame rate, video compression, Blob tracking, Kernel-based tracking, Contour tracking, Visual feature matching, Macroblock, Key frame, Blob detection, Optical flow, Affine transformation, Bhattacharyya distance, Bhattacharyya coefficient, Kalman filter, Particle filter, Match moving, Motion capture, SwisTrack.

3.1 Články z databáze ACM digital library

Zdroj: <http://portal.acm.org/portal.cfm>

[Image retrieval: Ideas, influences, and trends of the new age](#)

Ritendra Datta, Dhiraj Joshi, Jia Li, James Z. Wang

April 2008

ACM Computing Surveys (CSUR), Volume 40 Issue 2

Vydavatel: ACM

Full text  [pdf\(2.81 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)
available:

Bibliometrics: Downloads (6 Weeks): 852, Downloads (12 Months): 852, Citation Count: 0

We have witnessed great interest and a wealth of promise in content-based image retrieval as an emerging technology. While the last decade laid foundation to such promise, it also paved the way for a large number of new techniques and systems, got many ...

Klíčová slova: Content-based image retrieval, annotation, learning, modeling, tagging

[Critical video quality for distributed automated video surveillance](#)

Pavel Korshunov, Wei Tsang Ooi

November 2005 **MULTIMEDIA '05:** Proceedings of the 13th annual ACM international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(297.79 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)
available:

Bibliometrics: Downloads (6 Weeks): 15, Downloads (12 Months): 102, Citation Count: 3

Large-scale distributed video surveillance systems pose new scalability challenges. Due to the large number of video sources in such systems, the amount of bandwidth required to transmit video streams for

monitoring often strains the capability of the ...

Klíčová slova: rate-accuracy function, video quality adaptation, video surveillance

[Panoptes: scalable low-power video sensor networking technologies](#)

Wu-Chi Feng, Ed Kaiser, Wu Chang Feng, Mikael Le Bailif

May 2005 **ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)**, Volume 1 Issue 2

Vydavatel: ACM

Full text  [pdf\(5.84 MB\)](#) Additional Information: [full citation, abstract, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 12, Downloads (12 Months): 153, Citation Count: 1

Video-based sensor networks can provide important visual information in a number of applications including: environmental monitoring, health care, emergency response, and video security. This article describes the Panoptes video-based sensor networking ...

Klíčová slova: Video sensor networking, adaptive video, video collection

[Panoptes: scalable low-power video sensor networking technologies](#)

Wu-chi Feng, Brian Code, Ed Kaiser, Mike Shea, Wu-chang Feng, Louis Bavoil

November 2003 **MULTIMEDIA '03: Proceedings of the eleventh ACM international conference on Multimedia**

Vydavatel: ACM

Full text  [pdf\(483.71 KB\)](#) Additional Information: [full citation, abstract, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 3, Downloads (12 Months): 93, Citation Count: 3

Video-based sensor networks can provide important visual information in a number of applications including: environmental monitoring, health care, emergency response, and video security. This paper describes the Panoptes video-based sensor networking ...

Klíčová slova: JPEG, MPEG, sensors, video sensors, video streaming

[Facial modeling and animation](#)

Jörg Haber, Demetri Terzopoulos

August 2004

SIGGRAPH '04: ACM SIGGRAPH 2004 Course Notes

Vydavatel: ACM

Full text  [pdf\(18.15 MB\)](#)
available:

Additional Information: [full citation, abstract](#)

Bibliometrics: Downloads (6 Weeks): 157, Downloads (12 Months): 997, Citation Count: 0

In this course we present an overview of the concepts and current techniques in facial modeling and animation. We introduce this research area by its history and applications. As a necessary prerequisite for facial modeling, data acquisition is discussed ...

[Sharp or smooth?: comparing the effects of quantization vs. frame rate for streamed video](#)

John D. McCarthy, M. Angela Sasse, Dimitrios Miras

April 2004 **CHI '04:** Proceedings of the SIGCHI conference on Human factors in computing systems

Vydavatel: ACM

Full text  [pdf\(425.93 KB\)](#)
available:

Additional Information: [full citation, abstract, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 9, Downloads (12 Months): 63, Citation Count: 6

We introduce a new methodology to evaluate the perceived quality of video with variable physical quality. The methodology is used to evaluate existing guidelines - that high frame rate is more important than quantization when watching high motion video, ...

Klíčová slova: Quality of Service, eye tracking, quantization factors, video frame rate, video streaming

[Model-based face and lip animation for interactive virtual reality applications](#)

Michel D. Bondy, Nicolas D. Georganas, Emil M. Petriu, Dorina C. Petriu, Marius D. Cordea, Thomas E. Whalen

October 2001 **MULTIMEDIA '01:** Proceedings of the ninth ACM international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(4.29 MB\)](#)
available:

Additional Information: [full citation, abstract, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 15, Downloads (12 Months): 58, Citation Count: 0

In this paper, we describe an experimental performance-driven animation system for an avatar face using model-based video coding and audio-track driven lip animation.

Klíčová slova: audio/image/video processing, and compression, multi-modal interaction and integration, voice-image synchronization

[Seeing, hearing, and touching: putting it all together](#)

Brian Fisher, Sidney Fels, Karon MacLean, Tamara Munzner, Ronald Rensink

August 2004 **SIGGRAPH '04: ACM SIGGRAPH 2004 Course Notes**

Vydavatel: ACM

Full text  [pdf\(20.64 MB\)](#)
available:

Additional Information: [full citation, cited by](#)

Bibliometrics: Downloads (6 Weeks): 274, Downloads (12 Months): 1618, Citation Count: 2

[Video abstraction: A systematic review and classification](#)

Ba Tu Truong, Svetha Venkatesh

February 2007 **ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)**, Volume 3 Issue 1

Vydavatel: ACM

Full text  [pdf\(380.77 KB\)](#)
available:

Additional Information: [full citation, appendices and supplements, abstract, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 183, Downloads (12 Months): 820, Citation Count: 0

The demand for various multimedia applications is rapidly increasing due to the recent advance in the computing and network infrastructure, together with the widespread use of digital video technology. Among the key elements for the success of these ...

Klíčová slova: Video summarization, keyframe, survey, video abstraction, video skimming

[SAVE: an algorithm for smoothed adaptive video over explicit rate networks](#)

N. G. Duffield, K. K. Ramakrishnan, Amy R. Reibman

December **IEEE/ACM Transactions on Networking (TON)**, Volume 6 Issue 6

1998

Vydavatel: IEEE Press

Full text  [pdf\(539.13 KB\)](#) Additional Information: [full citation, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 4, Downloads (12 Months): 20, Citation Count: 12

Klíčová slova: compressed video, multiplexing, rate control, smoothing

[Real-time video content analysis: QoS-aware application composition and parallel processing](#)

Viktor S. Wold Eide, Ole-Christoffer Granmo, Frank Eliassen, Jørgen Andreas Michaelsen

May 2006 **ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)**, Volume 2 Issue 2

Vydavatel: ACM

Full text  [pdf\(393.86 KB\)](#) Additional Information: [full citation, abstract, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 31, Downloads (12 Months): 213, Citation Count: 0

Real-Time content-based access to live video data requires content analysis applications that are able to process video streams in real-time and with an acceptable error rate. Statements such as this express quality of service (QoS) requirements. In ...

Klíčová slova: QoS and resource management, Real-Time video content analysis, event-based communication, parallel processing, publish/subscribe, task graph scheduling

[Virtual videography](#)

Rachel Heck, Michael Wallick, Michael Gleicher

February 2007 **ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)**, Volume 3 Issue 1

Vydavatel: ACM

Full text  [pdf\(5.41 MB\)](#) Additional Information: [full citation, abstract, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 26, Downloads (12 Months): 161, Citation Count: 0

Well-produced videos provide a convenient and effective way to archive lectures. In this article, we offer a

new way to create lecture videos that retains many of the advantages of well-composed recordings, without the cost and intrusion of a video production ...

Klíčová slova: Automated camera management, attention modeling, computational cinematography, video production

[Scenario based dynamic video abstractions using graph matching](#)

JeongKyu Lee, JungHwan Oh, Sae Hwang

November 2005 **MULTIMEDIA '05:** Proceedings of the 13th annual ACM international conference on Multimedia

Vydavatel: ACM

Full text available:  [pdf\(454.16 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 13, Downloads (12 Months): 84, Citation Count: 2

In this paper, we present scenario based dynamic video abstractions using graph matching. Our approach has two main components: multi-level scenario generations and dynamic video abstractions. Multi-level scenarios are generated by a graph-based video ...

Klíčová slova: graph similarity measure, region adjacency graph, shot boundary detection, video summarization

[Defining user perception of distributed multimedia quality](#)

Stephen R. Gulliver, Gheorghita Ghinea

November 2006 **ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)**, Volume 2 Issue 4

Vydavatel: ACM

Full text available:  [pdf\(1.54 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 25, Downloads (12 Months): 266, Citation Count: 0

This article presents the results of a study that explored the human side of the multimedia experience. We propose a model that assesses quality variation from three distinct levels: the network, the media and the content *levels*; and from two ...

Klíčová slova: Human-computer interaction, multimedia quality, quality of perception

[Designing a large-scale video chat application](#)

Jeremiah Scholl, Peter Parnes, John D. McCarthy, Angela Sasse

November 2005 **MULTIMEDIA '05:** Proceedings of the 13th annual ACM international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(508.09 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 13, Downloads (12 Months): 80, Citation Count: 0

Studies of video conferencing systems generally focus on scenarios where users communicate using an audio channel. However, text chat serves users in a wide variety of contexts, and is commonly included in multimedia conferencing systems as a complement ...

