Curriculum Vitae
HANS E. KNUTSSON

Profession:	Professor
Employment:	Linköping University
Nationality:	Swedish
Date of birth:	17 December 1950
Place of birth:	Alanäs, Jämtlands Län
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Contents

1 Employment

2000 - present

Professor, July 2000 - present, Linköping University, Department of Biomedical Engineering, Division of Medical Informatics.

1986 - 2000

Associate Professor, January 1986 - June 2000, (January 1986 - April 1987 50% Associate Professor 50% Research Assistant), Linköping University, Department of Electrical Engineering, Division of Computer Vision.

Visiting Professor, September 1998 - December 1998, Technical University of Denmark, Department of Mathematical Modelling, Section for Image Analysis.

Acting Professor, July 1990 - July 1991, Department of Electrical Engineering, Division of Computer Vision.

1984 - 1985

Postdoctoral Fellow, September 1984 - December 1985, The Rockefeller University, Laboratory of Neurobiology (Headed by Nobel Laureate Torsten Wiesel), New York.

1976 - 1984

Research Assistant, January 1976 - September 1984, Linköping University, Department of Electrical Engineering, Division of Computer Vision.

Image Processing Consultant (50% employment), January 1984 - September 1984 and January 1986 - April 1986, Context Vision AB, Linköping. (50% leave of absence from Linköping University.)

1972 - 1975

Teaching Assistant (Parallel to the studies) Laboratory classes in Applied electronics, Measurement physics and Logical design. Linköping Institute of Technology, Sweden. (A one year interruption for military service.)

2 Academic Degrees

Docent Oct 1992
Computer Vision, Linköping University, Sweden

Ph.D. Dec 1982
Computer and Information Science, Linköping University, Sweden

M.S. 1975
Applied Physics and Electrical Engineering, Linköping Institute of Technology, Sweden

3 Research Activities

1975 - 1984

The research during this period consisted of work within the Image Processing area and can be divided into two main projects.

The first project, initiated by Professor Paul Edholm was in progress from 1976 to 1979. Was here responsible for the theoretical development of a new 3D radiological reconstruction method termed '**Ectomography**' [29]. Ectomography was developed in cooperation with the Division of Diagnostic Radiology at the Department of Radiation Physics at the University Hospital in Linköping, [30], and The Karolinska Institute in Stockholm, [31]. Ectomography is presently in clinical use.

The second project, initiated and supervised by Professor Gösta Granlund, aimed at the development of general principles and methods for image processing and computer vision. The project lead to important knowledge concerning the type of information analysis and information representation that is necessary for relevant and efficient processing of image information. Was here in a major way responsible for theoretical contributions on which future research was to be founded, [2], [27], [28], [183], [173], [172]. Examples of results are: - filter design for line and edge estimation in noisy signals, - techniques for image enhancement and image coding. Three important hardware designs for image processing based on these theories were later patented, [304] - [309]. Much as a consequence of the project the image processing company, '*Context Vision*', was founded, see section 8.

1984 - 1986

Was invited by Nobel Laureate Torsten Wiesel to join The Rockefeller University in New York as Postdoctoral Fellow (see supplement A). Worked as a Postdoctoral Fellow at the Neurobiology Laboratory headed by Torsten Wiesel from September 1984 to January 1986. This work aimed partly at generating and evaluating models for computer simulation of different parts of vertebrate visual systems, partly at investigating the possibilities of incorporating information processing principles used by biological systems in an image analysis framework [23]. Developed a new, surface charge based, model for ion flow through visual receptor cells. The operational relations predicted by the model led to a new set of experiments being carried out. The findings have been presented in two journal publications, one of which in *Science* [24], [25].

1986 - 1994

The main part of the research during this period can be viewed as a continuance of the development of general theories for image processing and computer vision, [161], [170], [165], [163] [166].

Suggested and developed a novel method of representation and estimation of local structure of multidimensional signals using tensors and **tensor fields**. [167], [154], [146]. The use of tensor representations for local signal features, e.g. orientation and velocity, has had far reaching consequences for the continuance of the research of the group, [137], [130], [131] [129].

Initiated and supervised the continued development of tensor based methods for signal processing (NUTEK project *Tensor Based Methods for Volume and Time Sequence Processing*. As a result of this research a method for handling irregularly sampled and uncertain data was developed. The method was termed **Normalized Convolution** and is based on a filtering technique for local production of a signal space metric [138], [139].

The tensor and normalized convolution concepts are now fully integrated in the work done by the computer vision group and has also made an impact on the vision community world wide [22]. The developed spatio-temporal filtering methods and the fundamentals of the tensor representation, including a number of applications, e.g. adaptive filtering, image/volume/sequence enhancement and local spectrum estimation, has been published as a textbook [1]. The book is presently used as the main text for the M.S.-level courses 'Multidimensional Signal Analysis' and 'Computer Vision'.

