Tutorials

November 11, 2012, 09:30-13:00 ICPR2012 Tutorials AM-01

Computer vision and image analysis in the study of master drawings and paintings (Part I)

November 11, 2012, 14:00-17:30 ICPR2012 Tutorials PM-01

Computer vision and image analysis in the study of master drawings and paintings (Part II)

Lecturer:
David G. Stork
Rambus Labs, USA

Abstract:
These half-day tutorials will apply methods from image processing, computer vision and pattern recognition to problems in the history and understanding of master paintings. Some of these analysis techniques are built upon methods used in forensic image analysis of photographs but are tailored to specific contingencies of painting. Questions addressed include: How do we judge the sizes and positions of objects depicted and the geometry of structures such as architecture? Was the image created using a mechanical or optical aid? What were the sources of illumination and their color? What form of perspective was used? What is revealed by shadows and reflections depicted within a painting? Some of the analysis techniques require nothing more than a tutored and perceptive eye; others merely a ruler and pencil; yet others require advanced statistical estimation procedures and computer analysis. This course is based almost entirely on the analysis of images, not the physical or chemical analysis of pigments and media, the purview of traditional art conservators.

Tutorials

November 11, 2012, 09:30-13:00 ICPR2012 Tutorials AM-02

Half-quadratic Optimization for Sparsity Estimation and Robust Learning in Pattern Recognition

Lecturer:

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**Sun Yat-sen University, China

Abstract:

In the past decade, half-quadratic (HQ) optimization has become increasingly popular for solving computational problems in sparsity estimation and robust learning, which is important for computer vision, image processing, and pattern recognition. In this half-day tutorial, we present basic theory and techniques of HQ optimization, as well as its applications in compressed sensing and pattern recognition. In addition, from the HQ perspective, we also give a general framework of the current developments in compressed sensing, including L1-minimization, robust sparse representation, low-rank matrix recovery and structured sparsity. Most of these developments can be simplified to the additive and multiplicative forms of HQ. Such a HQ perspective will help attendees to better understand the intrinsic relationship between several state-of-the-art methods in compressed sensing. It also motivates the development of HQ optimization to solve pattern recognition problems in the near future.

This tutorial only requires minimum knowledge of convex optimization and some basic knowledge in graduate-level pattern recognition. It includes four parts. First, we introduce the basic concept of HQ optimization (the additive form and the multiplicative form). Second, we introduce the applications of HQ in image denoising, subspace learning and feature extraction. Third, we focus on a general HQ view for L1 minimization and robust sparse representation. Lastly, we introduce recent advances in low rank matrix recovery and structured sparsity from the HQ viewpoint. This HQ analysis gives a general framework to unify the methods based on L21-norm, quasi-norm and other HQ norms, which have recently been used in low rank matrix recovery and structured sparsity.

Tutorials

November 11, 2012, 09:30-13:00 ICPR2012 Tutorials AM-03

The Algebraic Approaches and Techniques in Image Analysis

Lecturer:
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The Federal State Institution of Science Dorodnicyn Computing Centre of the Russian Academy of Sciences, Moscow, Russian Federation

Abstract:
The main task of the tutorial is to explain and discuss the opportunities and limitations of algebraic approaches in image analysis. During recent years there was accepted that algebraic techniques, in particular different kinds of image algebras, is the most prospective direction of construction of the mathematical theory of image analysis and of development an universal algebraic language for representing image analysis transforms and image models.
So, the main goal of the Algebraic Approach is designing of a unified scheme for representation of objects under recognition and its transforms in the form of certain algebraic structures. It makes possible to develop corresponding regular structures ready for analysis by algebraic, geometrical and topological techniques.
Development of this line of image analysis and pattern recognition is of crucial importance for automatic image-mining and application problems solving, in particular for diversification classes and types of solvable problems and for essential increasing of solution efficiency and quality.
The main subgoals of the tutorial are:
a) to set forth the state of the art of mathematical theory of image analysis;
b) to consider the algebraic approaches and techniques acceptable for image analysis;
c) to present a methodology, mathematical and computational techniques for automation of image mining on the base of Descriptive Approach to Image Analysis (DAIA);
d) to illustrate opportunities of algebraic techniques via an example of biomedical image analysis application problem.
In the Tutorial are essentially used the materials and discussions of the IAPR Technical Committee 16 "Algebraic and Discrete Mathematical Techniques in Pattern Recognition and Image Analysis".