Klíčová slova: bandwidth sharing, chat, collaboration, video conferencing

[Video query processing in the VDBMS testbed for video database research](#)

Walid Aref, Moustafa Hammad, Ann Christine Catlin, Ihab Ilyas, Thanaa Ghanem, Ahmed Elmagarmid, Mirette Marzouk

November 2003 **MMDB '03:** Proceedings of the 1st ACM international workshop on Multimedia databases

Vydavatel: ACM

Full text  [pdf\(357.93 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 4, Downloads (12 Months): 59, Citation Count: 0

The increased use of video data sets for multimedia-based applications has created a demand for strong video database support, including efficient methods for handling the content-based query and retrieval of video data. Video query processing presents ...

Klíčová slova: continuous query, query processing, rank-join algorithm, stream processing, video database, window-join algorithm

[A probabilistic framework for fusing frame-based searches within a video copy detection system](#)

Nicolas Gengembre, Sid-Ahmed Berrani

July 2008 **CIVR '08:** Proceedings of the 2008 international conference on Content-based image and video retrieval

Vydavatel: ACM

Full text  [pdf\(430.92 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 0, Downloads (12 Months): 0, Citation Count: 0

In the last few years, content-based video copy detection became an important and key tool for solving the tricky problem of video copyright protection. This problem has been heightened with the development of web video exchange platforms. In general, ...

Klíčová slova: copyright protection, probabilistic analysis, video copy detection, video indexing

[3D position, attitude and shape input using video tracking of hands and lips](#)

Andrew Blake, Michael Isard

July 1994 **SIGGRAPH '94:** Proceedings of the 21st annual conference on Computer graphics and interactive techniques

Vydavatel: ACM

Full text  [pdf\(341.03 KB\)](#)  [ps\(1.65 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 9, Downloads (12 Months): 165, Citation Count: 11

Recent developments in video-tracking allow the outlines of moving, natural objects in a video-camera input stream to be tracked live, at full video-rate. Previous systems have been available to do this for specially illuminated objects or for naturally ...

[Combined-media video tracking for summarization](#)

Jianying Hu, Jialin Zhong, Amit Bagga

October 2001 **MULTIMEDIA '01:** Proceedings of the ninth ACM international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(1.84 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 3, Downloads (12 Months): 23, Citation Count: 0

Video summarization is receiving increasing attention due to the large amount of video content made available on the Internet. In this paper we present a novel idea to track video from multiple sources for video summarization. An algorithm that takes ...

[A Coded Visual Marker for Video Tracking System Based on Structured Image Analysis](#)

Takeshi Kawano, Yoshihiro Ban, Kuniaki Uehara

October 2003 **ISMAR '03: Proceedings of the 2nd IEEE/ACM International Symposium on Mixed and Augmented Reality**

Vydavatel: IEEE Computer Society

Full text available:  [pdf\(97.53 KB\)](#) Additional Information: [full citation, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 4, Downloads (12 Months): 6, Citation Count: 0

[Automatic video tracking by probabilistic propagation](#)

Michael Isard, Andrew Blake

January 1996 **SIGGRAPH '96: ACM SIGGRAPH 96 Visual Proceedings: The art and interdisciplinary programs of SIGGRAPH '96**

Vydavatel: ACM

Additional Information: [full citation](#)

Bibliometrics: Downloads (6 Weeks): n/a, Downloads (12 Months): n/a, Citation Count: 0

[Web video topic discovery and tracking via bipartite graph reinforcement model](#)

Lu Liu, Lifeng Sun, Yong Rui, Yao Shi, Shiqiang Yang

April 2008 **WWW '08: Proceeding of the 17th international conference on World Wide Web**

Vydavatel: ACM

Full text available:  [pdf\(1.39 MB\)](#) Additional Information: [full citation, abstract, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 36, Downloads (12 Months): 36, Citation Count: 0

Automatic topic discovery and tracking on web-shared videos can greatly benefit both web service providers and end users. Most of current solutions of topic detection and tracking were done on news and cannot be directly applied on web videos, because ...

Klíčová slova: bipartite graph model, co-clustering, reinforcement, topic discovery, topic tracking, web videos

[Towards efficient context-specific video coding based on gaze-tracking analysis](#)

D. Agrafiotis, S. J. C. Davies, N. Canagarajah, D. R. Bull

December 2007 **ACM Transactions on Multimedia Computing, Communications, and Applications (TOMCCAP)**, Volume 3 Issue 4

Vydavatel: ACM

Full text available:  [pdf\(4.31 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 17, Downloads (12 Months): 119, Citation Count: 0

This article discusses a framework for model-based, context-dependent video coding based on exploitation of characteristics of the human visual system. The system utilizes variable-quality coding based on priority maps which are created using mostly ...

Klíčová slova: Eye tracking, applications, context-based video coding, multimedia perceptual quality, subjective video quality, transformation of eye movements into useful knowledge

[Tracking text in MPEG videos](#)

Julinda Gllavata, Ralph Ewerth, Bernd Freisleben

October 2004 **MULTIMEDIA '04: Proceedings of the 12th annual ACM international conference on Multimedia**

Vydavatel: ACM

Full text available:  [pdf\(271.30 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 6, Downloads (12 Months): 30, Citation Count: 0

Tracking superimposed text moving across several frames of a video is relevant for exploiting its temporal occurrence for effective video content indexing and retrieval. In this paper, an approach is presented that automatically detects, localizes and ...

Klíčová slova: MPEG motion vectors, content-based video indexing and retrieval, text detection and localization, text tracking in videos

[Tracking players in highly complex scenes in broadcast soccer video using a constraint satisfaction approach](#)

Jun Miura, Hiroyuki Kubo

July 2008 **CIVR '08**: Proceedings of the 2008 international conference on Content-based image and video retrieval

Vydavateľ: ACM

Full text available:  [pdf\(1.05 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 0, Downloads (12 Months): 0, Citation Count: 0

This paper deals with player tracking in broadcast soccer video. In soccer games, players sometimes gather in a small area in the case of, for example, a corner kick. In such a case, due to a heavy occlusion, a simple detection-and-tracking method will ...

Klíčová slova: broadcast soccer video, constraint satisfaction, player tracking

[Multiple video object tracking in complex scenes](#)

Andrea Cavallaro, Olivier Steiger, Touradj Ebrahimi

December 2002 **MULTIMEDIA '02**: Proceedings of the tenth ACM international conference on Multimedia

Vydavateľ: ACM

Full text available:  [pdf\(861.56 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#)

Bibliometrics: Downloads (6 Weeks): 20, Downloads (12 Months): 62, Citation Count: 4

We present an automatic video object tracking algorithm capable of dealing with multiple simultaneous objects. The tracking is based on interactions between high-level and low-level image analysis results. The high-level result is a partition defining ...

[Trajectory-based ball detection and tracking with applications to semantic analysis of broadcast soccer video](#)

Xinguo Yu, Changsheng Xu, Hon Wai Leong, Qi Tian, Qing Tang, Kong Wah Wan

November 2003 **MULTIMEDIA '03**: Proceedings of the eleventh ACM international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(344.43 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 30, Downloads (12 Months): 192, Citation Count: 13

This paper first presents an improved trajectory-based algorithm for automatically detecting and tracking the ball in broadcast soccer video. Unlike the object-based algorithms, our algorithm does not evaluate whether a sole object is a ball. Instead, ...

Klíčová slova: ball detection and tracking, event detection, semantic analysis, trajectory-based

[Video-based document tracking: unifying your physical and electronic desktops](#)

Jiwon Kim, Steven M. Seitz, Maneesh Agrawala

October 2004 **UIST '04:** Proceedings of the 17th annual ACM symposium on User interface software and technology

Vydavatel: ACM

Full text  [pdf\(7.33 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 19, Downloads (12 Months): 75, Citation Count: 2

This paper presents an approach for tracking paper documents on the desk over time and automatically linking them to the corresponding electronic documents using an overhead video camera. We demonstrate our system in the context of two scenarios, <i>paper ...

Klíčová slova: document recognition, intelligent office, interactive desktop, video analysis

[Improving video browsing with an eye-tracking evaluation of feature-based color bars](#)

Neema Moraveji

June 2004 **JCDL '04:** Proceedings of the 4th ACM/IEEE-CS joint conference on Digital libraries

Vydavatel: ACM

Full text  [pdf\(240.00 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 3, Downloads (12 Months): 44, Citation Count: 1

This paper explains a method for leveraging the standard video time line widget as an interactive visualization of image features. An eye-tracking experiment is described with results that indicate that such a widget

increases task efficiency without ...

Klíčová slova: digital video, user interface

[Face-tracking as an augmented input in video games: enhancing presence, role-playing and control](#)

Shuo Wang, Xiaocao Xiong, Yan Xu, Chao Wang, Weiwei Zhang, Xiaofeng Dai, Dongmei Zhang

April 2006 **CHI '06:** Proceedings of the SIGCHI conference on Human Factors in computing systems

Vydavatel: ACM

Full text  [pdf\(1.22 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 24, Downloads (12 Months): 185, Citation Count: 0

Motion-detection only games have inherent limitations on game experience in that the systems cannot identify the player's existence and identity. A way of improvement is by introducing information such as a player's face or head into the system. We designed ...

Klíčová slova: camera-based games, face tracking, first person shooter (FPS), game control, motion detection, presence, role-playing

[Video parsing based on head tracking and face recognition](#)

Pengxu Li, Haizhou Ai, Yuan Li, Chang Huang

July 2007 **CIVR '07:** Proceedings of the 6th ACM international conference on Image and video retrieval

Vydavatel: ACM

Full text  [pdf\(659.31 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 35, Downloads (12 Months): 223, Citation Count: 0

In this paper, we describe a fully automatic video retrieval prototype system that uses an image or a video sequence of an interested identity as probe. The system is based on face vision techniques including face detection and tracking, face alignment ...

