MAIPCV2011

若手研究者のための
画像処理とＣＶにおける数理的側面
ウィンタースクール

Winter School

for young researchers

on Mathematical Aspects of Image Processing and Computer Vision

2011年11月24日（木）～26日（土）
東北大学青葉山キャンパス
青葉記念会館
Aoba Memorial Hall, Tohoku University
24-26, November, 2011

Program

November 24 (Thu) Mathematical Aspects of Computer Graphics

10:00-12:00 Ken Anjyo (OLM Digital R&D, Japan)
Transforming 2D Image to 3D Animation – From a Practitioner's Viewpoint

13:30-16:30 Konrad Polthier (Freie Universität Berlin, Germany)
Discrete Differential Geometry – Concepts and Applications

November 25 (Fri) Variational Methods for Computer Vision

09:00-12:00 Kenji Kajiwara (Kyushu University, Japan)
Discretization of Planar Curve Motions and Discrete Integrable Systems

13:30-16:30 Ernie Esser (University of California, Irvine, USA)
Primal Dual Algorithms for Convex Optimization in Imaging Science

November 26 (Sat) Optimal Estimation for Computer Vision

09:00-12:00 Kenichi Kanatani (Okayama University, Japan)
Optimal Estimation for Computer Vision Applications

13:30-16:30 Sami Brandt (University of Copenhagen, Denmark/University of Oulu, Finland)
On the Probabilistic Multi-View Geometry

Abstracts

Transforming 2D Image to 3D Animation–From a Practitioner's Viewpoint

Ken Anjyo
Research and Development Division
OLM Digital R&D

In a digital production workplace, we often encounter the problems of how to construct and animate a 3D scene, based only on 2D information about the scene. For example, when a single image (photograph or drawing) is given for the scene, how we can transform it into 3D? This talk gives a brief overview of the transforming techniques used in our practice. Related research work will also be described along with the demonstration movies.

Discrete Differential Geometry – Concepts and Applications

Konrad Polthier
AG Mathematical Geometry Processing
Freie Universität Berlin

The talk introduces concepts from discrete differential geometry and applications to recent problems in computer graphics and CAD. The topics include polyhedral surfaces, discrete curvatures, differential forms, Hodge decomposition, manifolds and covering spaces with applications to surfaces segmentation and parameterization, shape optimization, mesh compression and spectral modeling. Special emphasis lies on effective algorithms and industrial applications.

Discretization of Planar Curve Motions and Discrete Integrable Systems

Kenji Kajiwara
Institute of Mathematics for Industry
Kyushu University

It is well-known that smooth curves on the Euclidean plane admit the motion described by the modified Korteweg-de Vries (mKdV) equation, which is one of the most typical integrable systems. In this lecture, we consider the problem of discretization of planar curve motions preserving the underlying integrable structure. More precisely, we introduce the discrete planar curves and discuss their continuous and discrete motions described by the semi-discrete and discrete mKdV equations, respectively. By applying the theory of discrete integrable systems, we construct explicit formulas for the curve motions in terms of the tau function. We will also discuss the discretization of space curve motions if time permits.

Primal Dual Algorithms for Convex Optimization in Imaging Science

Ernie Esser
School of Physical Sciences
University of California, Irvine

Variational models in image processing and computer vision often result in constrained optimization problems that are difficult in the sense that they involve minimizing nonsmooth functions of many variables but are easy in the sense that they are convex and have separable structure. For solving such convex minimization problems, we will discuss a class of primal dual algorithms whose generality, simplicity and efficiency make them an essential tool. These algorithms will be studied from the perspective of alternating direction methods applied to augmented Lagrangians. In three lectures we will review some convex analysis background, discuss connections between the algorithms and show how to practically implement them for general convex models with separable structure.

Optimal Estimation for Computer Vision Applications

Kenichi Kanatani
Department of Computer Science
Okayama University

In many computer vision applications, one frequently needs to estimate the parameters of the assumed model from noisy observations, for which maximum likelihood (ML) is widely regarded as the basic principle. In this talk, I describe the general framework of ML-based optimization and summarize assumptions and approximations associated with it. I also discuss algebraic methods that can produce approximate solutions to be used as initial values of ML iterations and introduce a recently established technique called ``HyperLS''. As practical applications, I discuss camera calibration of fish-eye lens cameras and optimal 3-D similarity estimation from noisy 3-D data.

On the Probabilistic Multi-View Geometry

Sami Brandt
Machine Vision Group
University of Copenhagen/University of Oulu

Where the classic multi-view geometry is deterministic in assessing the geometric constraints and relationships between several views, there has been recently proposed a modern, probabilistic approach for multi-view geometry. This approach is essentially a novel direction in the branch of integral geometry in mathematics that in the modern form studies integral transforms modeled with the Radon or Radon-like transforms. Where the classic way in geometric computer vision is, for instance, to take a point in an image and transfer it into another view, the probabilistic way is to replace the point coordinates by a 2D location distribution and transfer it into another view along with the uncertainty distribution of the multi-view geometric entity via the geometric incidence relation. Most importantly, the resulting dual distributions make a complete probabilistic, Bayesian treatment multilinear geometric relations possible where everything is modeled with probability distributions. In first part of the lecture, we will start to build the intuition with the simplest case of the point--line duality, construct the duals for epipolar lines, and discuss the approach from the viewpoint of two view geometry. On the second part of the lecture, we will proceed to the general case where we will study the general multilinear models, construct the related dual distributions, and demonstrate them with real examples. We will also discuss the possible future research directions of this topic.

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