Vetenskapsrådet

Application

2015-03-31

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Project site: 3202 - Signalbehandling och medicinsk teknik

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Descriptive data

Project info

Project title (Swedish)*

Stokastiska Modeller och Metoder för Domän-Adaptiv Klassificering och Maskininlärning av Mänskliga Rörelsemönster

Project title (English)*

Stochastic Models and Methods for Domain-Adaptive Classification and Machine Learning of Human Activities

Abstract (English)*

This proposed project aims at investigating stochastic models and methods for machine learning and classification of human activities in videos. Recognizing human activities is highly relevant as the core methodology underlying many applications. Examples of such applications include assisted-living for elderly or disabled, smart homes, autonomous driving, computer-aided medical diagnosis, and many more. Since each human activity is described by a time sequence of images, learning an activity requires carefully selecting models for characterizing its appearance and shape dynamics, and contextual information. Manifolds describe activities efficiently in terms of low-dimensional subspaces. At each time instant, a video activity typically shifts to a slightly different subspace, especially when non-planar motion occurs. Using a set of manifold points to describe a dynamic activity is hence equivalently to using a set of slowly shifting subspaces (or, domains) as its mathematical representation. Once an activity has been effectively modeled mathematically by points on a smooth manifold consisting of a set of subspaces, finding domain-adaptive classification methods becomes the natural next step for efficiently recognizing different activities.

Motivated by the above, this project proposes to study domain-adaptive models, methods and classifiers. The main aims of the project include: i) Theoretical study of some selected topics on smooth manifolds, in terms of stochastic modeling, analysis, estimation, and classification of dynamic activities; ii) Mathematic formulation that associates points on the appearance and shape manifolds of the same activity; iii) Investigation of feature descriptors, metrics and criteria for manifold-based classification. The project is aimed at achieving the objectives via: a) Develop stochastic models and Bayesian estimation on the smooth manifolds for dynamic activities, and establish relations between two manifolds representing the appearance and shape of activities; b) Develop domain-adaptive classification methods, through investigating kernel-SVMs on the manifolds, and seeking effective manifold metrics and criteria; c) Seek effective parts-based salient feature descriptors for characterizing activities based on dynamic appearance, shape, and contextual information; d) Apply these methods to case studies on a few selected issues in human activity analysis and classification.

Some possible methods are proposed, among many others, a nonlinear state-space model for manifold points and their tangent spaces; Bayesian estimation and particle filters on the nonlinear manifolds, and relating two manifolds through joint probability functions; Kernel-SVMs built on manifold-based classifiers, kernel metrics for similarity such as Stein divergence kernels.

The implementation of the project is done as follows: Members in the project consists of one new PhD student and 5 senior researchers from Chalmers, KTH, Linköping University and Sahlgrenska university hospital. This provides strong expertise and collaboration in the proposed research. The members in the project will regularly discuss scientific progress and the PhD student will visit the partner universities. The project is significant in terms of: a) The basic research for developing theories and methods in pattern classification and machine learning on the smooth manifolds. While theories and methods are relatively well established in the vector space, investigations on the nonlinear smooth manifolds are still much lack of. Developing these methods would, in return, benefit many applications that have large impact to the society; b) The collaboration among experts in 4 different universities is another important aspect. Through this project, extended research collaboration and knowledge exchanges are expected; c) The project is expected to benefit the education, generating new teaching courses and organizing workshops.