Klíčová slova: face recognition, face vision, video content retrieval, video parsing

[Predictive perceptual compression for real time video communication](#)

Oleg Komogortsev, Javed Khan

October 2004 **MULTIMEDIA '04:** Proceedings of the 12th annual ACM international conference on Multimedia

Vydavatel: ACM

Full available: text  [pdf\(514.78 KB\)](#) Additional Information: [full citation, abstract, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 9, Downloads (12 Months): 91, Citation Count: 2

Approximately 2 degrees in our 140 degree vision span has sharp vision. Many researchers have been fascinated by the idea of eye-tracking integrated perceptual compression of an image or video, yet any practical system has yet to emerge. The unique challenge ...

Klíčová slova: perceptual compression, video transcoding

[Techniques for FPGA implementation of video compression systems](#)

Brian Schoner, John Villasenor, Steve Molloy, Rajeev Jain

February 1995 **FPGA '95:** Proceedings of the 1995 ACM third international symposium on Field-programmable gate arrays

Vydavatel: ACM

Full available: text  [pdf\(439.74 KB\)](#) Additional Information: [full citation, abstract, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 4, Downloads (12 Months): 70, Citation Count: 2

Real-time video compression is a challenging subject for FPGA implementation because it typically has a large computational complexity and requires high data throughput. Previous implementations have used parallel banks of FPGAs or DSPs to meet these ...

[A new video compression algorithm for different videoconferencing standards](#)

Awad Kh. Al-Asmari

January 2003 **International Journal of Network Management**, Volume 13 Issue 1

Vydavatel: John Wiley & Sons, Inc.

Full available: text  [pdf\(173.88 KB\)](#) Additional Information: [full citation, abstract, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 20, Downloads (12 Months): 67, Citation Count: 1

In this paper, a new and simple predictive coding algorithm for video compression and multimedia communication for different network applications is investigated. This algorithm is called semi-hexagonal

absolute moment block truncation coding (SH-AMBTC). ...

[Backward compatible high dynamic range MPEG video compression](#)

Rafał Mantiuk, Alexander Efremov, Karol Myszkowski, Hans-Peter Seidel

July 2006

ACM Transactions on Graphics (TOG), Volume 25 Issue 3

Vydavatel: ACM

Full text  [pdf\(876.23 KB\)](#)  [mov\(17:14\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 73, Downloads (12 Months): 337, Citation Count: 0

To embrace the imminent transition from traditional low-contrast video (LDR) content to superior high dynamic range (HDR) content, we propose a novel backward compatible HDR video compression (HDR MPEG) method. We introduce a compact reconstruction function ...

Klíčová slova: MPEG, backward compatibility, high dynamic range, prefiltering, tone mapping, video compression, visible difference predictor, visual masking, visual perception

[Design flow for hardware/software cosynthesis of a video compression system](#)

Jörg Wilberg, Raul Camposano, Wolfgang Rosenstiel

September 1994

CODES '94: Proceedings of the 3rd international workshop on Hardware/software co-design

Vydavatel: IEEE Computer Society Press

Full text  [pdf\(690.42 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#)

Bibliometrics: Downloads (6 Weeks): 2, Downloads (12 Months): 11, Citation Count: 6

The implementation of a cosynthesis design flow in the CASTLE system is presented. The design flow generates a synthesizable hardware description and a C, C++, or Fortran compiler for an application-oriented processor. The approach is illustrated by ...

[Temporal semantic compression for video browsing](#)

Brett Adams, Stewart Greenhill, Svetha Venkatesh

January 2008

IUI '08: Proceedings of the 13th international conference on Intelligent user interfaces

Vydavatel: ACM

Full text  [pdf\(252.49 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 9, Downloads (12 Months): 9, Citation Count: 0

We present a video browsing approach, termed Temporal Semantic Compression (TSC), that uses automated measures of interest to support today's foraging behaviours. Conventional browsers 'compress' a video stream using simple 2x or 8x fast-forward. TSC ...

Klíčová slova: compression, media aesthetics, video browsing

[Display pre-filtering for multi-view video compression](#)

Matthias Zwicker, Sehoon Yea, Anthony Vetro, Clifton Forlines, Wojciech Matusik, Hanspeter Pfister

September 2007 **MULTIMEDIA '07:** Proceedings of the 15th international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(1.80 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 19, Downloads (12 Months): 147, Citation Count: 0

Multi-view 3D displays are preferable to other stereoscopic display technologies because they provide autostereoscopic viewing from any viewpoint without special glasses. However, they require a large number of pixels to achieve high image quality. Therefore, ...

Klíčová slova: 3D displays, antialiasing, multi-view compression

[Feature based volumetric video compression for interactive playback](#)

Bong-Soo Sohn, Chandrajit Bajaj, Vinay Siddavanahalli

October 2002 **VVS '02:** Proceedings of the 2002 IEEE symposium on Volume visualization and graphics

Vydavatel: IEEE Press

Full text  [pdf\(15.08 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#)

available: [MB\)](#)

Information: [index terms](#)

Bibliometrics: Downloads (6 Weeks): 2, Downloads (12 Months): 16, Citation Count: 7

In this paper, we describe a compression scheme for encoding time-varying isosurfaces and amorphous volumetric features (volumes within specified value ranges) in a unified way, which allows for on-line reconstruction and rendering. Since the size of ...

Klíčová slova: compression, hardware-acceleration, isocontouring, time-varying volume visualization, wavelet transform

[FPGA implementation of a novel, fast motion estimation algorithm for real-time video compression](#)

S. Ramachandran, S. Srinivasan

February 2001 **FPGA '01:** Proceedings of the 2001 ACM/SIGDA ninth international symposium on Field programmable gate arrays

Vydavatel: ACM

Full text available:  [pdf\(450.80 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 12, Downloads (12 Months): 80, Citation Count: 0

A novel block matching algorithm for motion estimation in a video frame sequence, well suited for a high performance FPGA implementation is presented in this paper. The algorithm is up to 40% faster when compared to one of the fastest existing algorithms, ...

Klíčová slova: block matching algorithm, discrete cosine transform, macroblock, motion estimation, quantization and variable length code, sum of absolute pixel intensity difference

[A Video Compression Case Study on a Reconfigurable VLIW Architecture](#)

D. Rizzo, O. Colavin

March 2002 **DATE '02:** Proceedings of the conference on Design, automation and test in Europe

Vydavatel: IEEE Computer Society

Full text available:  [pdf\(347.52 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [cited by](#)

Bibliometrics: Downloads (6 Weeks): 0, Downloads (12 Months): 13, Citation Count: 1

In this paper, we investigate the benefits of a flexible, application-specific instruction set by adding a runtime Reconfigurable Functional Unit (RFU) to a VLIW processor. Preliminary results on the motion estimation stage in an MPEG4 video encoder are ...

[Group behavior from video: a data-driven approach to crowd simulation](#)

Kang Hoon Lee, Myung Geol Choi, Qyoun Hong, Jehee Lee

August 2007 **SCA '07: Proceedings of the 2007 ACM SIGGRAPH/Eurographics symposium on Computer animation**

Vydavatel: Eurographics Association

Full text  [pdf\(15.96 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 26, Downloads (12 Months): 235, Citation Count: 0

Crowd simulation techniques have frequently been used to animate a large group of virtual humans in computer graphics applications. We present a data-driven method of simulating a crowd of virtual humans that exhibit behaviors imitating real human crowds. ...

[Object tracking: A survey](#)

Alper Yilmaz, Omar Javed, Mubarak Shah

December 2006 **ACM Computing Surveys (CSUR)**, Volume 38 Issue 4

Vydavatel: ACM

Full text  [pdf\(2.60 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 932, Downloads (12 Months): 6198, Citation Count: 0

The goal of this article is to review the state-of-the-art tracking methods, classify them into different categories, and identify new trends. Object tracking, in general, is a challenging problem. Difficulties in tracking objects can arise due to abrupt ...

Klíčová slova: Appearance models, contour evolution, feature selection, object detection, object

representation, point tracking, shape tracking

[Face-tracking as an augmented input in video games: enhancing presence, role-playing and control](#)

Shuo Wang, Xiaocao Xiong, Yan Xu, Chao Wang, Weiwei Zhang, Xiaofeng Dai, Dongmei Zhang

April **CHI '06:** Proceedings of the SIGCHI conference on Human Factors in computing systems
2006

Vydavatel: ACM

Full available: text  [pdf\(1.22 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 24, Downloads (12 Months): 185, Citation Count: 0

Motion-detection only games have inherent limitations on game experience in that the systems cannot identify the player's existence and identity. A way of improvement is by introducing information such as a player's face or head into the system. We designed ...

Klíčová slova: camera-based games, face tracking, first person shooter (FPS), game control, motion detection, presence, role-playing

[Real-time object tracking with relevance feedback](#)

Ard Oerlemans, Joachim T. Rijsdam, Michael S. Lew

July **CIVR '07:** Proceedings of the 6th ACM international conference on Image and video retrieval
2007

Vydavatel: ACM

Full available: text  [pdf\(149.52 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 21, Downloads (12 Months): 184, Citation Count: 0

Currently there are many systems available that use relevance feedback for text and image retrieval. This query by example method has been shown to optimize the search strategy whilst keeping a fast response time, two important factors when querying ...

Klíčová slova: motion detection, object tracking, relevance feedback, video analysis

[Tracking mean shift clustered point clouds for 3D surveillance](#)

Mark A. Keck, Jr., James W. Davis, Ambrish Tyagi

October 2006 **VSSN '06:** Proceedings of the 4th ACM international workshop on Video surveillance and sensor networks

Vydavatel: ACM

Full text  [pdf\(1.62 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 8, Downloads (12 Months): 133, Citation Count: 0

We present in this paper a method of tracking multiple objects (people) in 3D for application in video surveillance. The tracking method is designed to work on images with objects at low resolution and has two major contributions. First we propose a ...

