Literature Review

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Tez Başlığı :	EXPLORATORY SEARCH THROUGH LARGE VIDEO CORPORA
Yazar :	GREGORY D. CASTAÑÓN
Üniversite :	Boston University, College of Engineering
Yıl :	2016

ABSTRACT

Activity retrieval is a growing field in electrical engineering that specializes in the search and retrieval of relevant activities and events in video corpora. With the affordability and popularity of cameras for government, personal and retail use, the quantity of available video data is rapidly outscaling our ability to reason over it. Towards the end of empowering users to navigate and interact with the contents of these video corpora, we propose a framework for exploratory search that emphasizes activity structure and search space reduction over complex feature representations.

Exploratory search is a user driven process wherein a person provides a system with a query describing the activity, event, or object he is interested in finding. Typically, this description takes the implicit form of one or more exemplar videos, but it can also involve an explicit description. The system returns candidate matches, followed by query refinement and iteration. System performance is judged by the run-time of the system and the precision/recall curve of of the query matches returned.

Scaling is one of the primary challenges in video search. From vast web-video archives like youtube (1 billion videos and counting) to the 30 million active surveillance cameras shooting an estimated 4 billion hours of footage every week in the United States, trying to find a set of matches can be like looking for a needle in a haystack. Our goal is to create an efficient archival representation of video corpora that can be calculated in real-time as video streams in, and then enables a user to quickly get a set of results that match.

First, we design a system for rapidly identifying simple queries in large-scale video corpora. Instead of focusing on feature design, our system focuses on the spatiotemporal

relationships between those features as a means of disambiguating an activity of interest from background. We define a semantic feature vocabulary of concepts that are both readily extracted from video and easily understood by an operator. As data streams in, features are hashed to an inverted index and retrieved in constant time after the system is presented with a user's query.

We take a zero-shot approach to exploratory search: the user manually assembles vocabulary elements like color, speed, size and type into a graph. Given that information, we perform an initial downsampling of the archived data, and design a novel dynamic programming approach based on genome-sequencing to search for similar patterns. Experimental results indicate that this approach outperforms other methods for detecting activities in surveillance video datasets.

Second, we address the problem of representing complex activities that take place over long spans of space and time. Subgraph and graph matching methods have seen limited use in exploratory search because both problems are provably N P -hard. In this work, we render these problems computationally tractable by identifying the maximally discriminative spanning tree (MDST), and using dynamic programming to optimally reduce the archive data based on a custom algorithm for tree-matching in attributed relational graphs. We demonstrate the efficacy of this approach on popular surveillance video datasets in several modalities.

Finally, we design an approach for successive search space reduction in subgraph matching problems. Given a query graph and archival data, our algorithm iteratively selects spanning trees from the query graph that optimize the expected search space reduction at each step until the archive converges. We use this approach to efficiently reason over video surveillance datasets, simulated data, as well as large graphs of protein data.

Tez Başlığı :	IMPROVED GEO-REFERENCING AND PRE-SCREENING FOR DETECTION OF BURIED EXPLOSIVE HAZARDS IN FORWARD-LOOKING INFRARED IMAGERY
Yazar :	KEVIN E. STONE
Üniversite :	University of Missouri
Yıl :	2014

ABSTRACT

A new method for geo-referencing - the act of assigning location in physical space - of infrared imagery collected from a single camera on a moving platform under the assumption of a piecewise planar world is proposed and evaluated. The purpose is to develop an algorithm with less computational complexity than an arbitrary structure from motion approach, but with better accuracy than a naïve flat earth model approach. The proposed algorithm is used in conjunction with a forward-looking buried explosive hazard detection system which consists of an infrared camera mounted on a moving platform equipped with an inertial navigation system. This system requires fast and accurate geo-referencing in order to convert alarms detected in the captured images to world coordinates.