Popular scientific description (Swedish)*

Det föreslagna projekt syftar till att undersöka stokastiska modeller och metoder för maskininlärning och klassificering av mänsklig aktivitet i video. Undersökningen är viktig då metoderna utgör grundläggande byggstenar för många tillämpningar. Exempel på sådana tillämpningar är, bland många andra, stöd för hemtjänst för äldre eller handikappade, smarta hem, trafiksäkerhet, autonom körning, datorstödd medicinsk diagnos, intelligenta och cyberfysiska system.
Att automatiskt klassificera typen mänsklig aktivitet, utifrån en sekvens av bilder, en video, kräver inlärningsmetoder och noggrann modellering för att beskriva aktivitetens utseende, form och dynamik inklusive kontextuell information. Den matematiska teorin kring mångfalder och associerade underrum kan användas för att beskriva varje aktivitet. En aktivitet i en video kan därmed effektiv representeras av en mängd punkter som ligger i underrum som långsam förflyttas i tiden. Detta är speciellt användbart för rörelser som inte sker i planet eller om objektets pose ändras i videon.
Att använda en mängd punkter på en mångfald för att beskriva en dynamisk aktivitet är därmed ekvivalent med att som matematisk beskrivning använda en mängd underrum (eller domäner) som långsamt förändras. När en aktivitet effektivt kan beskrivas av punkter i en mängd av olinjärt relaterade underrum är det nästa naturliga steget att finna domän-adaptiva klassificeringsmetoder för att effektivt känna igen olika aktiviteter.

Motiverat av ovanstående kommer vårt projekt att undersöka några effektiva domän-adaptiva modeller och metoder. Målet är att utveckla domän-adaptiva klassificeringsmetoder på de släta mångfalderna. Vi kommer att utveckla stokastiska modeller, Bayesiansk estimering och klassificering på de släta mångfalderna. Även om dessa modeller och metoder är väl utvecklade i vektorrum, är metodiken underutvecklad i litteraturen vad det gäller olinjära mångfalder. Vi kommer också studera speciella egenskapsbeskrivningar och separata mångfalder för dynamiska utseenden och former för individuella aktiviteter. Eftersom de representerar samma aktivitet kommer den matematiska beskrivningen utnyttjas för att associera dessa två mångfalder. Som klassificerare kommer vi utveckla kernel support vector machines på mångfalderna, och utveckla effektiv metrik på mångfalderna för att jämföra likheten mellan en okänd aktivitet och en prototyp aktivitet beskriven på de olinjära mångfalderna. Vi kommer även att genomföra tre fallstudier som rör; aktivitet i äldreboende, datorstödd diagnos av neurologisk sjukdom hos nyfödda, samt autonom körning.

Projektet kommer genomföras med en ny doktorand och fem seniora forskare från Chalmers, KTH, Linköpings universitet och Sahlgrenska universitetssjukhuset. Detta ger en stark kompetens och samverkan inom den föreslagna forskningen. I Projektet kommer regelbundna möten anordnas, och doktoranden kommer genomföra besök på de olika deltagande lärosätena. De förväntade resultaten av projektet är betydande. Inte bara de vetenskapliga resultaten är viktiga för berörda forskningsområden och deras tillämpningar, utan kommer även resultera i fördjupade samarbeten under projektets löptid. Projektet förväntas dessutom att gynna utbildningen, genom att nytt material kommer kurser tillgodo på grund-, avancerad och doktorandnivå.

Project period

Number of project years*

4

Calculated project time*

2016-01-01 - 2019-12-31

Classifications

Select a minimum of one and a maximum of three SCB-codes in order of priority.

Select the SCB-code in three levels and then click the lower plus-button to save your selection.

SCB-codes*	2. Teknik > 202. Elektroteknik och elektronik > 20205. Signalbehandling

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Enter a minimum of three, and up to five, short keywords that describe your project.

Keyword 1*

Stochastic models and methods

Keyword 2*

Pattern Classification and Machine Learning

Keyword 3*

Video analysis

Keyword 4

Smooth Manifolds

Keyword 5

Domain-adaptive learning

Research plan

Ethical considerations

Specify any ethical issues that the project (or equivalent) raises, and describe how they will be addressed in your research. Also indicate the specific considerations that might be relevant to your application.

Reporting of ethical considerations*

The project will follow and obey all the general ethical rules for scientific research and research collaboration.
There are no special ethical issues in this project.
Video data we would use, are from publically available dataset, or made by ourselves at Chalmers or Linköping University.