Tutorials

November 11, 2012, 09:30-13:00 ICPR2012 Tutorials AM-04

3D Shape Analysis and Retrieval – Recent Advances and Trends

Lecturer:

Hamid Laga* and Ryutarou Ohbuchi**

*School of Mathematics and Statistics, University of South Australia, Australia

**Computer Science and Engineering Department, University of Yamanashi, Japan

Abstract:

In recent years, acquisition and modelling of 3D data has gained a significant boost due to the availability of commodity devices. Digital 3D shape models are becoming a key component in many industrial, entertainment and scientific sectors. Consequently, large collections of 3D data are nowadays available both in the public (e.g., on the Internet) as well as in private domains. Analysing, classifying, and querying such 3D data collections are becoming topics of increasing interest in the computer vision, pattern recognition, computer graphics and digital geometry processing communities. 3D shape analysis poses new challenges that are not existent in image and video analysis. The purpose of this tutorial is to introduce the foundation of this topic to the pattern recognition community, and overview the state-of-the-art techniques. The tutorial will start by introducing basic concepts such as 3D shape representations and shape descriptors, while outlining the major requirements and challenges. Then the tutorial looks at the fundamental problem of comparing shapes, where one seeks to design similarity measures that capture shape properties (ranging from geometry to semantics), and which are robust to different variabilities (such as non-rigid deformations). We will also discuss roles that machine learning plays in 3D shape analysis and retrieval. Then, we will review recent works on query specification for 3D retrieval. We conclude the tutorial with an overview of some (classical and non-classical) applications where 3D shape analysis plays a central role.

Tutorials

November 11, 2012, 09:30-13:00 ICPR2012 Tutorials AM-05

Music Information Research: Signal Processing, Machine Learning, Nonparametric Bayes, Interface, Retrieval, Singing, and Crowdsourcing

Lecturer:

Masataka Goto and Kazuyoshi Yoshii

National Institute of Advanced Industrial Science and Technology (AIST), Japan

Abstract:

This tutorial is intended for an audience interested in music itself, music technologies, or the application of ICPR-related technologies to music domains. Audience members who are not familiar with music information research are welcome, and researchers working on music technologies are likely to find something new to study.

First, the tutorial serves as a showcase of music information research. The audience can enjoy and study many state-of-the-art demonstrations of music information research based on signal processing and machine learning. This tutorial highlights timely topics such as active music listening interfaces, singing information processing systems, web-related music technologies, crowdsourcing, and consumer-generated media (CGM).

Second, this tutorial explains the music technologies behind the demonstrations. The audience can learn how to analyze and understand musical audio signals, process singing voices, and model polyphonic sound mixtures. As a new approach to advanced music modeling, this tutorial introduces unsupervised music understanding based on nonparametric Bayesian models.

Third, this tutorial provides a practical guide to getting started in music information research. The audience can try available research tools such as music feature extraction, machine learning, and music editors. Music databases and corpora are then introduced. As a hint towards research topics, this tutorial also discusses open problems and grand challenges that the audience members are encouraged to tackle.

In the future, music technologies, together with image, video, and speech technologies, are expected to contribute toward all-around media content technologies.

