



SSBAktuellt Nr. 25, december 2004

# SSBAktuellt



SVENSKA  
SÄLLSKAPET  
FÖR  
AUTOMATISERAD  
BILDANALYS

SWEDISH  
SOCIETY  
FOR  
AUTOMATED  
IMAGE ANALYSIS

MEMBER OF THE  
INTERNATIONAL  
ASSOCIATION FOR  
PATTERN  
RECOGNITION



Kom ihåg att skicka in din e-postadress till  
[ssba@ssba.se.org](mailto:ssba@ssba.se.org) för att få kommande  
utgåvor av SSBAktuellt **DIGITALT**



Vinterlandskap sett från stormansgraven Kung Björns hög.  
Söndagen den 14 november 2004, Uppsala.

*Foto: Kelly Palmquist*

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*Vid en tillbakablick över det gångna året kan vi se att vi doktorander har haft två uppskattade tillställningar detta år. En i form av en doktoranddag och en i form av en sommarkurs. Vi hoppas naturligtvis att båda dessa kommer att leva vidare under flera år framöver. Till sist vill vi på redaktionen önska alla en God Jul och ett Gott Nytt År med bland annat SSBA-symposiet i Malmö och SCIA i Joensuu. Deadline för bidrag till nästa SSBAktuellt är den 31/3 2005.*

## ORDFÖRANDENS ORD

Hej SSBA-medlemmar,

"Tre gubbar, tre gubbar från pepparkakeland, till julen, till julen vi komma hand i hand."

Det kom ett kuvert i er brevlåda. Innehållet var denna SSBAktuellt. Det är sista gången som distributionen sker med hjälp av postväsendet. I fortsättningen kommer SSBAktuellt fortfarande att sättas ihop av redaktionen i Uppsala, men spridningen kommer att ske elektroniskt. Vi följer därmed samma linje som IAPR har satt för IAPR Newsletter, vilken också kommer att distribueras enbart i elektronisk form från och med 2005. Jag påminner er därför om att följa uppmaningen från förra numret att skicka e-post till [ssba@ssba.org.se](mailto:ssba@ssba.org.se) "Subject: adress" innehållande namn, postadress OCH önskad e-postadress för utskick.

I detta nummer hittar ni diverse läsning, t.ex. presentation av de avhandlingar som kommit redaktionen till kännedom. Ni hittar också en rapport från SIGRADs konferens i Gävle nyligen. Intressant att få se hur ett närliggande område som datorgrafik sköter sin organisation.

Bifogat är en inbjudan till SSBA 2005 som infaller 10 och 11 mars vid Malmö högskola med Anders Heyden som symposieordförande. Deadline för att skicka uppsatser är 4 februari. SSBA-symposiet är ett forum där det presenteras vad som händer i bildanalys-Sverige. Man kan mycket väl skicka liknande bidrag till SSBA som man skickar till andra publikationsställen. Jag vill att doktorander skall se det som ett tillfälle att träna på att presentera era projekt i ett mera avslappnat sammanhang och för seniorer att tala om för kollegorna vad som pågår. Vid symposiet brukar också starka examensarbeten presenteras. Det är upp till varje handledare att vara granskare av de uppsatser som skickas till symposiet. Som tidigare år delas pris ut till Bästa industrirelevanta bidrag. Doktorandgruppen i Malmö bjuder in till en SSBA-sponsrad doktoranddag 9 mars.

En annan konferens under 2005 arrangeras av vår finska systerorganisation HATUTUS i Joensuu 19-22 juni. Jag avser givetvis SCIA 2005. Deadline är 28 februari. Konferensordförande Jussi Parkkinen hälsar alla bidrag varmt välkomna. Han uppmuntrar också seniora talare att träda fram.

Vid SCIA 2005 kommer pris för Bästa doktorsavhandling i Norden 2003-2004 att delas ut. Information om nominering hittar ni i detta nummer av SSBAktuellt och på SSBAs hemsida under doktorandinformation.