A continuation of earlier work resulted in a method for high resolution local frequency and bandwidth estimation. The method was cited in *Science* as the chosen tool for local wave-length estimation in MR data, [133].

Among other successful projects the ESPRIT - projects *Vision as Process* (BRA 3038) 1989-1992 and *Vision as Process II* (BRA 7108) 1992-1995 can be mentioned. In these projects methods for active vision systems were developed. A fundamental idea in the projects was to use visual feed-back and advanced spatio-temporal signal processing in robotic systems to achieve more efficient and 'intelligent' systems. When the results were presented in Brussels in 1993, the commission became excited: ' ... *The LiTH work on the normalized differential convolution technique promises to be a most interesting development in signal and image processing* ' [B F Buxton, B Neumann and J Wejchert, Esprit BR7108 VapII first review, Commission of the European Community, June 4 1993]. The results have been published in the Springer 'Basic Research Series' [39]-[43].

1994 - 2000

Initiated and directed the development of methods for extraction and presentation of clinically important information using a sequence of X-ray images obtained during contrast administration, [21]. The project *Spatio-temporal Subtraction Angiography* was carried out in collaboration with SECTRA Secure Transmission AB in Linköping and the department of clinical radiology at Örebro Regional Hospital. Developed methods have been patented [303]. The projects *Digital Adaptive Angiocardiography* and *Morphological Angiography* were continuations of this work. The project also resulted in a PhD thesis (Hemmendorff).

Initiated and supervised the development of methods for adaptive generation of efficient models and structures for multidimensional signal processing systems, [140]. The approach is based on signal representation using a data driven distribution of simple local adaptive models [127]. Models based on **Mutual information** and *canonical correlation* were introduced as central concepts in the theoretical development, [125], [121].

In a broader view much of the knowledge developed

within the areas of **information theory**, **signal theory**, **control theory** and **computer science** is in fact at the core of learning and the 'large scale' strategy was, and still is, to integrate pertinent theory and principles from these areas. It is fair to say that the project *Neural Structures for Adaptive Feature Extraction in Active Visual Systems* signifies the start of a new successful line of research that resulted in two Licentiate theses (Borga, Landelius) and two Ph.D. thesis (Borga, Landelius). After reading Landelius thesis Paul Werbos, neural net pioneer and program director of the NSF 'Neuroengineering' program, wrote ' *... this is extremely credible work, advancing the state of the art in an important way. For example, the stability proofs for ADHDP and ADDHP in the appendix are a major contribution, which I will need to cite in the future*'.

The success of the approach is further demonstrated by the fact that the project *Learning Simple Relations in High-dimensional Spaces* was one of the very few new projects approved by TFR in 1996. The development of canonical correlation based models for multidimensional signal processing is documented the Ph.D. thesis by Borga. This pioneering work was well received and I was, for example, invited to give a presentation at ICPR'98 in Brisbane, Australia [120].

2000 - present

Advanced spatio-temporal filtering techniques along with the development of tensor signal processing and design of efficient learning systems are currently the main targets of research. The interest in the ideas brought forward by the group is high as can be seen in the list of invited talks, section 11. As a result the group has many good international contacts and we are a partner of the European NoE SIMILAR and of the TENSOR consortium, see section 6.

Recently, in collaboration with Harvard Medical School and the Surgical Planning Laboratory in Boston, methods for 3D adaptive filtering and analysis of MR data have been developed, [97, 98, 19]. Good examples of recent results are also given by the application to angiography, [16] , ultrasound [95] and by the nationally awarded fMRI project, [12, 15, 18, 17, 20], see section 12. An recent result of fundamental caracter is the **LOGMAP** a fast manifold learning technique based on Riemannian normal coordinates, [82]. Equally important is the results on MR-reconstruction of beating heart-sequences presented in, [6, 8].

Perhaps the most important recent event, were I can claim considerable credit, is the launching of 'The center for Medical Image Science and Visualization' (CMIV) at Linköping University in 2003. I was one of the key people in conceiving and bringing about the launch of the center. Among other things the center convinced Linköping University, Hospital and County to declare Medical Image Science and Visualization a strategic area granting a total of 30.000 kSEK over 5 years. The center currently involves around 70 persons and brings together technical and medical researchers, industry and clinicians in a very creative environment.

For a full overview of the research activities see the list of publications, section 14.

4 Future research plans

I intend to continue doing focused front-line research within multidisciplinary projects providing solutions to tomorrow's clinical issues. In particular to develop future methods and tools for image analysis and visualization for applications within health care and medical research. Here I see a strong interdisciplinary approach as a key component to fully exploit the possibilities of image-based diagnosis and treatment. The goal will be to develop tomorrow's methods and tools for visual data analysis in health care, in order to combat diseases with a major effect on public health.