A new prescreening algorithm for detection of buried explosive hazards in infrared imagery is also proposed. The new algorithm uses a sliding window detector which extracts multi-scale histogram of oriented gradient features in a cell-structured fashion from dual grids centered inside the detection window. The feature vectors are classified using a SVM. This detector is compared to an existing prescreening algorithm that uses an ensemble of local RX anomaly detection filters trained via genetic algorithm. The proposed approach is shown to perform better across multiple cameras and data sets, and it does not require image preprocessing, such as contrast enhancement or denoising. Techniques for fast training and prediction of SVMs using additive kernels are combined. This allows the use of the non-linear histogram intersection and additive chi-square kernels with training time of a linear kernel SVM and prediction time independent of the number of support vectors.

Tez Başlığı :	Labeling Large Scale Image Datasets: Exploring Priors, Semantics and Scalability
Yazar :	Vignesh Jagadeesh
Üniversite :	University of California
Yıl :	2013

Recent advances in high throughput imaging have led to the creation of massive image repositories, where human analysis is often infeasible. Automated image analysis offers a promising alternative for reducing analysis time by several orders of magnitude. In order to design algorithms that are robust and practically usable, there are a variety of design considerations that require investigation.

This dissertation explores three specific considerations in visual segmentation and detection, namely domain specific priors, scalability, and semantics inherent in the data. The first part of this work proposes a framework that adapts a generic segmentation/tracing technique to application specific ones using priors such as topological dynamics and shape in a Markov Random Field (MRF) setting.

Subsequently, techniques to scale algorithms for tracing a large number of targets are explored. These tracing algorithms are based on graph diffusion, and are capable of scaling gracefully with increasing number of targets. The final part of this work explores semantic attributes that humans utilize for object detection in weakly supervised settings. Kernel methods are utilized to learn classifiers in multiple feature spaces proposed in this work for detecting non-rigid objects. This work adopts the problem of connectomics (neuronal circuit reconstruction from Electron Micrographs) to illustrate the applicability of proposed techniques. Specifically, the segmentation and tracing algorithms are shown to isolate neuronal structures in 3D while the detection algorithms localize synaptic junctions, thus taking a step closer to automated neural circuit constructions from raw image data. Further, the proposed algorithms are also applied on natural image and video data to illustrate their generalization capability.

Tez Başlığı	:	Understanding Activity from Trajectory Patterns
Yazar	:	Brendan Tran Morris
Üniversite	:	University of California
Yıl	:	2010

A fundamental goal of Computer Vision is to provide scene understanding and situational awareness. In order to deliver on this promise, traditional monitoring systems were designed for specific environmental situations, such as a specific time, place, or activity scenario. A well versed expert defines the events of interest by hand for the particular application. While effective, these techniques do not scale well, they typically have poor generalization, are inflexible to behavioral changes, and the analysis rules may not reflect the true nature of the scene but a priori expectations. The conventional methods to understand activities must be scaled to match growing need. Society's rapid acceptance of video use in a wide variety of locations and applications has promoted the deployment of large camera networks. These networks monitor complex scenes and deliver volumes of video data that can not be digested without automated assistance.

This dissertation investigates unsupervised activity understanding by analyzing patterns of motion trajectories. A practical approach is introduced and carefully developed to overcome the difficulties with trajectory learning, namely the definition of a simple activity model that can be robustly inferred from crude measurements, the automatic determination of the number of typical activities in a scene, and methods to observe dynamic scenes over long periods. The activity analysis framework is able to process and analyze activity, providing activity characterization, prediction, and abnormality detection, in real-time for real world utility.

The efficacy of the trajectory learning framework is demonstrated in three distinct arenas. Highway traffic is monitored using a single camera with the VECTOR system, multiple sensors are integrated and combined in a unified space with CANVAS, and driving maneuvers analyzed from within a moving automobile. This extension of the trajectory learning paradigm to a broad range of (untouched) application spaces further highlights the dissertation contributions. Finally, extensive performance evaluation and characterization is conducted to provide a missing benchmark for the field.