The project includes handling of personal data

No

The project includes animal experiments

No

Account of experiments on humans

No

Research plan

Stochastic Models and Methods for Domain-Adaptive Classification and Machine Learning of Human Activities

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March 2015

Project Proposal för Vetenskapsrådet

1 Purpose and Aims

There is a growing interest in pattern classification and machine learning theories and methods due to requirement from a wide variety of applications as well as a large amount of data available lately. These applications, among many others, include activity analysis and recognition in health/elderly care, traffic safety and autonomous driving, diagnosis systems, ambient intelligence and cyber-physical systems. Pattern classification and machine learning are one of the core theories underlying these applications. Many basic research issues remain open and challenging. For example, domain-adaptive classification and learning have drawn much interest lately, where one employs a set of low-dimensional subspaces on nonlinear manifolds for signal processing. New theories and methodologies on nonlinear smooth (differentiable) manifolds, in parallel to much studied theories in the vector space, need to be studied. Some examples of the topics include manifold-based analysis, estimation, learning, tracking and classification. For analyzing human activities in video, one needs to consider some complex issues, and to properly represent the temporal and contextual information in appearance and shape of individual activity during a certain time interval. The purpose of this project is to study some domain-adaptive machine learning and classification theories, models and methods. Main aims of this project proposal include:

- Theoretical study of some selected topics on *smooth manifolds*, in terms of stochastic modeling, analysis, estimation, and classification of dynamic activities;
- Mathematic formulation that associates points on the appearance and shape manifolds of the same activity;
- Investigation of feature descriptors, metrics and criteria for manifold-based classification.

More specifically, the project is aimed at achieving the following objectives:

(a) Develop stochastic models and Bayesian estimation on the *smooth manifolds* for dynamic activities, and establish relations between two manifolds representing the appearance and shape of activities;

(b) Develop domain-adaptive classification methods, through investigating kernel-SVMs on the manifolds, and seeking effective manifold metrics and criteria;

(c) Seek effective part-based salient feature descriptors for characterizing activities based on dynamic appearance, shape, and contextual information;

(d) Apply methods in (a)-(c) to three case studies on *a few selected issues* in human activity analysis and classification.

2 Survey of the Field

There have been increasing interest in developing new effective theories and methods for pattern classification and machine learning lately. This is partly driven by the requirement from a large variety of real world applications, where underlying theories and methodologies are rather similar despite these applications look rather different on the surface. We briefly mention several application examples where small case studies will be conducted after the main investigation of the basic theories and methodologies in this project. One application example is related to smart home care for disabled or assisted living for elderly [1]. Many studies have been conducted on activity classification based on visual information analysis and modeling [22, 41, 43, 29, 23]. Among a variety of classification methods studied, SVMs, boosting, decision forests, HMMs, deep (structured) learning, and manifolds [30, 44, 17] are among the most promising ones. One of the key issues in activity classification is to efficiently characterize and learn dynamic contextual patterns, where manifolds are found to be attractive for efficient low-dimensional description of object dynamics [39, 33, 34]. Another application example is related to autonomous driving, traffic safety, and advanced driver assistance system,

which have drawn considerable interest lately [4]. In such an application, one often requires to analyze road traffic, (e.g. the number and types of vehicles on road, the speed of vehicles, the distance between vehicles), to track and recognize traffic signs, to detect/classify driver's activities and inattention [25, 24, 19]. The third application example is related to computer-aided diagnosis of neurological dysfunctions. It is noticed by medical doctors that central nervous system dysfunctions of infants may be manifested through inconsistent, rigid and abnormal limb movements, and early treatment may improve their development[26]. Computer-aided video analysis may provide semi-automatic diagnosis through tracking, analysis and recognizing patterns of abnormal limb movements [28, 27].

Common *underlying issues* in many such applications are related to finding robust classification and machine learning models and methods, where this project will be focused on tackling some of these issues. We brief review some of theories and methods related to our proposed studies.

Domain-adaptive classification has drawn increasing interest as it exploits low-dimensional subspaces for efficient representation of high-dimensional signals. It is also known to be effective to handle visual objects with non-planar pose changes through domain-adaptation [30, 18]. Among them, manifold-based methods have attracted much attention lately, in different aspects, e.g., object modeling, tracking, learning and classification[34, 17, 44]. It is attractive not only due to low-dimensional signal representation, but also due to maintaining geometry, topology and other important signal properties. Among many types of manifolds, smooth (continuous and differentiable) manifolds are of particular interest, where metrics and operators may be defined on such manifolds. Among many manifold-based methods, stochastic modeling, estimation and classification of dynamic activities are of particular interest.