Methods to attain new types of information using a multitude of imaging modalities is continuously being developed. The detail and quality of recorded images, volumes, image sequences and volume sequences, is increasing rapidly. In addition the complexity of the measured properties is increasing, e.g. tensor diffusion MRI. In this way huge amounts of potentially relevant information, representing function as well as morphology, is tied to one single patient.

The main problem is no longer to obtain data but to be able to extract the relations that are pertinent in a given situation and to visualize them in a way that is simple to understand. Efficient solutions of this problem will be crucial components in future health care. To establish an environment, integrating technical and medical experts, where efficient research toward this end can be conducted is the grand challenge. I believe the following actions will be central in the process:

- Carry out focused research in cross-disciplinary projects, contributing to solutions of basic research questions and the clinical problems of tomorrow.
- Offer training of doctoral students with a background in medicine, engineering, natural or behavioral sciences within a unified graduate program.
- Aim for offering one of the worlds most attractive environment for research projects with high demands on competence and resources within medical image science and visualization.

Improving future health care implies the integration of medical and technical efforts. I believe that the best way to establish an excellent multidisciplinary research group is to target a number of areas where all involved clearly see the significance of potential results.

An important activity will be the continuous dissemination of research results into the health care system. New visualization techniques and tools for medical images will offer unique opportunities to transfer knowledge between system designers and the health care community. This will be useful not only to facilitate our own research but will also enable the users to pick up and clinically apply new medical techniques from the research community at large.

5 Selected Publications

The 10 publications listed below are intended to serve as an indication of the topics and quality of my research. Even though it is in fact not possible, the publications have been selected in an attempt to cover the different lines of research I have been involved in. More recent publications have been favored. There is perhaps also a first author bias even if this is somewhat incompatible with the 'recent' criteria since I, as group leader, in most cases, will find it appropriate to appear as the last name even if the work is based on my ideas.

The selected publications below can be found in section 14 (at the numbers in brackets).

Monographs

[1] **Signal Processing for Computer Vision.** Textbook on advanced image processing used in master courses. Covers important parts of the tensor signal processing theory that I have developed.

[2] **Filtering and Reconstruction in Image Processing.** My PhD thesis. The filter theory and image enhancement technique developed here still serves as a basis for current research. It also covers my early work on tomosynthesis reconstruction a field that is currently regaining interest for low dose imaging purpose's.

Refereed international journal publications

[6] **k-t^2 BLAST: Exploiting spatiotemporal structure in simultaneously cardiac and respiratory time resolved volumetric imaging.** Presents a novel technique to significantly reduce scan time with maintained image quality.

[9] **Prediction from off-grid samples using continuous normalized convolution.** Describes how accurate interpolation for grid-conversion can be efficiently done in the case of irregular grids and uncertain data.

[12] **Detection and detrending in fMRI data analysis.** A novel exploratory method for producing drift models that efficiently capture trends and drifts in the fMRI data is introduced.

[11] **Implications of invariance and uncertainty for local structure analysis filter sets.** State of the art in filter design for local image feature estimation. Introduces Spherical harmonics as a way to generalize the concepts of amplitude and phase.

[16] **Phase-based multidimensional volume registration.** A presentation of a new advanced methodology for registration of multidimensional objects using displacement basis-functions and local phase.

[24] **Divalent cations directly affect the conductance of excised patches of rod photoreceptor membrane.** .*Science* article representing my Postdoc work at Rockefeller University. Presents the effect of presence of Ca^{2+} and Mg^{2+} ions on photoreceptor membrane conductance.

Refereed international conference publications

[73] **The alpha-histogram: Using spatial coherence to enhance histograms and transfer function design.** Presents an algorithm for enhancing clarity in the visualization of medical data volumes. A patent based on this work is pending.

[81] **Morphons: Paint on priors and elastic canvas for seg- mentation and registration.** Presents a new robust approach to image registration and segmentation. The method has been implemented buy other groups and is praised for its performance.

6 Research Grants and Contracts

Projects having a total level of more than 30 MSEK has been successfully completed. All grants received are listed below. Main applicant Hans Knutsson unless otherwise stated.

- European -

SIMILAR - The Multimodal Interfaces Research Network
IST NoE #FP6-507609, Project coordinator Benoit Macq, Université Catholique de Louvain la Neuve, Belgium, Knutsson sub-project 240 kSEK/year, 2004-2007.

- National -

Classification of Multivariate Medical Data Sets using Deformable Models
VR/nt #70478601, Industrial Doctorate Project, Main Applicant Torbjörn Kronander, Covers one PhD student of mine for four years, 2008-2012.