Tez Başlığı :	Utilization of Robust Video Processing Techniques to Aid Efficient Object Detection and Tracking
Yazar :	Anand Balasubramanian
Üniversite :	Texas A&M University-Kingsville
Yıl :	2014

The primary source of information perused by Homeland Security is the images captured by surveillance cameras and Unmanned Aerial Vehicles (UAVs). In this research, data acquired by Unmanned Aerial Vehicles (UAVs) is primarily used to detect and track moving objects which pose a major security threat along the United States southern border. Factors such as camera motion, poor illumination and noise make detection and tracking of moving objects in surveillance videos a formidable task. The main objective of this research is to provide a less ambiguous image data for object detection and tracking by means of noise reduction, image enhancement, video stabilization, and illumination restoration. The improved data is later utilized to detect and track moving objects in surveillance videos. An optimization based image enhancement scheme was successfully implemented to increase edge information to facilitate object detection. Noise present in the raw video captured by the UAV was efficiently removed using search and match methodology. Undesired motion induced in the video frames was eliminated using block matching technique. Simulation results shows the efficiency of these image processing algorithms in processing noisy, un-stabilized raw video sequences which were utilized to detect and track moving objects in the video sequences.

Tez Başlığı :	Unsupervised methods to discover events from spatio-temporal data
Yazar :	Xi Chen
Üniversite :	UNIVERSITY OF MINNESOTA
Yıl :	2017

Abstract

Unsupervised event detection in spatio-temporal data aims to autonomously identify when and/or where events occurred with little or no human supervision. It is an active field of research with notable applications in social, Earth, and medical sciences. While event detection has enjoyed tremendous success in many domains, it is still a challenging problem due to the vastness of data points, presence of noise and missing values, the heterogeneous nature of spatio-temporal signals, and the large variety of event types. Unsupervised event detection is a broad and yet open research area. Instead of exploring every aspect in this area, this dissertation focuses on four novel algorithms that covers two types of important events in spatio-temporal data: change-points and moving regions.

The first algorithm in this dissertation is the Persistence-Consistency (PC) framework. It is a general framework that can increase the robustness of change-point detection algorithms to noise and outliers. The major advantage of the PC framework is that it can work with most modeling-based change-point detection algorithms and improve their performance without modifying the selected change-point detection algorithm. We use two real-world applications, forest fire detection using a satellite dataset and activity segmentation from a mobile health dataset, to test the effectiveness of this framework.

The second and third algorithms in this dissertation are proposed to detect a novel type of change point, which is named as contextual change points. While most existing change points more or less indicate that the time series is different from what it was before, a contextual change point typically suggests an event that causes the relationship of several time series changes. Each of these two algorithms introduces one type of contextual change point and also presents an algorithm to detect the corresponding type of change point. We demonstrate the unique capabilities of these approaches with two applications: event detection in stock market data and forest fire detection using remote sensing data.

The final algorithm in this dissertation is a clustering method that discovers a particular type of moving regions (or dynamic spatio-temporal patterns) in noisy, incomplete, and heterogeneous data. This task faces two major challenges: First, the regions (or clusters) are dynamic and may change in size, shape, and statistical properties over time. Second, numerous spatio-temporal data are incomplete, noisy, heterogeneous, and highly variable (over space and time). Our proposed approach fully utilizes the spatial

contiguity and temporal similarity in the spatio-temporal data and, hence, can address the above two challenges. We demonstrate the performance of the proposed method on a real-world application of monitoring in-land water bodies on a global scale.

Tez Başlığı :	STOCHASTIC CONTROL APPROACHES FOR SENSOR MANAGEMENT IN SEARCH AND EXPLOITATION
Yazar :	Darin Chester Hitchings
Üniversite :	Boston University
Yıl :	2010

ABSTRACT

Recent improvements in the capabilities of autonomous vehicles have motivated their increased use in such applications as defense, homeland security, environmental monitoring, and surveillance. To enhance performance in these applications, new algorithms are required to control teams of robots autonomously and through limited interactions with human operators. In this dissertation we develop new algorithms for control of robots performing information-seeking missions in unknown environments. These missions require robots to control their sensors in order to discover the presence of objects, keep track of the objects, and learn what these objects are, given a fixed sensing budget.