Jag passar härmed på att tacka SSBAktuellt-redaktionen som har försett oss medlemmar med information rörande SSBA under 2004. Vi ser fram emot kommande nummer i elektronisk form (där färgbilder kommer till sin rätt!).

Det är inte så långt kvar till jul och nyår. Någon sa till mig att i år blir det få lediga dagar pga kalendern. Jag ber er dock fundera en gång till. Nog kan väl en eller ett par semesterdagar användas till att förlänga julleddigheten? För er hälsas och för era familjers skull.

"Men tomten och bocken vi lämnat vid vår spis,  
de ville inte resa från vår pepparkakegris."

*Ingela Nyström*  
Ordförande

## RAPPORT FRÅN SIGRAD 2004

SIGRAD är intresseorganisationen för datorgrafik i Sverige. Man ordnar en årlig konferens som i år tog plats vid högskolan i Gävle den 24-25 november. Konferensen har ett tema varje år, och årets var "Environmental visualization". Inbjudna talare var Oliver Deussen från University of Constance, Tomas Landelius från SMHI och Ken Museth från Linköpings universitet. Konferensen invigdes av programkommitténs ordförande Stefan Seipel från Högskolan i Gävle/Uppsala universitet. Flera intressanta bidrag presenterades och på torsdags-



kvällen blev det middag och underhållning på Café Spegeln, Konstcentrum. Under fredagen fortsatte konferensen med ytterligare presentationer innan den avslutades av SIGRADs ordförande Anders Backman från Umeå universitet. Det finns säkert många medlemmar av SSBA som forskar inom områden i gränslandet mellan datorgrafik och bildanalys. Ta gärna en titt på SIGRADs hemsida [sigrad.org](http://sigrad.org) och skicka in ett bidrag till nästa år då konferensen ges i Lund.

*Erik Vidholm*

## ÖVERVAKNING I FLERA DIMENSIONER

Forskarna på FOI har återigen demonstrerat hur kraftfullt bildanalys kan vara. I SVT:s Vetenskapsmagasinet den 29/11 visades ett reportage om övervakning av stora evenemang med hjälp av flerdimensionell bild- och ljudanalys. Ett stort experiment genomfördes i Norrköpings hamn där man lyckades lokalisera och följa en skytt bland en stor mängd skådespelande huliganer. Reportaget hittar du på [svt.se/vetenskapsmagasinet](http://svt.se/vetenskapsmagasinet). Medverkande från FOI var Lena Klasén, Tomas Chevalier och Hans Habberstad.



*Foto: FOI*

*Erik Vidholm*

## DAGS ATT NOMINERA TILL "BÄSTA DOKTORSAVHANDLING I NORDEN 2003-2004"

I samband med SCIA 2005 i Joensuu utdelas priset "Bästa doktorsavhandling i Norden inom mönsterigenkänning 2003-2004". Vinnaren utses i en tvåstegsprocess. I det första skedet väljer en kommitté ur SSBAs styrelse ut två kandidater bland de svenska deltagarna. I nästa skede bedömer en nordisk kommitté åtta nominerade avhandlingar, två nomineringar från varje nordisk systerorganisation. Vinnaren erhåller förutom äran en summa pengar.

Vid SCIA 2003 i Göteborg delades priset ut till Fredrik Kahl, Matematikcentrum, Lunds uni-

versitet. Har den bästa nordiska avhandlingen presenterats i Sverige även för perioden 2003-2004? Ur patriotisk synvinkel, hoppas jag det. Ni som läser detta: tipsa alla som disputerat de senaste två åren att skicka in sina avhandlingar för bedömning. Information finns också på SSBAs hemsida under doktorandinformation.