Machine learning of activities is another important issue, where each *dynamic* activity is represented by a sequence of images. An activity may be described by a time-evolving appearance and shape and the contextual information of object-parts interacting with background objects. Further, objects may experience out-of-plane pose changes, occlusions and intersections during the activity, making machine learning of objects/activities a challenging issue [22, 34]. Finding effective feature descriptors is another important issue for machine learning of activities. Among them, many part-based appearance features (e.g. histograms of oriented gradients (HoG), histogram of optical flows (HoF), Gabor features) and shape features [37], bags of words (BoW)[36], and color and texture features [11, 12] have been studied. Visual-saliency is another interesting subject that has been exploited lately [20, 21]. Visually salient regions refer to the areas/objects in the scene that human eyes are usually focused on, or pay attention to. Most studies on visual-saliency are on detection of saliency objects/areas [2]. More research is needed for effective saliency-enhanced features and classifiers.

3 Project Description

In this section, we shall describe the main methods and techniques to be investigated (Sections 3.1 and 3.2), and case studies of some issues in three applications (Section 3.3).

3.1 Domain-adaptive modeling, Bayesian formulation, and methods for learning and classification of dynamic activities

Human activities in videos frequently contain non-planar (or, out-of-plane) movement of objects, as real world 3D dynamic scenes in a video is captured as 2D in time. Without exploiting 3D modeling, a classifier needs to be efficient and insensitive to non-planar changes in activities. New effective methods for domain-adaptive classification are needed. We plan to focus on manifold-based methods, by investigating novel models, learning and classification methods on the smooth manifolds for dynamic activities. The rationale behind this choice is that manifolds are found suitable for characterizing non-planar activities as it consists of all k-dimensional subspaces from a high n-dimensional

space [39, 40]. Smooth (differentiable) manifolds are of particular interest as metrics and operators can be defined and performed on these manifolds.

Manifold-based state space modeling, manifold Bayesian formulation, and manifold-based particle filters will be studied for dynamic activities. Since each dynamic activity can be described as a set of time-dependent points (related to the subspace spanned by the feature vectors) on a smooth manifold, dynamic modeling of an activity can be set, e.g. by nonlinear state-space model under a constant position and velocity model *on the manifold*,

$$\begin{cases} C_t = h(C_{t-1}, \Delta_t) = \exp_{C_{t-1}}(\Delta_t) \\ \Delta_t = \Delta_{t-1} + v_1 \end{cases} \tag{1}$$

where Δ_t is the velocity vector in the tangent plane of a given manifold point, C_t is the covariance matrix of activity features at t, $\exp_{C_{t-1}}(\cdot)$ is a nonlinear exponential mapping function (from the tangent plane of a given point to the manifold), and v_1 is the model noise assuming zero-mean white. Eq.(1) is defined in two different but interrelated spaces (manifold and tangent planes). Depending on the activity of interest, the model could also include the acceleration term in the state vector. It is worth noting that, this model is a natural extension from our previous one on manifold-based object tracking, however, the current model for "activities" will be more complex. Key difference arises since: (a) learning activities is more complex than learning objects, where the former one requires modeling a sequence of time-dependent features from dynamic appearance, shape and contextual information from the foreground object (human) of interest as well as that of the interacting background object parts (e.g. cup, sofa, table); (b) our previous work only studied appearance models on the manifolds, while this study will include shape models on the manifolds as well; (c) Part-based foreground activity and background objects need to be considered. The investigation in this part can be outlined as seeking shape models on the manifolds, Bayesian formulation on the manifolds, and particle filters on the manifolds for part-based single/multi-view activities. Our studies will be conducted using the methods similar in the spirit of our previous appearance-based manifold tracking work [33, 34].