MOVIII: Modeling, Visualization and Information Integration: A center for decision support in complex systems.
- SSF, Main Applicant Lennart Ljung, My groups share 500 kSEK/year, 2006-2011.

New Clinical Quality Level for Medical Image Volumes - Industrial funding, ContextVision AB, 1.800 kSEK 2006-2008.

SMIV - Strategic research area for Medical Image science and Visualization Joint program by Linköping University, Hospital and County, Main applicant Örjan Smedby, 6.000 kSEK/year. Knutsson sub-project (fMRI) 800 kSEK/year, 5 years, 2004-2009.

Manifold Valued Signal Processing
VR/nt #40472101, 621 kSEK/year, 3 years, 2005-2007.

Dynamic Adaptive Reconstruction in MRI: Motion Artifact Reduction Through Generalized Fourier Transformation
VR/nt #621-2003-5149, 608 kSEK/year, 3 years, 2004-2006.

Computer Aided Diagnosis for Digital Mammography Screening
NiMed/VINNOVA, 800 kSEK/year, 1 year, 2003-2004.

Efficient convolution operators for image processing of volumes and volume sequences
SSF/VINNOVA (VINST) #P23153-1A, 1.400 kSEK/year, 2.5 years 2003-2005.

Automated Generation of Patient Specific Models for Visual and Haptic Simulation of Hip Fracture Surgery
SSF/VINNOVA (VINST) #P23197-1A, Main applicant Magnus Borga, Full support of Knutsson Phd student and part of Knutsson group staff, Total 1.600 kSEK/year, 2.5 years, 2003-2005.

Automatic segmentation and volumetry of brain structures from MRI data
VR/nt #2002-5462, Main applicant Helge Malmgren at Göteborgs University. Knutsson sub-project 2003 - 2005, 340 kSEK/year

Advanced Signal Processing Methods for High Quality Functional Magnetic Resonance Imaging
VR/m #K2003-73XD-14541-01A and #K2003-73IT-14542-01A , Main applicant Magnus Borga, Full support of Knutsson PhD student, 520 kSEK/year 2003 - 2005.

Spatio-temporal Structure Tensor Resampling and Transformation
NiMed/LiU, 2002 - 2004, 220 kSEK/year.

Adaptive Methods for Multidimensional Image Analysis and Visualization in Medicine.
TFR project 221-2000-330, 2000 - 2003, 3 years, 487 kSEK/year.

Analysis of Contrast Ultrasound Images
NUTEK(VINNOVA) NIMED (Center for Non-invasive Medical Measurements) project. An industry/university project in cooperation with Amersham Imaging, Norway. 2000- 2004, 3.5 years, 1.430 kSEK/year (average).

Novel Methods for Acquisition and Analysis of Functional Nuclear Magnetic Resonance Relaxation Data
NFR #I-AA/MN 06325-311, Main applicant Peter Lundberg at Linköping University Hospital. 1999 - 2003, All funds in support of Knutsson PhD student, 4 years, 370 kSEK/year. (Award winning project, see section 12.)

MR-based standardized volumetry of the hippocampus
MFR project, Main applicant Helge Malmgren, University of Göteborg. 1999 - 2002, 3 years, Knutsson sub-project 370.000 Skr/year.

Morphological Angiography.
NUTEK #P9305120-6, An industry/university project in cooperation with SECTRA Imaging AB, Linköping, Sweden. 1999 - 2000, 1.5 years, 750 kSEK/year (average).

Fusion of Multi-modal Information
KK project, Main applicant Bengt Wranne at Linköping University Hospital, 1999 - 2000, 2 years, Knutsson sub-project 200 kSEK/year.

Quality Estimation for Image Sequences
SSF project within the VISIT program. In cooperation with Robert Forchheimer at the department of Electrical Engineering, Linköping University. 1997 - 2002, 4.5 years, 960 kSEK/year.

Learning Simple Relations in High-dimensional Spaces.
TFR #96-792, 970101-981231 , 3 years, 328 kSEK/year.

Feature Tensor Estimation and Classification using Mutual Information Analysis.
NUTEK #P9303114-5 (+SSF support), 970101-970630, 540 kSEK.

Process Modeling using Adaptive Models for Monitoring and Control of Continuous Boilers for Paper Pulp Production.
NUTEK #P9303114-4, 960701-961231, 314 kSEK.

Spatio-temporal Subtraction Angiography.
NUTEK #9305120, 940101-990701, 3.865 kSEK.

Neural Structures for Adaptive Feature Extraction in Active Visual Systems.
NUTEK #9303114, 930701-960930, 1.600 kSEK

Tensor-based Methods for Volume and Time Sequence Processing.
NUTEK #92-04716P, 920701-930630, 1.035 kSEK.