Klíčová slova: 3D tracking, mean shift clustering, reconstruction

[Multi-camera indoor video processing for context awareness](#)

L. Marcenaro, I. Magliano, A. Beoldo, M. Valla, C. S. Regazzoni

August 2007 **MobiMedia '07:** Proceedings of the 3rd international conference on Mobile multimedia communications

Vydavatel: ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering)

Full text  [pdf\(336.69 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

Bibliometrics: Downloads (6 Weeks): 0, Downloads (12 Months): 0, Citation Count: 0

In this paper a system is presented able to acquire images from multiple indoor network cameras and extract contextual information about persons detected within the considered environment. Distributed system architecture allows one to process images ...

Klíčová slova: ambient intelligence context aware applications, video processing, video surveillance

[Understanding human intentions via hidden markov models in autonomous mobile robots](#)

Richard Kelley, Alireza Tavakkoli, Christopher King, Monica Nicolescu, Mircea Nicolescu, George Bebis

March 2008 **HRI '08:** Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction

Vydavatel: ACM

Full text  [pdf\(945.63 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 41, Downloads (12 Months): 118, Citation Count: 0

Understanding intent is an important aspect of communication among people and is an essential component of the human cognitive system. This capability is particularly relevant for situations that involve collaboration among agents or detection of situations ...

Klíčová slova: hidden markov models, human-robot interaction, intention modeling, theory of mind, vision-based methods

[A novel technique for indexing video surveillance data](#)

Eamonn Keogh, Bhriagu Celly, Chotirat Ann Ratanamahatana, Victor Brian Zordan

November 2003 **IWVS '03:** First ACM SIGMM international workshop on Video surveillance

Vydavatel: ACM

Full text  [pdf\(961.84 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 7, Downloads (12 Months): 70, Citation Count: 0

Recent worldwide events have renewed interest in the use of video surveillance as a tool for private security, law enforcement and military applications. After appropriate feature extraction has taken place, most video surveillance problems are reduced ...

Klíčová slova: indexing, lower bounding, surveillance data, uniform scaling

[Segmentation, categorization, and identification of commercial clips from TV streams using multimodal analysis](#)

Ling-Yu Duan, Jinqiao Wang, Yantao Zheng, Jesse S. Jin, Hanqing Lu, Changsheng Xu

October 2006 **MULTIMEDIA '06:** Proceedings of the 14th annual ACM international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(1.88 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 36, Downloads (12 Months): 215, Citation Count: 0

TV advertising is ubiquitous, perseverant, and economically vital. Millions of people's living and working habits are affected by TV commercials. In this paper, we present a multimodal ("visual + audio + text") commercial video digest scheme to segment ...

Klíčová slova: TV commercial, mid-level features, multimodal analysis, segmentation, semantics, text categorization, video classification

[An integrated approach to video retrieval](#)

Liang-Hua Chen, Kuo-Hao Chin, Hong-Yuan Liao

January 2008 **ADC '08: Proceedings of the nineteenth conference on Australasian database - Volume 75**, Volume 75

Vydavatel: Australian Computer Society, Inc.

Full text  [pdf\(571.98 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

Bibliometrics: Downloads (6 Weeks): 5, Downloads (12 Months): 5, Citation Count: 0

The usefulness of a video database depends on whether the video of interest can be easily located. In this paper, we propose a video retrieval algorithm based on the integration of several visual cues. In contrast to key-frame based representation of ...

Klíčová slova: similarity measure, video database, video matching, video retrieval

[Demonstration of grid-enabled ensemble Kalman Filter data assimilation methodology for reservoir characterization](#)

Ravi Vadapalli, Ping Luo, Taesung Kim, Ajitabh Kumar, Shameem Siddiqui

January 2008 **MG '08: Proceedings of the 15th ACM Mardi Gras conference: From lightweight mash-ups to lambda grids: Understanding the spectrum of distributed computing requirements, applications, tools, infrastructures, interoperability, and the incremental adoption of key capabilities**

Vydavatel: ACM

Full text  [pdf\(337.36 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index](#)

available: [KB](#) Information: [terms](#)

Bibliometrics: Downloads (6 Weeks): 15, Downloads (12 Months): 98, Citation Count: 0

Ensemble Kalman filter data assimilation methodology is a popular approach for hydrocarbon reservoir simulations in energy exploration. In this approach, an ensemble of geological models and production data of oil fields is used to forecast the dynamic ...

Klíčová slova: EnKF, GridWay, TIGRE, energy exploration, reservoir modeling

[Automating the implementation of Kalman filter algorithms](#)

Jon Whittle, Johann Schumann

December 2004 **ACM Transactions on Mathematical Software (TOMS)**, Volume 30 Issue 4

Vydavatel: ACM

Full text  [pdf\(312.63 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 59, Downloads (12 Months): 342, Citation Count: 1

autofilter is a tool that generates implementations that solve state estimation problems using Kalman filters. From a high-level, mathematics-based description of a state estimation problem, autofilter automatically generates code that computes a statistically ...

Klíčová slova: Code generation, Kalman filters, automatic programming, state estimation

[Hybrid tracking of human operators using IMU/UWB data fusion by a Kalman filter](#)

J. A. Corrales, F. A. Candelas, F. Torres

March 2008 **HRI '08:** Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction

Vydavatel: ACM

Full text  [pdf\(1.91 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 46, Downloads (12 Months): 97, Citation Count: 0

The precise localization of human operators in robotic workplaces is an important requirement to be satisfied in order to develop human-robot interaction tasks. Human tracking provides not only safety for human operators, but also context information ...

Klíčová slova: data fusion, human tracking and monitoring, indoor location, inertial sensors, kalman filter, motion capture, uwb

[Tracking time-varying parameters in software systems with extended Kalman filters](#)

Tao Zheng, Jinmei Yang, Murray Woodside, Marin Litoiu, Gabriel Iszlai

October 2005 **CASCON '05:** Proceedings of the 2005 conference of the Centre for Advanced Studies on Collaborative research

Vydavatel: IBM Press

Full text  [pdf\(310.15 KB\)](#) Additional Information: [full citation, abstract, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 16, Downloads (12 Months): 123, Citation Count: 2

Autonomic control of a service system can take advantage of a performance model only if a way can be found to track the changes in the system. A Kalman Filter provides a framework for integrating various kinds of measured data, and for tracking changes ...

[Traffic matrix tracking using Kalman filters](#)

Augustin Soule, Kavé Salamatian, Antonio Nucci, Nina Taft

December 2005 **ACM SIGMETRICS Performance Evaluation Review**, Volume 33 Issue 3

Vydavatel: ACM

Full text  [pdf\(1.53 MB\)](#) Additional Information: [full citation, abstract, references, index terms](#)

Bibliometrics: Downloads (6 Weeks): 16, Downloads (12 Months): 58, Citation Count: 0

In this work we develop a new approach to monitoring origin-destination flows in a large network. We start by building a state space model for OD flows that is rich enough to fully capture temporal and spatial

correlations. We apply a Kalman filter to ...

[Estimation of motion and position of a rigid object using a sequence of images \(tridimensional Kalman filter approach\)](#)

R. Vasquez, J. Mayora

April 1991 **CSC '91**: Proceedings of the 19th annual conference on Computer Science

Vydavatel: ACM

Full text  [pdf\(598.01 KB\)](#) Additional Information: [full citation, references](#)

Bibliometrics: Downloads (6 Weeks): 1, Downloads (12 Months): 39, Citation Count: 0

[Multi-views tracking within and across uncalibrated camera streams](#)

Jinman Kang, Isaac Cohen, Gérard Medioni

November 2003 **IWVS '03**: First ACM SIGMM international workshop on Video surveillance

Vydavatel: ACM

Full text  [pdf\(2.60 MB\)](#) Additional Information: [full citation, abstract, references, cited by, index terms](#)

Bibliometrics: Downloads (6 Weeks): 28, Downloads (12 Months): 152, Citation Count: 1

This paper presents novel approaches for continuous detection and tracking of moving objects observed by multiple, stationary or moving cameras. Stationary video streams are registered using a ground plane homography and the trajectories derived by Tensor ...

Klíčová slova: Kalman Filter, Tensor Voting, camera registration, detection, heterogeneous cameras, joint probability data association filter, multiple cameras, tracking, video analysis, video surveillance

[Robust line tracking using a particle filter for camera pose estimation](#)

Fakhreddine Ababsa, Malik Mallem

November 2006 **VRST '06**: Proceedings of the ACM symposium on Virtual reality software and technology

Vydavatel: ACM

Full text  [pdf\(589.70 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 26, Downloads (12 Months): 120, Citation Count: 0

This paper presents a robust line tracking approach for camera pose estimation which is based on particle filtering framework. Particle filters are sequential Monte Carlo methods based on point mass (or "particle") representations of probability densities, ...

Klíčová slova: 3D pose estimation, augmented reality, line tracking, particle filter

[A joint particle filter for audio-visual speaker tracking](#)

Kai Nickel, Tobias Gehrig, Rainer Stiefelhagen, John McDonough

October 2005 **ICMI '05:** Proceedings of the 7th international conference on Multimodal interfaces

Vydavatel: ACM

Full text  [pdf\(460.78 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 19, Downloads (12 Months): 96, Citation Count: 3

In this paper, we present a novel approach for tracking a lecturer during the course of his speech. We use features from multiple cameras and microphones, and process them in a joint particle filter framework. The filter performs sampled projections ...