Methods for associating shape and appearance manifolds of individual activity is another interesting topic that we will investigate. Emphasis in this part is on seeking stochastic models, e.g. stochastic process of joint dynamic shape and appearance under some geometrical and topological constrains in the spatial domain. In the conventional vector space study, the posterior pdf with nonlinear non-Gaussian distributed signals can be estimated recursively, e.g., by particle filters,

$$p(x_t|z_{0:t}) \propto p(z_t|x_t) \int p(x_t|x_{t-1}) p(x_{t-1}|z_{0:t-1}) dx_{t-1} \tag{2}$$

In our study, the state vector consists of shape and appearance components constrained by some parameters, $x_t(\beta) = [x_t^s(\beta^s)\ x_t^a(\beta^a)]^T$, transition probability becomes $p(x_t|x_{t-1}) = p(x_t^s|x_{t-1}^s)p(x_t^a|x_t^s, x_{t-1}^a)$ if the shape is independent of appearance, and the likelihood $p(z_{0:t}|x_t, \beta)$ contains the latent parameter vector β as the geometrical constraint, x_t and z_t are on the manifolds. Based on our previous work on the manifold characterization of object appearance, our study here will be focused on formulating problems under joint shape and appearance manifolds under some constrains, in particular, attentions will be given on models for geometrical constraint parameter vector, particle filters built on the manifold, kernel-based models on the manifold, models that associate shape and appearance manifolds, and efficient techniques for the implementation. One way is to formulate the problem as Bayesian estimation of joint posterior state vector, once the relations of shape and appearance manifolds are established. One idea is to model an activity through joint probability function (pdf) on a sequence of manifold points, where points on two smooth manifolds (for shape and appearance) from a same activity are linked by component pdf and conditional pdf as described above. It is worth mentioning that although [46] uses joint shape and appearance manifolds built on under latent variable models under topological constraints [31], these experimentally formed manifolds are not smooth and hence

difficult to apply metrics and operators on them. It is worth noting that many existing action classifiers are only designed for *cyclic* actions (e.g. walking) [38, 41, 42], whereas many activities studied in this project would be noncyclic (e.g. fall down) and hence our methods should be more generic.

Efficient methods for manifold-based classification of activities will be investigated. To build classifiers on the smooth manifold, we shall start with investigating simple types of classifiers. One way is to 'extend' some previous existing classifiers from vector space to the smooth manifold, e.g., SVMs, AdaBoost, random forests, deep structured learning. Since manifolds are nonlinear, this is not a trivial extension. Our preliminary work has successfully extended SVMs onto the manifold for kernel-based manifold classification on static activity (i.e. from using image) [43], further investigation is needed to exploit such manifold-based classifiers on activities from videos.

3.2 Feature descriptors and metrics on the manifolds for machine learning

Finding discriminative feature descriptors, metrics and operators on the manifolds are another essential issues in machine learning, and in high performance classification of activities. The following sub-areas will be investigated:

(a) Robust feature descriptors for individual activity, its surrounding background, and their interactions. Based on our observations that recognizing a human activity usually does not require to consider the features from the entire human body, rather one only some small parts along with the interacted background object parts are needed. Though exceptions exist for a small number of activities (e.g., fall down) that may require features from the whole body. Many previous studies uses features extracted from the entire subject, which not only leads to a large size of feature vectors but also is ineffective. For example, the activity "drinking cafe/tea" only involves in hand(s) holding a cup being moved towards the mouth, while the remaining human body and background parts do not play any essential role, rather including all these parts as features may hamper the recognition. Our idea behind this is, hence, to *only* exploit important activity parts including the foreground human parts and background object parts. We shall select *some* of the candidate methods for our investigations, e.g., coarse-to-fine feature descriptors; part-based saliency-based features; BoW (Bags of visual Words) with a new aspect to include the dynamics and spatial connectivity/geometry of activity and background; graphs for relating different part-based features.

Coarse features will be exploited for the general description of individual activity. This is both for the efficiency and privacy concerns, as some features could be inherited from a previous detection or tracking process, further, videos could be removed after this part due to privacy and memory space concerns. Coarse features are naturally used in the activity models (Section 3.1). Basic components in each appearance and shape feature vector should be carefully chosen. Among them, we shall consider features, e.g., extended HoG (histograms of oriented gradients), HoF (histograms of oriented optical flow), skeleton-, geometry-, structure- and shape-related features, dense SIFT features, apart from other features that we studied previously studied.