Modeling and Simulation of Early Visual Processes
NFR #F-FU 1822-101, Post-doc grant 1984-1985, 80 kSEK.

7 Professional Activities

Board commissions

Member of the scientific board for **CMIV** - Center for Medical Image Science and Visualization, Linköping University.

Member of the board of directors for **IMT** - Department of Biomedical Engineering, Linköping University.

Vice Chairman of SSAB, 1996-2000, *Swedish Society for Automated Image Analysis*.

University commissions

Member of the Linköping university hospital 'research committee' (Forsknings och docenturnämnden), 2003-2007.

Responsible for the M.S. educational profile programs *Signal and Image Processing* (1989-2000) and *Computer Vision and Computer Graphics* (1988-2000). Linköping Institute of Technology.

Member of the working team for EC-related matters at Linköping Institute of Technology, 1994-1996.

Committees

Member of the program committee for the *MICCAI workshop on Analysis of Functional Medical Images* 2008.

Member of the program committee for *MICCAI 2007, the 10th International Conference on Medical Image Computing and Computer Assisted Intervention* 2007.

Member of the ECCV program committee, *European Conference on Computer Vision*, 1992-2001.

Chairman of IAPR - TC14, 1994-1998, *International Association for Pattern Recognition - Technical Committee for Image Processing*.

Member of the ICPR2002 program committee, *International Conference on Pattern Recognition*.

Member of the advisory committee for '*The Clinical Use of Medical Images - the Present and the Future*', The Summer University of Southern Stockholm.

Member of the scientific program committee for *Statistical Methods for Image Processing workshop*. Uppsala, Sweden, 1999

PhD thesis opponent

Opponent for the review of:

Michael van Ginkel's PhD thesis *Image Analysis using Orientation Space based on Steerable Filters*, Delft Technical University, Netherlands, 2002.

Roger Lundquist's PhD thesis *Atlas Based Fusion of Medical Brain Images*, Uppsala University, 2001

Scientific Evaluations

Evaluation of scientific qualifications of:

Irene Gu for appointment as Professor, Chalmers University of Technology, 2008.

Fredrik Bergholm for appointment as Professor, Uppsala University, 2001.

Vito Roberto for appointment as Professor, University of Udine, Italy 2000.

Stefan Carlsson for appointment as 'oavlönad docent' at KTH (The Royal Institute of Technology) 1995.

Thesis reviews

Member of the review committee for:

Jens Nilsson's Ph.D thesis *Manifold Learning in Computational Biology* LTH, 2008.

Barbara Caputo's *A New Kernel Method for Object Recognition: Spinn Glass-Markov Random Fields* KTH, 2004.

Anna Linderhed's PhD thesis *Adaptive Image Compression with Wavelet Packages and Emprical Mode Decomposition* LiTH, 2004.

Mattias Aronsson's PhD thesis *On 3D Fiber Measurements of Digitized Paper - From Microscopy to the Fiber Network* SLU, 2002.

Henrik Turbell's Ph.D thesis *Cone-Beam Reconstruction using Filtered Backprojection*, LiTH, 2000.

Carsten G. Bräutigham's Ph.D thesis *A Model-Free Voting Approach to Cue Integration*, KTH, 1998.

Håkan Andersson's Ph.D thesis *Error-Correcting Codes Based on Chaotic Dynamical Systems*, LiTH, 1998.

Anders Holst's Ph.D thesis *The Use of Bayesian Neural Networks for Classification Tasks*, KTH, 1997.

Mirek Novak's Ph.D thesis *Fractal Methods for Greyscale Image Data Compression*, LiTH, 1997.

Caroline Jacobson's Ph.D. thesis *Fourier methods in 3D-reconstruction from cone-beam data*, LiTH, 1996.

Atsuto Maki's Ph.D. thesis *Stereo Vision in Attentive Scene Analysis*, KTH, 1996.

Jonas Sjöberg's Ph.D thesis *Non-Linear System Identification with Neural Networks*, LiTH, 1995 .

Member of the review committee for Antonio Franciscos PhD thesis *Active Structure Acquisition by Continuous Fixation Movements*, KTH, 1994.

Official Licentiate thesis reviewer for:

Sanbao Xu's Licentiate thesis *Motion and Optical Flow in Robot Vision*, LiTH, 1994.

Journal reviews

Have on a number of occasions acted as reviewer for the journals: *IEEE Transactions on Image Processing, Journal of Image Processing, Computer Methods and Programs in Biomedicine, IEE Proceedings, IAPR Pattern Recognition Letters and Signal Processing*,

Patents

The numbers refer to the publication list, section 14

[301] Pending US patent concerning visualization of data-volumes.

[302] Swedish patent for measuring curvature and color of the ear-drum.