Medlem i SSBA som erhållit doktorsgrad från ett svenskt universitet (högskola) under perioden 2003-2004 och önskar delta omedes att senast 31 januari 2005 skicka två (2) exemplar av sin doktorsavhandling till

**SSBA**  
**c/o Ingela Nyström**  
**Centrum för bildanalys**  
**Lägerhyddsvägen 3**  
**752 37 Uppsala**

Dessutom skall en pdf-version antingen skickas via e-post till **ingela@cb.uu.se** eller finnas tillgänglig att ladda ner från Internet.

Lycka till!

*Ingela Nyström*  
Ordförande

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## SÖKES: STUDENTMEDLEMMAR

För att sprida kunskap om och intresse för SSBA bland blivande ingenjörer och forskare erbjuder SSBA studenter som läser någon grundutbildningskurs inom bildanalys, bildbehandling och närliggande områden gratis medlemskap i föreningen. Erbjudandet gäller även studenter som gör examensarbete inom något sådant område. Studentmedlemskapet gäller fram till slutet av nästa år. Erbjudandet gäller dock inte forskarstuderande, vilka istället hänvisas till ordinarie medlemskap.

Vi ber examinatorer/handledare tipsa sina studenter om att ansöka om medlemskap genom att skicka ett e-postmeddelande till

**ssba@ssba.org.se** med följande information:

**Namn**  
**Hemadress**  
**Universitet/högskola, linje och årskurs**  
**Aktuell kurs**  
**Kursansvarig/Examinator**

"Studentmedlemskap" skall anges i ämnesfältet!

*Ingela Nyström*  
Ordförande

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## 2005 års svenska symposium i bildanalys



**9/3      Doktoranddag**  
**10-11/3      SSBA 2005**

SSBA 2005 samt doktoranddagen äger rum på Teknik och samhälle, **Malmö**

**[www.mah.se/ssba2005](http://www.mah.se/ssba2005)**

**Deadline för konferensbidrag är 4/2 2005**

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### **Doktoranddag 9/3 2005**

#### **Plats**

Sal C109, Kranen (Östra Varvsgatan 11 H, Malmö)

(Ta rulltrappan, gå direkt till vänster, genom glasörrarna och sedan direkt till vänster igen)

#### **Program**

11.30 - 12.00	Samling och mingel i C109
12.00 - 13.00	Lunch
13.00 - 14.00	Föredrag av inbjuden talare
14.00 - 16.00	Gruppdiskussioner

Middag på kvällen (detaljer kommer senare).

Anmälan görs via e-post till Jan Erik Solem: **[jes@ts.mah.se](mailto:jes@ts.mah.se)**

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## Avhandlingar 2004

Här följer abstract till de avhandlingar inom bildanalys som producerats under året och kommit redaktionen till känna. Grattis till alla nyblivna doktorer!

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### **Image Analysis using the Physics of Light Scattering**

Peter Nillius, KTH

Any generic computer vision algorithm must be able to cope with the variations in appearance of objects due to different illumination conditions. While these variations in the shading of a surface may seem a nuisance, they in fact contain information about the world. This thesis tries to provide an understanding what information can be extracted from the shading in a single image and how to achieve this. One of the challenges lies in finding accurate models for the wide variety of conditions that can occur. Frequency space representations are powerful tools for analyzing shading theoretically. Surfaces act as low-pass filters on the illumination making the reflected light band-limited. Hence, it can be represented by a finite number of components in the Fourier domain, despite having arbitrary illumination. This thesis derives a basis for shading by representing the illumination in spherical harmonics and the BRDF in a basis for isotropic reflectance. By analyzing the contributing variance of this basis it is shown how to create finite dimensional representations for any surface with isotropic reflectance. The finite representation is used to analytically derive a principal component analysis (PCA) basis of the set of images due to the variations in the illumination and BRDF. The PCA is performed model-based so that the variations in the images are described by the variations in the illumination and the BRDF. This has a number of advantages. The PCA can be performed over a wide variety of conditions, more than would be practically possible if the images were captured or rendered. Also, there is an explicit mapping between the principal components and the illumination and BRDF so that the PCA basis can be used as a physical model. By combining a database of captured illumination and a database of captured BRDFs a general basis for shading is created. This basis is used to investigate material classification from a single image with known geometry but arbitrary unknown illumination. An image is classified by estimating the coefficients in this basis and comparing them to a database. Experiments on synthetic data show that material classification from reflectance properties is hard. There are mis-classifications and the materials seem to cluster into groups. The materials are grouped using a greedy algorithm. Experiments on real images show promising results.