Klíčová slova: multimodal systems, particle filters, speaker tracking

[Particle filter on GPUs for real-time tracking](#)

Antonio S. Montemayor, Juan José Pantrigo, Ángel Sánchez, Felipe Fernández

August 2004 **SIGGRAPH '04:** ACM SIGGRAPH 2004 Posters

Vydavatel: ACM

Full text  [pdf\(77.60 KB\)](#) Additional Information: [full citation](#), [references](#)

[KB\)](#)

[cited by](#)

Bibliometrics: Downloads (6 Weeks): 14, Downloads (12 Months): 75, Citation Count: 1

[Improving GPU particle filter with shader model 3.0 for visual tracking](#)

Antonio S. Montemayor, Bryson R. Payne, Juan José Pantrigo, Raúl Cabido, Ángel Sánchez, Felipe Fernández

July 2006 **SIGGRAPH '06:** ACM SIGGRAPH 2006 Research posters

Vydavatel: ACM

Full available: text  [pdf\(75.54 KB\)](#) Additional Information: [full citation](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 7, Downloads (12 Months): 38, Citation Count: 0

[Tracking a moving object with a binary sensor network](#)

Javed Aslam, Zack Butler, Florin Constantin, Valentino Crespi, George Cybenko, Daniela Rus

November 2003 **SenSys '03:** Proceedings of the 1st international conference on Embedded networked sensor systems

Vydavatel: ACM

Full available: text  [pdf\(442.97 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [cited by](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 28, Downloads (12 Months): 251, Citation Count: 18

In this paper we examine the role of very simple and noisy sensors for the tracking problem. We propose a binary sensor model, where each sensor's value is converted reliably to one bit of information only: whether the object is moving toward the sensor ...

Klíčová slova: minimalism, particle filters, sensor networks, tracking

[ROBOTRAK: a centralized real-time monitoring, control, and coordination system for robot swarms](#)

Ming Li, Anthony Alvarez, Francesco De Pellegrini, B. Prabhakaran, Imrich Chlamtac

October 2007 **RoboComm '07**: Proceedings of the 1st international conference on Robot communication and coordination

Vydavatel: IEEE Press

Full text  [pdf\(133.57 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

Bibliometrics: Downloads (6 Weeks): 4, Downloads (12 Months): 4, Citation Count: 0

Robotic swarm has been a hot topic in recent years. In robotic swarms, a team of network enabled bots are dispatched to some areas to fulfill certain tasks, such as military actions and chemical substance tracking. However, how to monitor, control, and ...

Klíčová slova: GUI, robot swarm, security, software development

[Cast indexing for videos by NCuts and page ranking](#)

Yong Gao, Tao Wang, Jianguo Li, YangZhou Du, Wei Hu, Yimin Zhang, HaiZhou Ai

July 2007 **CIVR '07**: Proceedings of the 6th ACM international conference on Image and video retrieval

Vydavatel: ACM

Full text  [pdf\(953.97 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 19, Downloads (12 Months): 109, Citation Count: 0

Cast indexing is an important video mining technique which provides audience the capability to efficiently retrieve interested scenes, events, and stories from a long video. This paper proposes a novel cast indexing approach based on Normalized Graph ...

Klíčová slova: NCuts, cast indexing, cast ranking, local neighbor distance, main cast detection, page ranking

[An object-based video coding framework for video sequences obtained from static cameras](#)

Asaad Hakeem, Khurram Shafique, Mubarak Shah

November 2005 **MULTIMEDIA '05**: Proceedings of the 13th annual ACM international conference on Multimedia

Vydavatel: ACM

Full text  [pdf\(2.24 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 17, Downloads (12 Months): 120, Citation Count: 0

This paper presents a novel object-based video coding framework for videos obtained from a static camera. As opposed to most existing methods, the proposed method does not require explicit 2D or 3D models of objects and hence is general enough to cater ...

Klíčová slova: affine and projective transformation, background subtraction, contour-based tracking, incremental PCA, object-based video coding, tracking

[How many high-level concepts will fill the semantic gap in news video retrieval?](#)

Alexander Hauptmann, Rong Yan, Wei-Hao Lin

July 2007 **CIVR '07:** Proceedings of the 6th ACM international conference on Image and video retrieval

Vydavatel: ACM

Full text  [pdf\(356.13 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 27, Downloads (12 Months): 169, Citation Count: 0

A number of researchers have been building high-level semantic concept detectors such as outdoors, face, building, etc., to help with semantic video retrieval. Using the TRECVID video collection and LSCOM truth annotations from 300 concepts, we simulate ...

Klíčová slova: LSCOM, concept-based video retrieval, high-level semantic concepts, semantic gap

[Object tracking in the presence of occlusions via a camera network](#)

Ali Ozer Ercan, Abbas El Gamal, Leonidas J. Guibas

April 2007 **IPSN '07:** Proceedings of the 6th international conference on Information processing in sensor networks

Vydavatel: ACM

Full text  [pdf\(356.20 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Bibliometrics: Downloads (6 Weeks): 38, Downloads (12 Months): 361, Citation Count: 0

This paper describes a sensor network approach to tracking a single object in the presence of static and moving occluders using a network of cameras. To conserve communication bandwidth and energy, each camera first performs simple local processing to ...

Klíčová slova: auxiliary particle filter, camera network, noisy perspective camera model, occlusion, tracking, wireless sensor network

3.2 Články z databáze IEEE Computer Society

Zdroj článků: <https://dialog.cvut.cz/>

Kernel-Based Object Tracking

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Dorin Comaniciu , Visvanathan Ramesh , Peter Meer

Issue Date: May 2003

pp. 564-575

Abstract—A new approach toward target representation and localization, the central component in visual tracking of nonrigid objects, is proposed. The feature histogram-based target representations are regularized by spatial masking with an ...

A Pixel-wise Object Tracking Algorithm with Target and Background Sample

Found in: [18th International Conference on Pattern Recognition \(ICPR'06\) Volume 1](#)

By Chunsheng Hua , Haiyuan Wu , Qian Chen , Toshikazu Wada

Issue Date: August 2006

pp. 739-742

In this paper, we present a clustering-based tracking algorithm

Event Detection from MPEG Video in the Compressed Domain

Found in: [15th International Conference on Pattern Recognition \(ICPR'00\) - Volume 1](#)

By Kyongil Yoon , Daniel DeMenthon , David Doermann

Issue Date: September 2000

pp. 1819

This paper describes two techniques for detecting dynamic events using the motion vectors obtained from the MPEG video encoding. In the first technique, feature vectors from motion information form a high dimensional curve for a video clip, and curve simpl...

Framework for Performance Evaluation of Face, Text, and Vehicle Detection and Tracking in Video: Data, Metrics, and Protocol

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Rangachar Kasturi , Dmitry Goldgof , Padmanabhan Soundararajan , Vasant Manohar , Matthew Boonstra , Valentina Korzhova , Jing Zhang , Rachel Bowers , John Garofolo

Publication Date: March 2008

pp. N/A

Common benchmark datasets, standardized performance metrics, and baseline algorithms have demonstrated considerable impact on research and development in a variety of application domains. In this paper, we present such a framework for evaluating object det...

Bittracker—A Bitmap Tracker for Visual Tracking under Very General Conditions

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Ido Leichter , Michael Lindenbaum , Ehud Rivlin

Issue Date: September 2008

pp. 1572-1588

This paper addresses the problem of visual tracking under very general conditions: a possibly non-rigid target whose appearance may drastically change over time; general camera motion; a 3D scene; and no a priori information except initialization. This is ...

Novel Seed Selection for Multiple Objects Detection and Tracking

Found in: [17th International Conference on Pattern Recognition \(ICPR'04\) - Volume 2](#)

By Zailiang Pan , Chong-Wah Ngo

Issue Date: August 2004

pp. 744-747

This paper proposes a unified approach for initializing,

Fast Multiple Object Tracking via a Hierarchical Particle Filter

Found in: [Tenth IEEE International Conference on Computer Vision \(ICCV'05\) Volume 1](#)

By Changjiang Yang , Ramani Duraiswami , Larry Davis

Issue Date:October 2005

pp. 212-219

A very efficient and robust visual object tracking algorithm

Pfinder: Real-Time Tracking of the Human Body

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Christopher Richard Wren , Ali Azarbayejani , Trevor Darrell , Alex Paul Pentland

Issue Date:July 1997

pp. 780-785

Abstract—Pfinder is a real-time system for tracking people and interpreting their behavior. It runs at 10Hz on a standard SGI Indy computer, and has performed reliably on thousands of people in many different physical locations. The system ...

Approximate Bayesian Multibody Tracking

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Oswald Lanz

Issue Date:September 2006

pp. 1436-1449

Visual tracking of multiple targets is a challenging problem, especially when efficiency is an issue. Occlusions, if not properly handled, are a major source of failure. Solutions supporting principled occlusion reasoning have been proposed but are yet unp...

Efficient Visual Search of Videos Cast as Text Retrieval

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Josef Sivic , Andrew Zisserman

Publication Date: April 2008

pp. N/A

We describe an approach to object retrieval which searches for and localizes all the occurrences of an object in a video, given a query image of the object. The object is represented by a set of viewpoint invariant region descriptors so that recognition ca...

Robust Visual Tracking via Pixel Classification and Integration

Found in: [18th International Conference on Pattern Recognition \(ICPR'06\) Volume 3](#)

By Cha Zhang , Yong Rui

Issue Date:August 2006

pp. 37-42

We propose a novel framework for tracking non-rigid objects

Model-Based Hand Tracking Using a Hierarchical Bayesian Filter

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Bjorn Stenger , Arasanathan Thayananthan , Philip H.S. Torr , Roberto Cipolla

Issue Date:September 2006

pp. 1372-1384

This paper sets out a tracking framework, which is applied to the recovery of three-dimensional hand motion from an image sequence. The method handles the issues of initialization, tracking, and recovery in a unified way. In a single input image with no pr...