Fine features will then be investigated as refined descriptors for individual activity within the area of interest, generating contextual-related dynamic parts-based salient features. Some candidate issues of interest to be selected for this study include: (a) BoW for parts-based features and graphs for relating contextual information; (b) dynamic features reflecting the time-evolving activity; (c) visual saliency-weighted features for selecting essential activity parts. We consider both contextual and dynamics are important aspects for characterizing activities since an activity often involves foreground human parts interacting with some background object parts [43] (e.g, "drinking cafe" contains a person's hand holding a cup and moves it towards the mouth), also, a normal or abnormal activity often depends on the surrounding context (e.g., lying in sofa is a normal activity, while lying on the ground could be the result of falling down). Based on the above thoughts, an example of our investigation can be outlined as follows (*noting some parts in the outline can be skipped, or as optional*): Forming a set of time

sequences of BoW on parts-based activity and its surrounding background; employing visual-saliency for selecting activity-parts and/or saliency-weighted features (using similar ideas from our previous study on saliency [20, 21]); Using tree-structure parts-based features and seeking graph models to associate these parts.

(b) Metrics and operators on the manifolds. Seeking effective metrics on the manifolds, that measure the similarity between an activity being recognized with the learned activities in the classifier, is another essential issues for designing the classifier, and is worth to study *when time is available in the project*. Otherwise, we can choose among commonly used manifold metrics, e.g., Riemannian or Karcher means, Riemannian distance, geodesic distance, and principle angles, instead. To examine the similarity of candidate activity to a set of learned activities in the classifier, one idea is to keep a list of parts-based multi-view, multi-instance learning (MIL) [47] activities during the learning, and apply some similarity measure when a new activity is to be recognized.

Several candidate metrics on the manifolds, that we are interested in investigating, are described below. Symmetric Stein divergence kernel on the SPD (Symmetric Positive Definite) manifolds is one of candidate metrics for our study. One reason is that kernel SVMs have been incorporated on the smooth manifolds in our previous study [44], and Stein divergence kernel can be easily employed as a kernel function in SVMs. The symmetric Stein divergence kernel is defined as,

$$K(\mathbf{X},\mathbf{Y}) = \exp\{-\sigma J_\phi(\mathbf{X},\mathbf{Y})\} \tag{3}$$

where $J_\phi(\mathbf{X},\mathbf{Y}) = \log(\frac{\det(\mathbf{X}+\mathbf{Y})}{2}) - \frac{1}{2}\log(\det(\mathbf{XY}))$, and $\mathbf{X}$, $\mathbf{Y}$ are matrices associated with manifold points. We could study this for similarity measure of activities. Another metric of interest for our study is the Hellinger distance measure, which is defined on a *statistical manifold* (i.e. a Riemannian manifold, where each of whose points is a probability distribution),

$$H(P,Q) = \frac{1}{\sqrt{2}}||\sqrt{P} - \sqrt{Q}||_2 \tag{4}$$

where $P = \{p_i\}_{i\in[n]}$ and $Q = \{q_i\}_{i\in[n]}$ are probability distributions supported on $[n]$. This distance measure would be of particular interest if we would consider the statistical manifolds, or employing pdf's as the description of points on the Riemannian manifolds. Finally, seeking mathematical formulations on the cost functions that minimize the generalization errors on the test sets for manifold classifiers is another general interest for us. We are interested in cost function formulated, e.g. by using Lagrangian equations, or with regularization terms. *Noting that the candidate methods mentioned in (b) will only be studied when there is available time in the project.*

3.3 Case studies: selected issues in application scenarios

Using the above developed methods, three case studies will be conducted which are selected from the following applications: human activity classification for smart home/elderly care; computer-aided diagnostics of neurological dysfunctions in infants; traffic sign and driver's activity classification for autonomous driving/vehicle safety. Each of them has significant social impact in its own right.