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### **Local Spatio-Temporal Image Features for Motion Interpretation**

Ivan Laptev, KTH

Visual motion carries information about the dynamics of a scene. Automatic interpretation of this information is important when designing computer systems for visual navigation, surveillance, human-computer interaction, browsing of video databases and other growing applications.

In this thesis, we address the issue of motion representation for the purpose of detecting and recognizing motion patterns in video sequences. We localize the motion in space and time and propose to use local spatio-temporal image features as primitives when representing and recognizing motions. To detect such features, we propose to maximize a measure of local variation of the image function over space and time and show that such a method detects meaningful events in image sequences. Due to its local nature, the proposed method avoids the influence of global variations in the scene and

*forts. nästa sida*

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overcomes the need for spatial segmentation and tracking prior to motion recognition. These properties are shown to be highly useful when recognizing human actions in complex scenes.

Variations in scale and in relative motions of the camera may strongly influence the structure of image sequences and therefore the performance of recognition schemes. To address this problem, we develop a theory of local spatio-temporal adaptation and show that this approach provides invariance when analyzing image sequences under scaling and velocity transformations. To obtain discriminative representations of motion patterns, we also develop several types of motion descriptors and use them for classifying and matching local features in image sequences. An extensive evaluation of this approach is performed and results in the context of the problem of human action recognition are presented.

In summary, this thesis provides the following contributions: (i) it introduces the notion of local features in space-time and demonstrates the successful application of such features for motion interpretation; (ii) it presents a theory and an evaluation of methods for local adaptation with respect to scale and velocity transformations in image sequences and (iii) it presents and evaluates a set of local motion descriptors, which in combination with methods for feature detection and feature adaptation allow for robust recognition of human actions in complex scenes with cluttered and non-stationary backgrounds as well as camera motion.

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## **A Component Framework for Autonomous Mobile Robots**

Anders Orebäck, KTH

The major problem of robotics research today is the barrier to entry into robotics research. Robot system software is complex and a researcher that wishes to concentrate on one particular problem often needs to learn about details and dependencies of the complete system. This is because a robot system needs several different subsystems that need to communicate and execute in parallel.

Today there is not much controlled comparisons of algorithms and solutions for a given task, which is the standard scientific method of other sciences. There is also very little sharing between groups and projects, requiring code to be written from scratch over and over again.

Component-based Software Engineering (CBSE) is an approach that could solve many of the aforementioned problems. It enforces modularity which helps to manage complexity. Components can be developed in isolation, since algorithms are encapsulated in components where only the interfaces need to be known by other users. A complete system can be created by assembling components from different sources. Comparisons and sharing can greatly benefit from CBSE.

An examination of successful systems and architectures of past and present, yields a number of key characteristics. Some of these are ease of use, modularity, portability and efficiency. By not enforcing a specific architecture, generality is improved. This implies a framework where modules are seen as common peers and not divided into clients and servers or forced into a set layering. Using a standardized middleware, efficient communication can be carried out between different platforms and languages.

A component-based framework called ORCA has been developed with the following properties. All communication is carried out by either of three communication patterns, query, send and push. Communication is done using CORBA, although most of the CORBA code is hidden for the developer and can in the future be replaced by other mechanisms. The framework also includes a component model and a hardware abstraction scheme. This framework has been verified by the implementation of a number of working systems.