3D Object Tracking Using Shape-Encoded Particle Propagation

Found in: [Eighth International Conference on Computer Vision \(ICCV'01\) - Volume 2](#)

By H. Moon , R. Chellappa , A. Rosenfeld

Issue Date:July 2001

pp. 307

We present a comprehensive treatment of 3D object

Tracking Deforming Objects Using Particle Filtering for Geometric Active Contours

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Yogesh Rathi , Namrata Vaswani , Allen Tannenbaum , Anthony Yezzi

Issue Date:August 2007

pp. 1470-1475

Tracking deforming objects involves estimating the global motion of the object and its local deformations as a function of time. Tracking algorithms using Kalman filters or particle filters have been proposed for finite dimensional representations of shape...

MonoSLAM: Real-Time Single Camera SLAM

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Andrew J. Davison , Ian D. Reid , Nicholas D. Molton , Olivier Stasse

Issue Date:June 2007

pp. 1052-1067

We present a real-time algorithm which can recover the 3D trajectory of a monocular camera, moving rapidly through a previously unknown scene. Our system, which we dub MonoSLAM, is the first successful application of the SLAM methodology from mobile roboti...

Tracking of Human Body Parts using the Multiocular Contracting Curve Density Algorithm

Found in: [Sixth International Conference on 3-D Digital Imaging and Modeling \(3DIM 2007\)](#)

By Markus Hahn , Lars Kruger , Christian Wohler , Horst-Michael Gross

Issue Date:August 2007

pp. 257-264

In this contribution we introduce the Multiocular Con-

M³: Marker-Free Model Reconstruction and Motion Tracking from 3D Voxel Data

Found in: [Computer Graphics and Applications, 12th Pacific Conference on \(PG'04\)](#)

By Edilson de Aguiar , Christian Theobalt , Marcus Magnor , Holger Theisel , Hans-Peter Seidel

Issue Date:October 2004

pp. 101-110

In computer animation, human motion capture from video is a widely used technique to

Multi-Target Tracking Using Hybrid Particle Filtering

Found in: [Seventh IEEE Workshops on Application of Computer Vision \(WACV/MOTION'05\) - Volume 1](#)

By Jens Rittscher , Nils Krahnstoeber , Luis Galup

Issue Date:January 2005

pp. 447-454

We address the problem of multi-target tracking based on

A Color-based Tracking by Kalman Particle Filter

Found in: [17th International Conference on Pattern Recognition \(ICPR'04\) - Volume 3](#)

By Yoshinori Satoh , Takayuki Okatani , Koichiro Deguchi

Issue Date:August 2004

pp. 502-505

In this paper, a method for real-time tracking of moving

Model-Based Tracking by Classification in a Tiny Discrete Pose Space

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Limin Shang , Piotr Jasiobedzki , Michael Greenspan

Issue Date: June 2007

pp. 976-989

A method is presented for tracking 3D objects as they transform rigidly in space within a sparse range image sequence. The method operates in discrete space and exploits the coherence across image frames that results from the relationship between known bou...

Bayesian Filtering for Location Estimation

Found in: [IEEE Pervasive Computing](#)

By Dieter Fox , Jeffrey Hightower , Lin Liao , Dirk Schulz , Gaetano Borriello

Issue Date: July 2003

pp. 24-33

Location awareness is important to many pervasive computing applications. Unfortunately, no location sensor takes perfect measurements or works well in all situations. So, it is crucial to represent uncertainty in sensed location information and combine...

Model-Based Hand Tracking Using a Hierarchical Bayesian Filter

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Bjorn Stenger , Arasanathan Thayananthan , Philip H.S. Torr , Roberto Cipolla

Issue Date: September 2006

pp. 1372-1384

This paper sets out a tracking framework, which is applied to the recovery of three-dimensional hand motion from an image sequence. The method handles the issues of initialization, tracking, and recovery in a unified way. In a single input image with no pr...

Object Tracking with Bayesian Estimation of Dynamic Layer Representations

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Hai Tao , Harpreet S. Sawhney , Rakesh Kumar

Issue Date: January 2002

pp. 75-89

Decomposing video frames into coherent two-dimensional motion layers is a powerful method for representing videos. Such a representation provides an intermediate description that enables applications such as object tracking, video summarization and visu...

Visual Tracking by Continuous Density Propagation in Sequential Bayesian Filtering Framework

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Bohyung Han , Ying Zhu , Dorin Comaniciu , Larry S. Davis

Publication Date: May 2008

pp. N/A

Particle filtering is frequently used for visual tracking problems since it provides a general framework for estimating and propagating probability density functions for non-linear and non-Gaussian dynamic systems. However, this algorithm is based on a Mon...

Object Detection in Video via Particle Filters

Found in: [18th International Conference on Pattern Recognition \(ICPR'06\) Volume 1](#)

By Jacek Czyz

Issue Date: August 2006

pp. 820-823

We propose an object detection method using particle filters.

Automatic Registration of Color and Infrared Videos Using Trajectories Obtained from a Multiple Object Tracking Algorithm

Found in: [2008 Canadian Conference on Computer and Robot Vision](#)

By Fran?ois Morin , Atousa Torabi , Guillaume-Alexandre Bilodeau

Issue Date:May 2008

pp. 311-318

The registration of images from multiple types of sensors (particularly infrared sensors and color sensors) is the first step to achieving multi-sensor fusion. This is the subject of this paper. Registration is performed by using the trajectories of the mo...

An Effective Shape-Texture Weighted Algorithm for Multi-view Face Tracking in Videos

Found in: [2008 Congress on Image and Signal Processing, Vol. 4](#)

By Wing-Pong Choi , Kin-Man Lam

Issue Date:May 2008

pp. 156-160

In this paper, an effective face tracking algorithm based on the combination of shape and texture information is proposed. The edge map is used to represent the shape of a face, while the texture information is characterized by the local binary pattern (LB...

Particle Filter with Multiple Motion Models for Object Tracking in Diving Video Sequences

Found in: [2008 Congress on Image and Signal Processing, Vol. 4](#)

By Beiji Zou , Xiaoning Peng , Liqin Han

Issue Date:May 2008

pp. 224-228

This paper addresses the problem of object tracking in diving video sequences by particle filter. Because the diversity of motions in diving video sequences such as bouncing on the springboard, somersaulting in the air increases the difficulty to construct...

Framework for Performance Evaluation of Face, Text, and Vehicle Detection and Tracking in Video: Data, Metrics, and Protocol

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Rangachar Kasturi , Dmitry Goldgof , Padmanabhan Soundararajan , Vasant Manohar , Matthew Boonstra , Valentina Korzhova , Jing Zhang , Rachel Bowers , John Garofolo

Publication Date: March 2008

pp. N/A

Common benchmark datasets, standardized performance metrics, and baseline algorithms have demonstrated considerable impact on research and development in a variety of application domains. In this paper, we present such a framework for evaluating object det...

SIFT Features Tracking for Video Stabilization

Found in: [14th International Conference on Image Analysis and Processing \(ICIAP 2007\)](#)

By Sebastiano Battiato , Giovanni Gallo , Giovanni Puglisi , Salvatore Scellato

Issue Date:September 2007

pp. 825-830

This paper presents a video stabilization algorithm

Video Tracking Of 2D Face Motion During Speech

Found in: [2006 IEEE International Symposium on Signal Processing and Information Technology](#)

By A.V. Barbosa , E. Vatikiotis-Bateson

Issue Date:August 2006

pp. 791-796

We present a video-based system for tracking 2D face motion during speech. The system tracks dot markers on the speaker's face from video sequences. A digital video camera is used to film the speaker during speech production experiments. The acquired digit...

Segmentation and Tracking of Multiple Humans in Crowded Environments

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Tao Zhao , Ram Nevatia , Bo Wu

Issue Date:July 2008

pp. 1198-1211

Segmentation and tracking of multiple humans in crowded situations is made difficult by interobject occlusion. We propose a model based approach to interpret the image observations by multiple, partially occluded human hypotheses in a Bayesian framework. W...

Fast Multiple Object Tracking via a Hierarchical Particle Filter

Found in: [Tenth IEEE International Conference on Computer Vision \(ICCV'05\) Volume 1](#)

By Changjiang Yang , Ramani Duraiswami , Larry Davis

Issue Date:October 2005

pp. 212-219

A very efficient and robust visual object tracking algorithm

Approximate Bayesian Multibody Tracking

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Oswald Lanz

Issue Date:September 2006

pp. 1436-1449

Visual tracking of multiple targets is a challenging problem, especially when efficiency is an issue. Occlusions, if not properly handled, are a major source of failure. Solutions supporting principled occlusion reasoning have been proposed but are yet unp...

Looking at People: Sensing for Ubiquitous and Wearable Computing

Found in: [IEEE Transactions on Pattern Analysis and Machine Intelligence](#)

By Alex Pentland

Issue Date:January 2000

pp. 107-119

Abstract—The research topic of looking at people, that is, giving machines the ability to detect, track, and identify people and more generally, to interpret human behavior, has become a central topic in machine vision research. In...

Active Blobs

Found in: [Sixth International Conference on Computer Vision \(ICCV'98\)](#)

By Stan Sclaroff , John Isidoro

Issue Date:January 1998

pp. 1146

A new region-based approach to nonrigid motion tracking is described. Shape is defined in terms of a deformable triangular mesh that captures object shape plus a color texture map that captures object appearance. Photometric variations are also modeled. No...