In the first (main) case study, we shall select several types of activities from the candidate list from our own Chalmers video dataset or public datasets, e.g.: fall down, lying down, eating food, drinking tea/cafe, look TV and reading. Algorithms for the methods in Sections 3.1 and 3.2 will then be developed and tested. The results will be examined and compared with our previous preliminary work [43, 44], to examine the impact of introducing some individual module methods, for example, by employing two inter-connected Riemannian manifolds on dynamic appearance and shape; by using the Stein-divergence metric as the kernel of SVMs (or, other metrics) on the Riemannian manifolds; by using saliency-enhanced feature descriptors; by using graph theory to connect parts-based features; and many more. The impact of manifold-based classification will finally be examined by comparing to some state-of-the-art classification results.

In the second (minor) case study, we shall examine the impact of using nonlinear state space model in (1) on Riemannian manifolds for analyzing the limb movement of infants, and compare the results to those obtained from our study by using Kalman filters in the vector space [28].
In the third (minor) case study, methods developed for manifold-based Bayesian estimation will be applied to road traffic analysis. Results will then be compared with our previous work on the vector space [25, 24], where the impact of manifold-based estimation will be examined.
It is worth mentioning that, the aim of these case studies is to test the feasibility of methods from the previous theoretical studies. To limit the scope of work in the project, the second and third case studies are designed to be small, despite the social impact of associated applications is equally significant as comparing to that in the first case study. Further, in the first case study, without loss of generality we only select a small class of activities (<15 classes) for our feasibility study.

4 Significance and Expected Outcome

The proposed project is significant, in terms of the following aspects:

(a) Basic research for developing new/novel theories and methods in pattern classification and machine learning on the smooth (differentiable) manifolds, especially, the following aspects of anticipated outcomes from the project:
   + Methods on nonlinear state-space modeling, stochastic modeling and Bayesian formulation of dynamic activities *on the manifolds*;
   + Methods on associating *on two manifolds* related to dynamic shape and dynamic appearance, for efficiently representing individual activity;
   + Methods for parts-based saliency-enhanced feature descriptors, manifold metrics and similarity measures, and kernel SVM manifold classifiers;
   + Validation of the developed methods through conducting case studies.

(b) Bringing up close collaborations among experts (and also students) in Chalmers, KTH, Linköping University and Sahlgrenska University Hospital. The project will also lead to strengthening the research depths and quality, exchanging and learning new knowledge, and creating more future joint research cooperations.

(c) Benefiting undergraduate and PhD education in image analysis, computer vision, pattern classification, and machine learning. Some joint courses for PhD and undergraduate students may be generated during this project. Also some workshops may be organized.

5 Preliminary Results

This section describes some preliminary research results that are closely related to the subjects in this proposal that may be beneficial to this project.
On stochastic modeling, learning, tracking, and classification of images/videos: We have many of previous theoretical studies conducted on these subjects. They will be both benefit to the in-depth theoretical studies as well set solid background expertise in this project. Some of these studies (most relevant) are briefly mentioned below, categorized according to different subjects.
Visual tracking: In our previous studies, we have developed several new visual object tracking methods in complex scenes [52, 48, 49, 33, 34, 10, 11, 35, 51, 50]. Among them, part work in manifold-based tracking [33, 34] can be regarded as pre-studies of this project, where Bayesian estimation on the Grassmann/Riemannian manifolds is purely formulated based on object appearance, using a nonlinear state space model. This lays the good foundation for further study by exploiting both shape, appearance and contextual information on two inter-related smooth manifolds. Our previous experience on other manifolds [15] would also be useful.