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## **Algorithms for the analysis of 3D magnetic resonance angiography images**

Xavier Tizon, SLU Uppsala

Atherosclerosis is a disease of the arterial wall, progressively impairing blood flow as it spreads throughout the body. The heart attacks and strokes that result of this condition cause more deaths than cancer in industrial countries. Angiography refers to the group of imaging techniques used through the diagnosis, treatment planning and follow-up of atherosclerosis. In recent years, Magnetic Resonance Angiography (MRA) has shown promising abilities to supplant conventional, invasive, X-ray-based angiography. In order to fully benefit from this modality, there is a need for more objective and reproducible methods. This thesis shows, in two applications, how computerized image analysis can help define and implement these methods. First, by using segmentation to improve visualization of blood-pool contrast enhanced (CE)-MRA, with an additional application in coronary Computerized Tomographic Angiography. We show that, using a limited amount of user interaction and an algorithmic framework borrowed from graph theory and fuzzy logic theory, we can simplify the display of complex 3D structures like vessels. Second, by proposing a methodology to analyze the geometry of arteries in whole-body CE-MRA. The vessel centreline is extracted, and geometrical properties of this 3D curve are measured, to improve interpretation of the angiograms. It represents a more global approach than the conventional evaluation of atherosclerosis, as a first step towards screening for vascular diseases. We have developed the methods presented in this thesis with clinical practice in mind. However, they have the potential to be useful to other applications of computerized image analysis.

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## **Segmentation and classification of individual tree crowns**

Mats Erikson, SLU Uppsala

By segmentation and classification of individual tree crowns in high spatial resolution aerial images, information about the forest can be automatically extracted. Segmentation is about finding the individual tree crowns and giving each of them a unique label. Classification, on the other hand, is about recognising the species of the tree. The information of each individual tree in the forest increases the knowledge about the forest which can be useful for managements, biodiversity assessment, etc.

Different algorithms for segmenting individual tree crowns are presented and also compared to each other in order to find their strengths and weaknesses. All segmentation algorithms developed in this thesis focus on preserving the shape of the tree crown. Regions, representing the segmented tree crowns, grow according to certain rules from seed points. One method starts from many regions for each tree crown and searches for the region that fits the tree crown best. The other methods start from a set of seed points, representing the locations of the tree crowns, to create the regions. The segmentation result varies from 73 to 95 % correctly segmented visual tree crowns depending on the type of forest and the method. The former value is for a naturally generated mixed forest and the latter for a non-mixed forest.

The classification method presented uses shape information of the segments and colour information of the corresponding tree crown in order to decide the species. The classification method classifies 77 % of the visual trees correctly in a naturally generated mixed forest, but on a forest stand level the classification is over 90 %.



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## Improved Algorithms for Fast Shading and Lighting

Anders Hast, Uppsala universitet

Shading is a technique that is used in computer graphics to make faceted objects appear smooth and more realistic. In the research presented in this thesis we have investigated how shading can be generated as efficiently as possible without sacrificing quality.

In the classical approach to high quality shading proposed by Phong, the illumination equation is computed per pixel using an interpolated normal. The normals at the vertices are bi-linearly interpolated over the polygon to obtain a normal per pixel. Correct shading requires normalization of these normals, which is computationally demanding involving a square root. In our research we have shown how this normalization can be eliminated through the use of spherical interpolation and the Chebyshev recurrence formula, reducing the calculation to a few single arithmetic operations per pixel.

Still a substantial setup operation is needed for each scanline. We have studied how also this can be made more efficient, with some limited progress so far. An alternative approach is to do the most of the setup on polygon level and incrementally compute the setup needed per scanline. In particular, we have studied quadratic shading approaches, i.e. fitting second degree surfaces to the polygons. The most successful approach has been through what we have called X-shading, where the setup is calculated by using an efficient approximation for the mid-edge normals. This setup is about four times faster than previously known methods.