[303] United States patent for performing non-rigid registration of images in digital subtraction angiography.

[304] - [309] Swedish and United States patents of methods for producing different local features in images, see section 8.

8 Industrial Activities

Participated, together with Professor Gösta Granlund, in the launching of the image processing company **Context Vision** AB in Linköping. This process involved activities at several different levels, from signal processing knowledge transfer to potential investor contacts.

During the employment at Context Vision a large part of the work consisted in the development of efficient signal processing algorithms and specification of user friendly interfaces for the image processing system **GOP 300**. The work also involved the preparation of a number of patents that were later tied to the company, [304] - [309]. The algorithms developed are still the core of many of the products currently supplied by the company.

Have since then during various periods been active as consultant for Context Vision. The work has partly consisted in transfer of knowledge gained through research at the Image Processing Laboratory at the department of Electrical Engineering at Linköping University. Other parts of the work has had a more company-specific nature, for example:

1. Design of hardware for real time processing of video signals.

This commission was carried out in collaboration with the French telecommunications company **TRT** and mainly consisted in the development of integrated circuits for specific purposes.

2. Production of specifications for processing of two and three dimensional signal using real time hardware

This commission implied design of image processing hardware configurations using the circuits and chips manufactured by **TRT**.

Algorithms developed in the *Spatio-temporal Subtraction Angiography* and the continuation projects were implemented in the SECTRA Imtec AB system IDS4. Our group was also involved in a VINNOVA supported project for Computer Aided Detection (CAD) in cooperation with MAMEA Imaging in Stockholm.

The development of new methods in our group has been closely followed by Context Vision AB and algorithms for 3D and 4D signal processing have been investigated by the company in collaboration with our group. The research, supported by VINNOVA - see section 6, has enabled Context Vision to start the development of a new line of products performing fast true 3D image enhancement.

9 Teaching and Course Development

A substantial part of my activities have been related to the educational role of the university. The work has involved developing, producing texts and teaching aids for, lecturing in and being responsible for undergraduate and doctorate courses. An example of this work is the textbook 'Signal Processing for Computer Vision, [1] presently used as the main text for M.S.-level courses. A brief account of activities is given below.

My general view on education is that the best way to engage students and awaken their interest is to be an engaged teacher. One way to accomplish this is to constantly bring in new elements in the teaching. New material (preferably related to your own interests and research), new protocols etc. An additional route to success is to activate the students by defining projects (or make them define them) that should be carried out. I'm strong believer in 'learning by doing'.

Undergraduate courses

All at Linköping University.

Biomedical Modeling and Simulation Masters course, 2008. Development of part of a new course, Definition of problems and exercises.

Medical Image Analysis 4:th year (M.S. level), 2003-present.

Development of new course, Definition of problems and exercises, Development of teaching aids, Lectures, Examination, Course responsibility.

Classification Learning and Neural Nets 4:th year (M.S. level), 1995-2000. The course is still given.

Development of new course, Definition of problems and exercises, Development of teaching aids, Lectures, Examination, Course responsibility.

Computer Vision - 4:th year (M.S. level), 1987-1997. The course is still given.

Development of new course, Co-author of textbook '*Signal Processing for Computer Vision*'[1], Lectures, Examination, Course responsibility (1990-1994), The textbook is also the main text for the course **Multidimensional signal processing**.

Electronic systems design - 4:th year (M.S. level), 1977-1994

Development of new course, Project catalogue, Lectures, Examination, Course responsibility.

Optoelectronics - 4:th year (M.S. level), 1976-1995

Exercise and laboratory classes, Definition of problems and exercises, Development of texts and teaching aids, Development of laboratory exercises, Lectures, Examination, Course responsibility (1986-1995).

Applied electronics - 1:st year, 1975-1977

Exercise and laboratory classes

M.S. theses (Final year projects)

Supervision, Examination. On average roughly 5-10 projects/year within the areas of: Computer Vision, Medical Image Processing, Learning and Neural Nets, Optoelectronics and Analog Electronics.

Doctorate courses

Kernel methods for Pattern analysis, 7.5p (Seminars and examination) 2007, Linköping University

Differential geometry, 7.5p (Organisation and examination) 2006, Linköping University

Level Sets and ITK, 3p (National course, Organisation and examination) 2005, Linköping University

Tensor Analysis, 6p (Organisation and examination) 2004, Linköping University.

Image Processing in Medicine 2002, Linköping University (Cortech tutor, sponsored by SSF).

Wavelets and Signal Processing 7.5p (Seminars and examination) 2000, Linköping University.

Adaptive Multidimensional Image Analysis, (Seminars and examination) 1998, Technical University of Denmark.

Learning and Neural Computation, (Seminars and examination) 1996, Linköping University.