Initially, we investigate control of multiple sensors, with a finite set of sensing options and finite-valued measurements, to locate and classify objects given a limited resource budget. The control problem is formulated as a Partially Observed Markov Decision Problem (POMDP), but its exact solution requires excessive computation. Under the assumption that sensor error statistics are independent and time-invariant, we develop a class of algorithms using Lagrangian Relaxation techniques to obtain optimal mixed strategies using performance bounds developed in previous research. We investigate alternative Receding Horizon (RH) controllers to convert the mixed strategies to feasible adaptive-sensing strategies and evaluate the relative performance of these controllers in simulation. The resulting controllers provide superior performance to alternative algorithms proposed in the literature and obtain solutions to large-scale POMDP problems several orders of magnitude faster than optimal Dynamic Programming (DP) approaches with comparable performance quality.

We extend our results for finite action, finite measurement sensor control to scenarios with moving objects. We use Hidden Markov Models (HMMs) for the evolution of objects, according to the dynamics of a birth-death process. We develop a new lower bound on the performance of adaptive controllers in these scenarios, develop algorithms for computing solutions to this lower bound, and use these algorithms as part of a RH controller for sensor allocation in the presence of moving objects.

We also consider an adaptive Search problem where sensing actions are continuous and the underlying measurement space is also continuous. We extend our previous hierarchical decomposition approach based on performance bounds to this problem and develop novel implementations of Stochastic Dynamic Programming (SDP) techniques to solve this problem. Our algorithms are nearly two orders of magnitude faster than previously proposed approaches and yield solutions of comparable quality.

For supervisory control, we discuss how human operators can work with and augment robotic teams performing these tasks. Our focus is on how tasks are partitioned among teams of robots and how a human operator can make intelligent decisions for task partitioning. We explore these questions through the design of a game that involves robot automata controlled by our algorithms and a human supervisor that partitions tasks based on different levels of support information. This game can be used with human subject experiments to explore the effect of information on quality of supervisory control.

Tez Başlığı :	MULTI-AGENT PERSISTENT SURVEILLANCE UNDER TEMPORAL LOGIC CONSTRAINTS
Yazar :	KEVIN LEAHY
Üniversite :	Boston University
Yıl :	2017

ABSTRACT

This thesis proposes algorithms for the deployment of multiple autonomous agents for persistent surveillance missions requiring repeated, periodic visits to regions of interest. Such problems arise in a variety of domains, such as monitoring ocean conditions like temperature and algae content, performing crowd security during public events, tracking wildlife in remote or dangerous areas, or watching traffic patterns and road conditions. Using robots for surveillance is an attractive solution to scenarios in which fixed sensors are not sufficient to maintain situational awareness. Multi-agent solutions are particularly promising, because they allow for improved spatial and temporal resolution of sensor information.

In this work, we consider persistent monitoring by teams of agents that are tasked with satisfying missions specified using temporal logic formulas. Such formulas allow rich, complex tasks to be specified, such as "visit regions A and B infinitely often, and if region C is visited then go to region D, and always avoid obstacles." The agents must determine how to satisfy such missions according to fuel, communication, and other constraints. Such problems are inherently difficult due to the typically infinite horizon, state space explosion from planning for multiple agents, communication constraints, and other issues. Therefore, computing an optimal solution to these problems is often infeasible. Instead, a balance must be struck between computational complexity and optimality.

This thesis describes solution methods for two main classes of multi-agent persistent surveillance problems. First, it considers the class of problems in which persistent surveillance goals are captured entirely by TL constraints. Such problems require agents to repeatedly visit a set of surveillance regions in order to satisfy their mission. We present results for agents solving such missions with charging constraints, with noisy observations, and in the presence of adversaries. The second class of problems include an additional optimality criterion, such as minimizing uncertainty about the location of a target or maximizing sensor information among the team of agents. We present solution methods and results for such missions with a variety of optimality criteria based on information metrics. For both classes of problems, the proposed algorithms are implemented and evaluated via simulation, experiments with robots in a motion capture environment, or both.