In the process of studying shading methods we have also made some contributions to improving bump-mapping and simulation of different kinds of light sources.

The developed methods will be of interest in future generations of computer graphics software and hardware systems, ranging from high end systems to generate realistic movies and 3D games, to handheld devices such as mobile phones with graphics displays.

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## On Modelling Nonlinear Variation in Discrete Appearances of Objects

Felix Wehrmann, Uppsala universitet

Mathematical models of classes of objects can significantly contribute to the analysis of digital images. A major problem in modelling is to establish suitable descriptions that cover not only a single object but also the variation that is usually present within a class of objects.

The objective of this thesis is to develop more general modelling strategies than commonly used today. In particular, the impact of the human factor in the model creation process should be minimised. It is presumed that the human ability of abstraction imposes undesired constraints on the description. In comparison, common approaches are discussed from the viewpoint of generality.

The technique considered introduces *appearance space* as a common framework to represent both shapes and images. In appearance space, an object is represented by a single point in a high-dimensional vector space. Accordingly, objects subject to variation appear as *nonlinear manifolds* in appearance space. These manifolds are often characterised by only a few intrinsic dimensions. A model of a class of objects is therefore considered equal to the mathematical description of this manifold.

The presence of nonlinearity motivates the use of artificial auto-associative neural networks in the modelling process. The network extracts nonlinear modes of variation from a number of training examples. The procedure is evaluated on both synthetic and natural data of shapes and images and shows promising results as a general approach to object modelling.

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## Low and Medium Level Vision using Channel Representations

Per-Erik Forssén, Linköpings universitet

This thesis introduces and explores a new type of representation for low and medium level vision operations called channel representation. The channel representation is a more general way to represent information than e.g. as numerical values, since it allows incorporation of uncertainty, and simultaneous representation of several hypotheses. More importantly it also allows the representation of "no information" when no statement can be given. A channel representation of a scalar value is a vector of channel values, which are generated by passing the original scalar value through a set of kernel functions. The resultant representation is sparse and monopolar. The word sparse signifies that information is not necessarily present in all channels. On the contrary, most channel values will be zero. The word monopolar signifies that all channel values have the same sign, e.g. they are either positive or zero. A zero channel value denotes "no information", and for non-zero values, the magnitude signifies the relevance.

In the thesis, a framework for channel encoding and local decoding of scalar values is presented. Averaging in the channel representation is identified as a regularised sampling of a probability density function. A subsequent decoding is thus a mode estimation technique.

The mode estimation property of channel averaging is exploited in the channel smoothing technique for image noise removal. We introduce an improvement to channel smoothing, called alpha synthesis, which deals with the problem of jagged edges present in the original method. Channel smoothing with alpha synthesis is compared to mean-shift filtering, bilateral filtering, median filtering, and normalized averaging with favourable results.

A fast and robust blob-feature extraction method for vector fields is developed. The method is also extended to cluster constant slopes instead of constant regions. The method is intended for view-based object recognition and wide baseline matching. It is demonstrated on a wide baseline matching problem.

A sparse scale-space representation of lines and edges is implemented and described. The representation keeps line and edge statements separate, and ensures that they are localised by inhibition from coarser scales. The result is however still locally continuous, in contrast to non-max-suppression approaches, which introduce a binary threshold.

The channel representation is well suited to learning, which is demonstrated by applying it in an associative network. An analysis of representational properties of associative networks using the channel representation is made.

Finally, a reactive system design using the channel representation is proposed. The system is similar in idea to recursive Bayesian techniques using particle filters, but the present formulation allows learning using the associative networks.

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## Aktuella licentiatavhandlingar

- **Ola Ramström**, KTH, Visual Attention using Game Theory
- **Jan Erik Solem**, Malmö högskola, Variational Surface Fitting for Computer Vision Problems
- **Jiong Sun**, Umeå universitet, Wireless Video-Complexity, Adaptability and Predictability