Filtering of Irregular and Uncertain Data, (Seminars and examination) 1995, Linköping University.

Multidimensional Adaptive Filtering and Analysis, G. Granlund and H. Knutsson, 1991, Linköping University.

An Introduction to Artificial Intelligence, G. Granlund and H. Knutsson, 1988, Linköping University.

10 Doctorate Student Supervision

An important part of the activities at the department of electronic engineering is the supervision of doctorate students. A constant effort in this work has been to produce a creative environment. Frequent discussions where the students feel free to discuss their thoughts and problems constitute a major part of the supervisory activities. In these discussions consequences of alternate research routes are considered and the presentation of 'ready made truths' are avoided. In this way the students have been encouraged to gain insights 'of their own'. Apart from being being most rewarding to the supervisor this platonic teaching approach has been very well received and given excellent results.

PhD dissertations

Have been the main supervisor for the 13 PhD theses listed below and official main supervisor for the nine most recent.

A Multidimensional Filtering Framework with Applications to Local Structure Analysis and Image Enhancement Björn Svensson, LiTH No 1171, Apr 2008.

Manifolds in Image Science and Visualization Anders Brun, LiTH no 1157, Jan 2008.

Advanced MRI Data Processing Joakim Rydell, LiTH No 1140, Dec 2007 (50/50 Main supervisor/Assistant supervisor)

Adaptive Analysis of Functional MRI Data
Ola Friman, LiTH No 836, 2003.

Motion Estimation for Perceptual Image Sequence Coding
Kenneth Andersson, LiTH No 794, 2003.

Motion Estimation and Compensation in Medical Imaging
Magnus Hemmendorff, LiTH No 703, 2001.

Learning Multidimensional Signal Processing
Magnus Borga, LiTH No 531, 1998.

Reinforcement Learning and Distributed Local Model Synthesis
Tomas Landelius, LiTH No 469, 1997.

Focus of Attention and Gaze Control for Robot Vision
Carl Johan Westelius, LiTH No 379, 1995.

A Tensor Framework for Multidimensional Signal Processing
Carl-Fredrik Westin, LiTH No 348, 1994.

Controllable Multidimensional Filters and Models in Low Level Computer Vision
Mats Andersson, LiTH No 282, 1992.

Adaptive Multidimensional Filtering
Leif Haglund, LiTH No 284, 1992.

Hierarchical Curvature Estimation in Computer Vision
Håkan Bårman, LiTH No 253, 1991.

Licentiate dissertations

Have been the main supervisor for the following 11 Licentiate theses.

Multidimensional MRI of Cardiac Motion
Andreas Sigfridsson, LiTH No 1262, 2006

Fast Multi-dimensional Filter Networks Design, Optimization and Implementation
Björn Svensson, LiTH no 1245, 2006

Manifold Learning and Representations for Image Analysis and Visualization
Anders Brun, LiTH No 1235, 2006

Adaptive Spatial Filtering of fMRI Data
Joakin Rydell, LiTH No 1200, 2005

A Bayesian Framework for Image Denoising
Andreas Wrangsjö, LiTH No 1109, 2004

Spatio-temporal Filtering of Ultrasound Image Sequences
Nina Eriksson Bylund, LiTH No 1077, 2004

Quality and Motion Estimation for Image Sequence Coding
Kenneth Andersson, LiTH No 928, 2002.

Single and Multiple Motion Field Estimation
Magnus Hemmendorff, LiTH No 764, 1999

Reinforcement Learning Using Local Adaptive Models
Magnus Borga, LiTH No 507, 1995.

Behavior Representation by Growing a Learning Tree
Tomas Landelius, LiTH No 397, 1993.

Preattentive Gaze Control for Robot Vision
Carl-Johan Westelius, LiTH No 322, 1992.

Current PhD Supervision

I am currently supervising the following PhD students:

Anders Eklund, IMT LiU.

Qaiser Mamhood, IMT LiU.

Andreas Sigfridsson, IMV LiU.

(From Sept 2008 also Daniel Forsberg, Sectra/IMT)

11 Invited Popular Science Seminars and Tutorials

Short list of invited popular science seminars and tutorials:

Some Examples of Advanced Medical Image Processing at CMIV
NOBIM 2008 - Norwegian Conference in Image Processing and Pattern Recognition, Trondheim, Norway, June 2008

The Morphon: A Robust Tool for Image Fusion and Segmentation
University of Warwick, UK, May 2008

Images and Mainfolds - Signal processing goes round the bend
British Machine Vision Conference, University of Warwick, UK, September 2007

The manifold ways of image analysis
University of Hawaii at Manoa, USA, April 2007

Medical Image Science and Visualization in Linkoping
(times 2) University of La Laguna, Teneriffe and University of Las Palmas de Gran Canaria, 2005

Medical Image Science and Visualization
20-year celebration of CMT at LiU, 2005.