3.3 Články – Web of Science

Title: [Deriving and evaluating eye-tracking controlled volumes of interest for variable-resolution video compression](#)
Author(s): Nystrom M, Holmqvist K
Source: JOURNAL OF ELECTRONIC IMAGING Volume: 16 Issue: 1 Article Number: 013006 Published: JAN-MAR 2007
Times Cited: 0

Title: [3-D model-based frame interpolation for distributed video coding of static scenes](#)
Author(s): Maitre M, Guillemot C, Morin L
Source: IEEE TRANSACTIONS ON IMAGE PROCESSING Volume: 16 Issue: 5 Pages: 1246-1257 Published: MAY 2007
Times Cited: [1](#)

Title: [A Stochastic framework for rate-distortion optimized video coding over error-prone networks](#)
Author(s): Harmanci O, Tekalp AM
Source: IEEE TRANSACTIONS ON IMAGE PROCESSING Volume: 16 Issue: 3 Pages: 684-697 Published: MAR 2007
Times Cited: 0

Title: [Semi-regular representation and progressive compression of 3-D dynamic mesh sequences](#)
Author(s): Yang JH, Kim CS, Lee SU
Source: IEEE TRANSACTIONS ON IMAGE PROCESSING Volume: 15 Issue: 9 Pages: 2531-2544 Published: SEP 2006
Times Cited: 0

Title: [An affine-based algorithm and SIMD architecture for video compression with low bit-rate applications](#)
Author(s): Sayed M, Badawy W
Source: IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY Volume: 16 Issue: 4 Pages: 457-471 Published: APR 2006
Times Cited: [2](#)

Title: [Fast object tracking using adaptive block matching](#)
Author(s): Hariharakrishnan K, Schonfeld D
Source: IEEE TRANSACTIONS ON MULTIMEDIA Volume: 7 Issue: 5 Pages: 853-859 Published: OCT 2005
Times Cited: [3](#)

Title: [Motion layer extraction in the presence of occlusion using graph cuts](#)
Author(s): Xiao JJ, Shah M
Source: IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE Volume: 27 Issue: 10 Pages: 1644-1659 Published: OCT 2005
Times Cited: [8](#)

Title: [Automatic moving object extraction or content-based applications](#)
Author(s): Xu HF, Younis AA, Kabuka MR
Source: IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY Volume: 14 Issue: 6 Pages: 796-812 Published: JUN 2004

Times Cited: [5](#)

Title: [A neuro-fuzzy approach for segmentation of human objects in image sequences](#)

Author(s): Lee SJ, Ouyang CS, Du SH

Source: IEEE TRANSACTIONS ON SYSTEMS MAN AND CYBERNETICS PART B-CYBERNETICS Volume: 33 Issue: 3 Pages: 420-437 Published: JUN 2003

Times Cited: [4](#)

Title: [Object tracking with Bayesian estimation of dynamic layer representations](#)

Author(s): Tao H, Sawhney HS, Kumar R

Source: IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE Volume: 24 Issue: 1 Pages: 75-89 Published: JAN 2002

Times Cited: [27](#)

Title: [Monitoring human behavior from video taken in an office environment](#)

Author(s): Ayers D, Shah M

Source: IMAGE AND VISION COMPUTING Volume: 19 Issue: 12 Pages: 833-846 Published: OCT 1 2001

Times Cited: [16](#)

[Full Text](#)

Title: [An efficient parallel algorithm for motion estimation in very low bit-rate video coding systems](#)

Author(s): Konstantopoulos C, Svolos A, Kaklamanis C

Source: CONCURRENCY-PRACTICE AND EXPERIENCE Volume: 12 Issue: 5 Pages: 289-309 Published: APR 25 2000

Times Cited: 0

Title: [Affine-structure-based facial image encoding](#)

Author(s): Chatterjee S, Banerjee S, Biswas KK

Source: IEE PROCEEDINGS-VISION IMAGE AND SIGNAL PROCESSING Volume: 146 Issue: 4 Pages: 211-221 Published: AUG 1999

Times Cited: 0

Title: [Video tracking using morphological pyramids](#)

Author(s): Segall CS, Chen W, Acton ST

Source: JOURNAL OF ELECTRONIC IMAGING Volume: 8 Issue: 2 Pages: 176-184 Published: APR 1999

Times Cited: [2](#)

Title: [Trifocal motion modeling for object-based video compression and manipulation](#)

Author(s): Sun ZH, Tekalp AM

Source: IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY Volume: 8 Issue: 5 Pages: 667-685 Published: SEP 1998

Times Cited: [5](#)

Title: [MOTION CODING OF IMAGE PRIMITIVES](#)

Author(s): ZHANG S, LIANG MQ, ROBINSON JA, et al.

Source: SIGNAL PROCESSING-IMAGE COMMUNICATION Volume: 7 Issue: 4-6 Pages: 457-469 Published: NOV 1995

Times Cited: 0

[Full Text](#)

Title: [INTELLIGENT IMAGE INTERPRETATION FOR HIGH-COMPRESSION HIGH-QUALITY SEQUENCE CODING](#)

Author(s): BEDINI G, FAVALLI L, MARAZZI A, et al.

Source: EUROPEAN TRANSACTIONS ON TELECOMMUNICATIONS Volume: 6 Issue: 3 Pages: 255-265 Published: MAY-JUN 1995

Times Cited: [1](#)

3.4 Časopisy

Zdroj <http://www.ulrichsweb.com/ulrichsweb>

Záznam 1

ISSN: 0179-2555

Title: Augen-Blick: Marburger Hefte zur Medienwissenschaft

Publishing Body: Schueren Verlag GmbH

Country: Germany

Frequency: Irregular

Language: Text in German

Subject: MOTION PICTURES
COMMUNICATIONS - VIDEO

Záznam 2

ISSN: 1050-9208

Title: Quarterly Review of Film and Video

Publishing Body: Routledge

Country: United States

Frequency: 5 times a year

Language: Text in English

Subject: MOTION PICTURES
COMMUNICATIONS - VIDEO

URL: <http://www.tandf.co.uk/journals/titles/10509208.asp>

Document [British Library Document Supply Centre \(7206.700000\) Information Express](#)

Availability: [IngentaConnect](#)

Záznam 3

ISSN: 1468-2753

Title: Journal of Media Practice

Publishing Body: Intellect Ltd.

Country: United Kingdom

Frequency: 3 times a year

Language: Text in English

Subject: COMMUNICATIONS
COMMUNICATIONS - TELEVISION AND CABLE
COMMUNICATIONS - VIDEO
EDUCATION - TEACHING METHODS AND CURRICULUM

URL: <http://www.intellectbooks.co.uk/journals.php?issn=14682753>

Description: Contains articles that build a profile of established and innovative practical approaches to teaching and research, providing and interdisciplinary forum where practice in one field stimulates thinking in another. Encourages analysis of practical work on the shifting boundaries between existing and emerging media forms and explores paths that connect education with creative and industry oriented practice.

Document Availability: [British Library Document Supply Centre \(5017.045700\) Information Express IngentaConnect](#)

Záznam 4

ISSN: 0300-7472

Title: Afterimage: the journal of media arts and cultural criticism in the social and decision sciences

Publishing Body: Visual Studies Workshop

Country: United States

Frequency: Bi-monthly

Language: Text in English

Subject: PHOTOGRAPHY
COMMUNICATIONS - VIDEO

MOTION PICTURES

- URL: <http://www.vsw.org/afterimage/>
- Description: Presents independent critical commentary on issues in media arts, including scholarly research, in-depth and bite-size reviews, and investigative journalism.
- Document Availability: [British Library Document Supply Centre \(0735.632000\) Information Express Infotrieve IngentaConnect](#)
- Free Sample Available: Yes, contact Vydavatel.

Záznam 5

- Title: Educators Guide to Free Videotapes (Secondary Edition)
- Publishing Body: Educators Progress Service, Inc.
- Country: United States
- Frequency: Annual
- Language: Text in English
- Subject: EDUCATION - TEACHING METHODS AND CURRICULUM COMMUNICATIONS - VIDEO
- Description: Lists free videotapes specially suited for students in grades K-8.

Záznam 6

- ISSN: 1520-281X
- Title: P A J: a journal of performance and art
- Publishing Body: M I T Press
- Country: United States
- Frequency: 3 times a year
- Language: Text in English
- Subject: THEATER
MUSIC
COMMUNICATIONS - VIDEO
- URL: <http://www.mitpress.mit.edu/paj>

Description: Integrates theater and the visual arts in charting the directions of new work in performance, video, film, and music. Featured in the issues are artists' writings, critical commentary, interviews and dialogues, historical documents, critical commentary, performance texts and plays.

Document Availability: [British Library Document Supply Centre \(6340.433800\) Information Express](#)
[IngentaConnect](#)
[Thomson Reuters, Scientific](#)

Free Sample Yes, contact Vydavatel.
Available:

Záznam 7

ISSN: 0742-4671

Title: Journal of Film and Video

Publishing Body: University of Illinois Press

Country: United States

Frequency: Quarterly

Language: Text in English

Subject: MOTION PICTURES
COMMUNICATIONS - TELEVISION AND CABLE
COMMUNICATIONS - VIDEO

URL: <http://www.press.uillinois.edu/journals/jfv.html>

Description: Publishes scholarly articles on film and television history, theory and production. Mission includes media pedagogy.

Document Availability: [British Library Document Supply Centre \(4984.190000\) Information Express](#)
[Infotrieve](#)
[IngentaConnect](#)
[Thomson Reuters, Scientific](#)

Záznam 8

ISSN: 1125-1727

Title: Cinema Studio
Publishing Body: Bulzoni Editore
Country: Italy
Frequency: Irregular
Language: Text in Italian
Subject: MOTION PICTURES
COMMUNICATIONS - VIDEO

Záznam 9

ISSN: 1863-1703
Title: Signal, Image and Video Processing
Publishing Body: Springer U K
Country: United Kingdom
Frequency: Quarterly
Language: Text in English
Subject: COMMUNICATIONS - VIDEO
Description: Targeted to engineers and scientists. Designed to disseminate research results and engineering developments, and present practical solutions for current processing problems.