Tutorials

November 11, 2012, 14:00-17:30 ICPR2012 Tutorials PM-02

Penalised likelihood methods for high-dimensional pattern analysis

Lecturer:
Jing-Hao Xue
Department of Statistical Science, University College London, UK

Abstract:
In recent years penalised likelihood methods, such as the least absolute shrinkage and selection operator (lasso), the elastic net, the smoothly clipped absolute deviation (SCAD) and the adaptive lasso, have become popular and been extensively studied in the statistics and machine-learning communities. These methods were developed to achieve both model fitting and feature selection, originally for regression and most recently for classification and clustering. Therefore they are extremely attractive for high-dimensional pattern analysis, in particular when sparsity is present in a so-called 'large-p-small-n' context, the context that the sample size, n, is smaller than the feature dimension, p, and that traditional methods often fail. In this tutorial, we shall review some established penalised likelihood methods for regression, and discuss some state-of-the-art penalised likelihood methods for classification and clustering, with respect to their intuitions, methodologies, implementations and theoretical properties.

Tutorials

November 11, 2012, 14:00-17:30 ICPR2012 Tutorials PM-03

Connectivity, Connected Filters, and Beyond: Theory and Applications for Fast Filtering and Object Recognition

Lecturer:

Michael H.F. Wilkinson

Johann Bernoulli Institute for Mathematics and Computer Science, University of Groningen., the Netherlands

Abstract:

Connected filters have rapidly become one of the most important classes of morphological filters. They allow edge preserving image simplification using a variety of strategies, and can be applied to many different tasks, ranging from image de-noising at the low-level end of the spectrum, to object recognition at the high-level task. Besides their edge preserving nature, connected filters can model the Gestalt notion of perceptual grouping, by using more generalised notions of connectivity, allowing, e.g., a flock of birds to be viewed as a single entity. Furthermore, they allow very fast multi-scale analysis of images and volumes, and can be made scale or even affine invariant very easily. In this tutorial the foundations of connected filters and connectivity will be presented. The aim is to give participants insight into the properties of these methods, and how to apply them in practical problems.

Tutorials

November 11, 2012, 14:00-17:30 ICPR2012 Tutorials PM-04

Advanced Nature Exteriors Modelling

Lecturer:
Michal Haindl & Jiří Filip,
Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic

Abstract:
A multidimensional visual texture is the appropriate paradigm for physically correct material visual properties representation. The course will present recent advances in texture modelling methodology applied in computer vision, pattern recognition, computer graphics, and virtual/augmented reality applications. This topic is introduced in wider and complete context of pattern recognition and image processing. It comprehends modelling of multi-spectral images and videos which can be accomplished either by a multi-dimensional mathematical models or sophisticated sampling methods from the original measurements. The key aspects of the topic, i.e., different multi-dimensional data models with their corresponding benefits and drawbacks, optimal model selection, parameter estimation and model synthesis techniques are discussed. These methods produce compact parametric sets that allow not only to faithfully reproduce material appearance, but are also vital for visual scene analysis, e.g., texture segmentation, classification, retrieval etc. Special attention is devoted to a recent most advanced trend towards Bidirectional Texture Function (BTF) modelling, used for materials that do not obey Lambertian law, whose reflectance has non-trivial illumination and viewing direction dependency. BTFs recently represent the best known effectively applicable textural representation of the most real-world materials? visual properties. Introduced approaches will be categorized and compared in terms of visual quality, analysis and synthesis speed, texture compression rate, and their ability to be applied in GPU. The course also deals with proper data measurement, visualization of texture models in virtual scenes, visual quality evaluation feedback, as well as description of key industrial and research applications.

Tutorials

November 11, 2012, 14:00-17:30 ICPR2012 Tutorials PM-05

Visualisation and browsing of large image repositories

Lecturer:
Gerald Schaefer
Loughborough University, U.K.

Abstract:
Image database visualisation and browsing systems provide a visual overview of image collections together with means of interactively browsing through the image dataset. As such they have been shown to provide a useful alternative to query based image retrieval systems.
In this tutorial we will discuss image database visualisation based on image features and timestamp information, will look at the principal methods of visualising image databases, in particular approaches based on dimensionality reduction, clustering and graph structures, and will cover the various browsing operations that can be offered in such systems.
We will further look at immersive image browsing (i.e. image browsing using VR hardware), at mobile image browsing (using smartphones and other portable devices), and discuss the issue of evaluation which so far has received relatively little attention.