What's so good about quadrature filters?
ICIP conference, Barcelona 2003.

A few High Points of Medical Informatics at Linköping University
DTU Vison Days
Technical University of Denmark, Copenhagen 2002.

The Image of a Thought
International presentation of Linköping University (TV coverage)
Linköping 2002.

Finding needles in hay stacks
CUGS conference, Stockholm 2002.

Task driven feature generation: Finding relevant relations in high-dimensional signal spaces.
MIT AI-Laboratory, Boston, MA, USA, 2001.

Automated Generation of Representations in Vision
ICPR2000 15:th International Conference on Pattern Recognition,
Barcelona, Spain, 2000.

Bildbehandling inom medicinen
Årsmötet för Svenska föreningen för medicinsk

teknik och fysik,
Göteborg, 2000.

Learning Visual Operators from Examples: A New Paradigm in Image Processing
ICIAP'99 10:th International Conference on Image Analysis and Processing,
Venice, Italy, 1999.

Learning Multidimensional Signal Processing
ICPR'98 14:th International Conference on Pattern Recognition,
Brisbane, Australia, 1998

Generating Image Operators from Examples
GOPUS'97,
Copenhagen, Denmark, 1997

Sequences of X-ray Images
SSHP:s 20-års Jubileum (Swedish Society of High Speed Photography)
Linköping, 1996

Robot Vision
Biologik Konferens
Stockholm, 1990

Image Processing
Pharo's teknikdag
Linköping, 1990

Tensors and Image Processing
University of Warwick, Great Britain, 1987

12 Honours, Awards and TV

'The Gold Mouse' Our fMRI research was awarded the best Swedish IT-project 2001 price. (NyTeknik:s Framstegspris)

TV-Presentation of the awarded fMRI project on local TV news (Östnytt) and on the nationally broadcasted news program 'Landet runt' 2002.

Erna Ebelings Pris 2000, For development of important generic methods in image processing (The Swedish society for biomedical engineering and physics). 31.000 Skr

Saab-Combitech Stipendiet 1984, 25.000 Skr

13 International Contacts

Short list of personal international academic contacts:

Edward Adelson, Prof., MIT, Boston, USA

Fritz Albregtsen, Prof., Oslo University, NORWAY

Yiannis Aloimonos, Prof., University of Maryland, College Park,USA

Charles Anderson, Ass Prof, Colorado State University, Colorado, USA

Ruzena Bajcsy, Prof., University of Pennsylvania, Philadelphia, USA

Dana Ballard, Prof., University of Rochester, Rochester, USA

Knut Conradsen, Prof., Technical University of Denmark, DENMARK

Prof. Rachid Deriche Institut National de Recherche en Informatique et en Automatique , France

Prof. Olivier Faugeras Institut National de Recherche en Informatique et en Automatique , France

Alan Gevins, Director, EEG Systems Laboratory, San Francisco, USA

Erik Granum, Prof., Ålborgs University, Ålborg, DENMARK

Steven Haker, PhD, Brigham and Womens Hospital, Boston, USA

Josef Kittler, Prof., University of Surrey, ENGLAND

Prof. Carlos Alberola-López, Universidad de Valladolid, Spain

Peter MacLeish, Prof., Morehouse School of Medicine, Atlanta, USA

Prof. Benoit Macq, Université Catholique de Louvain, Belgium

Erkki Oja, Prof. Helsinki University of Technology, Helsinki, FINLAND

Prof. Juan Ruiz-Alzola, Universidad de Las Palmas de Gran Canaria, Spain

Giulio Sandini, Prof., University of Genoa, Genoa, ITALY

Dr. Jean-Philippe Thiran, Echole Polytechnique Fédérale de Lausanne, Switzerland

Prof. Joachim Weickert, Universität des Saarlandes, Germany

Carl-Fredrik Westin, PhD, Harvard Medical School, Boston, USA

Torsten Wiesel, President Emeritus, Rockefeller University, New York, USA

Roland Wilson, Prof., Warwick University, Coventry, ENGLAND

14 List of Publications

A total of more than 300 publications of which one text book, nine patents and more than 200 full papers in international journals, books or fully reviewed international conference proceedings.

Monographs

References [1] and [2]

Refereed international journal publications

References [6] - [31]

Book chapters

References [35] - [49]

Refereed international conference publications (Full papers)

References [58] - [184]

Refereed international conference publications (Abstracts and other)

References [189] - [204]

Reports and national conference publications

References [205] - [300]

Patents

References [301] - [309]

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reconstruction. In *International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI'07)*, volume II, pages 385–392, Brisbane, Australia, October 2007.

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