Document Availability: [Information](#) [Express](#)
[Institut de l'Information Scientifique et Technique \(INIST-CNRS\)](#)

Záznam 10

ISSN: 1051-8215
Title: I E E E Transactions on Circuits and Systems for Video Technology
Publishing Body: I E E E
Country: United States
Frequency: Monthly
Language: Text in English

Subject: ELECTRONICS
COMMUNICATIONS - VIDEO

Description: Covers video processing algorithms, real-time implementation, VLSI architecture and technology, and related topics.

Document Availability: [AskIEEE](#)
[British Library Document Supply Centre \(4363.166500\)](#)
[C I S T I](#)
[Information Express](#)
[Infotrieve](#)
[IngentaConnect](#)
[Institut de l'Information Scientifique et Technique \(INIST-CNRS\)](#)
[Linda Hall Library of Science, Engineering & Technology, Document Delivery Services](#)
[Thomson Reuters, Scientific](#)

Záznam 11

Title: Regent Online Journal of Communication

Publishing Body: Regent University, College of Communication and the Arts

Country: United States

Frequency: Semi-annually

Language: Text in English

Subject: MOTION PICTURES
COMMUNICATIONS - VIDEO

URL: <http://www.regent.edu/acad/schcom/rojcc/rojcc.html>

Záznam 12

ISSN: 1550-3917

Title: Educators Guide to Free Videotapes (Elementary/Middle School Edition)

Publishing Body: Educators Progress Service, Inc.

Country: United States

Frequency: Annual (3rd Ed.)

Language: Text in English

Subject: EDUCATION - TEACHING METHODS AND CURRICULUM
COMMUNICATIONS - VIDEO

URL: http://www.freeteachingaids.com/vfc_877083460.html

Záznam 13

ISSN: 1744-9901

Title: Talking Images

Publishing Body: Berg Vydavatel's

Country: United Kingdom

Frequency: Irregular

Language: Text in English

Subject: MOTION PICTURES
COMMUNICATIONS - TELEVISION AND CABLE
COMMUNICATIONS - VIDEO

Description: Publishes radical (and classic) work on the key art form of modern times, the moving image. Focusing chiefly on film - but also encompassing video, TV and digital imaging - the series brings together philosophers, critics, directors and artists to analyze the central role of the visual in contemporary culture.

Záznam 14

ISSN: 1687-5176

Title: Eurasip Journal on Image and Video Processing

Publishing Body: Hindawi Publishing Corp.

Country: United States

Frequency: Irregular

Language: Text in English

Subject: COMMUNICATIONS - VIDEO

Bibliographic notes: Previously announced as: International Journal of Image and Video Processing

URL: <http://www.hindawi.com/journals/ivp/>

Description: Covers all theoretical and practical aspects of image and video processing, from basic research to application development.

Záznam 15

ISSN: 1326-8694

Title: Mesh: film video - digital media - installation - performance - art

Publishing Body: Experimenta Media Arts

Country: Australia

Frequency: Annual

Language: Text in English

Subject: ART
MOTION PICTURES
COMMUNICATIONS - VIDEO

URL: <http://www.experimenta.org>

Description: Covers experimental media arts, including digital media, film, video, sound, performance, installation and visual arts.

Záznam 16

ISSN: 0847-5911

Title: Canadian Journal of Film Studies

Publishing Body: Film Studies Association of Canada

Country: Canada

Frequency: Semi-annually

Language: Text in English, French

Subject: MOTION PICTURES
COMMUNICATIONS - TELEVISION AND CABLE
COMMUNICATIONS - VIDEO

URL: <http://www.film.queensu.ca/FSAC/CJFS.html>

Description: Publishes articles on history, theory and criticism of film and television.

Záznam 17

ISSN: 1571-2559

Title: Mediamatic Off-Line

Publishing Body: Mediamatic Foundation

Country: Netherlands

Frequency: Irregular

Language: Text in Dutch, English

Subject: ART
COMMUNICATIONS - VIDEO
ART - COMPUTER APPLICATIONS

Description: Covers books, films, software reviews, illustrations.

Document Availability: [Information Express](#)

3.5 Knihy dostupné v knihovnách

Zde uvedené knihy jsou dostupné v knihovnách v ČR a zahraničí – zdroj Jednotná informační brána - <http://www.jib.cz/>

[Automatic Text Detection and Tracking in Digital Video.](#) - Doermann,David.1998

Text which either appears in a scene or is graphically added to video can provide an important supplemental source of index information as well as clues for decoding the video's structure and for classification. In this paper we present algorithms for detecting and tracking text components that appear within digital video frames. Our system implements a scale-space ...

[An Appearance Based Approach for Human and Object Tracking.](#) - Balcells Capellades,Marti.2002

[Tracking Deforming Objects using Particle Filtering for Geometric Active Contours.](#) - Tannenbaum,Allen. 2007

Tracking deforming objects involves estimating the global motion of the object and its local deformations as a function of time. Tracking algorithms using Kalman filters or particle filters have been proposed for finite dimensional representations of shape, but these are dependent on the chosen parametrization and cannot handle changes in curve topology. Geometric active contours provide a framework which is parametrization independent and ...

[Adaptation of Panoramic Annular Lens \(PAL\) to Some Military Video Systems.](#) - Greguss,Pal. 2000

This report results from a contract tasking OPTOPAL Panoramic Metrology Consulting as follows: This investigation will consist of adaptation of a Hungarian-developed single-piece imaging block, the Panoramic Annular Lens (PAL) to a few military applications. A multipurpose breadboard platform will be constructed to test the optimized ...

[Real-Time Multi-Resolution Blob Tracking.](#) - Francois,Alexandre R. 2004

[Analyzing video sequences of multiple humans tracking, posture estimation and behavior recognition](#) - Ohya, Jun ctua000150043, 2002

[Evaluation of digitized video frames from the queos experiment with cold solid spheres results of image analysis experiment Q02](#) - Vavřín, J., 1995

[Thirty frames per second the visionary art of the music video](#) - Reiss, Steve aut, 2000

[Application of speech rate conversion technology to video editing allows up to 5 times normal speed playback while maintaining speech intelligibility](#) - Imai, Atsushi aut, 2001

[Efficient algorithms for MPEG video compression](#) - Hoang, Dzung Tien aut, 2002

[H.264 and MPEG-4 video compression video coding for next-generation multimedia](#) - Richardson, Iain E. G. ctua000321148 aut, 2003

[Image and Video Compression Standards Algorithms and architectures](#) - Bhaskaran, Vasudev aut, 1997

[Kompresa digitálních obrazových signálů The compression of digital video signals : obor Elektronika, měřičí a sdělovací technika](#) - Chromý, Ivo 1974- ola2002100926 aut, 2001

[Komprimace obrazových signálů pomocí transformace 3D DCT Video signal compression using 3D DCT transform : zkrácená verze Ph.D. Thesis](#), Frýza, Tomáš 1977- jo2007416178 dis, 2007

[Motion estimation algorithms for video compression](#) - Furht, Borivoje xx0018504 aut, 1997

[Video compression and communications from basics to H.261, H.263, H.264, MPEG2, MPEG4 for DVB and HSDPA-style adaptive turbo-transceivers](#) - Hanzo, Lajos 1952- aut, 2007

[Image and video compression standards algorithms and architectures](#) - Bhaskaran, Vasudev aut, 1995

[Program na prehrávanie videosekvencií](#) - Juhász, Peter 1982- [absolvent FI MU] UČO 50739 dis, 2008

Predmetom tejto práce je popísať jednotlivé formáty pre uloženie videosekvencií (AVI, MPEG, Quicktime) a popísať základy kompresie digitálneho videa. V práci je uvedený aj krátky popis jednotlivých kodekov a výsledok ich porovnania z hľadiska kvality výsledného obrazu a kompresného pomeru...

[Komprese obrazu v interaktivních aplikacích digitálního televizního vysílání Image compression in interactive applications in digital video broadcasting : zkrácená verze Ph.D. Thesis](#) - Bodeček, Kamil 1981- mzk2008442788 dis, 2008

[Způsoby komprimace videa, jejich výhody, nevýhody a možnosti využití](#) - Munduch, Tomáš dis, 2005

Porovnání nejpoužívanějších způsobů komprimace videa (kodeky), jejich vývojem a trendy

[Digital compression of still images and video](#) - Clarke, R. J. aut, 1995

[Signal compression coding of speech, audio, text, image and video](#) - Jayant, Nikil edt, 1997

[A practical guide to video and audio compression from sprockets and rasters to macroblocks](#) - Wootton, Cliff xx0042938 aut, 2005

[Beyond the Kalman filter particle filters for tracking applications](#) - Ristic, Branko aut, 2004

[Data assimilation the ensemble Kalman filter](#) - Evensen, Geir, 2007

[Estimation, control, and the discrete Kalman filter](#) - Catlin, Donald E. aut, 1989

[Forecasting, structural time series models and the Kalman filter](#) - Harvey, Andrew C. aut, 1996

[Softwarová podpora zpracování signálů s využitím Kalmanovy filtrace Software support for signal processing based on the Kalman filter utilization : teze disertační práce](#) - Popek, Jiří mzk2007417557 dis, 2007

[Data assimilation the ensemble kalman filter](#) - Evensen, Geir aut, 2007

[Forecasting, structural time series models and the Kalman filter](#) - Harvey, Andrew C. aut, 1991

[Kalman-Filter und - Glättung und deren Anwendung auf Erwartungsbildungsmechanismen Dissertation](#) - Weymann, Peter 1954- dis, 1987