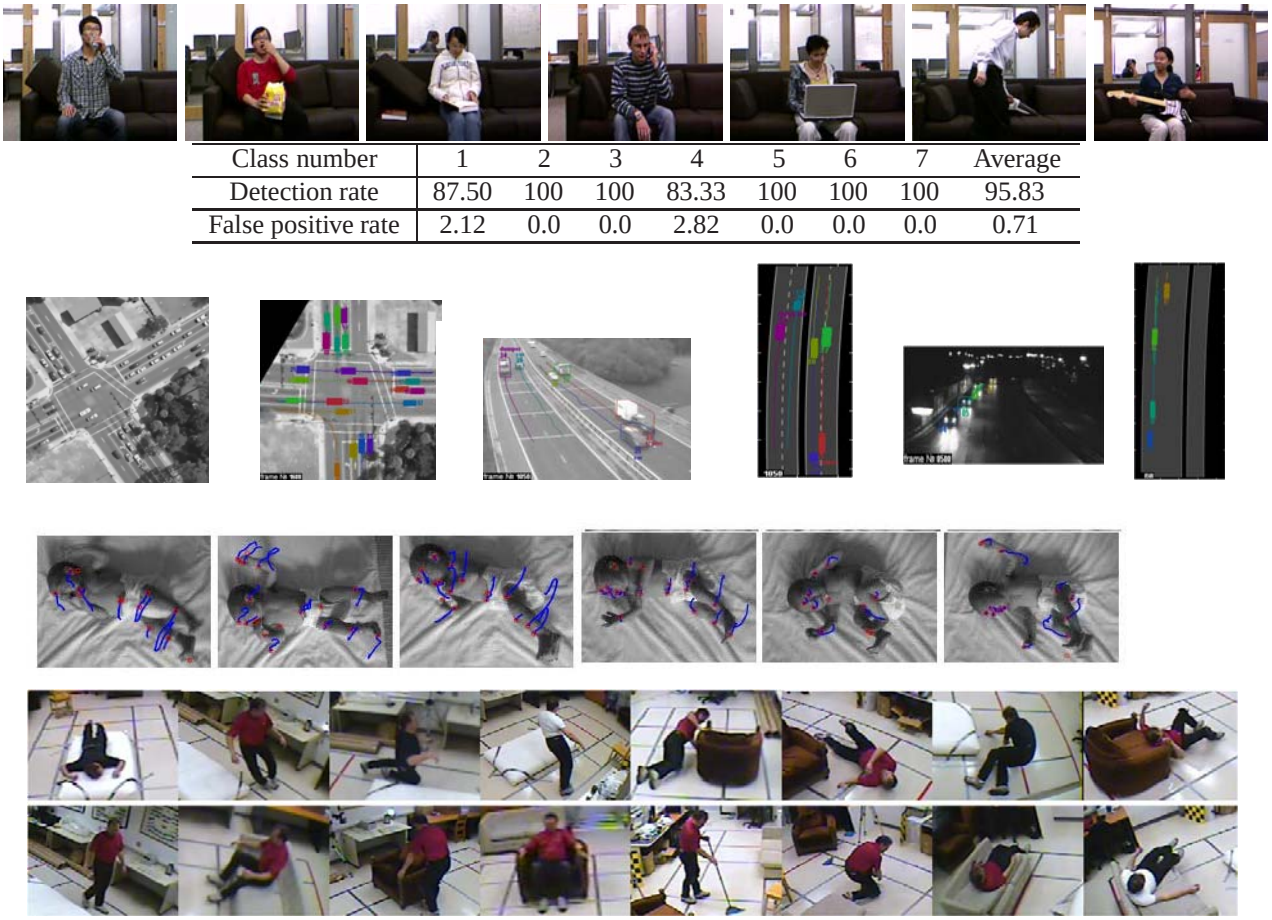
Activity/action classification: In our previous work, several studies were conducted on classification of small number of activities or actions from *still images* [43, 7, 59, 60, 53, 55, 13, 14], and a small number of dynamic human activities from *videos* [44]. These pre-studies are very useful for further in-depth studies in this project.

Online learning: Other related work from our previous studies is online learning of visual objects/actions [5, 6, 34, 16, 8]. They have laid good foundation and are very useful for in-depth studying in this project.

Feature descriptors: In our previous studies, many different feature descriptors were studied based on, e.g., context, shape, colors, appearances, textures [54, 56, 57, 58, 12, 8, 7]. Studies on salient object detection [21, 20] will also be useful to saliency-enhanced features and classifiers in this project.

Pre-study in the case study applications: In our previous studies, several related work to the case studies in the project have also been conducted. Using these developed methods and programs, we will be able to quickly set up some test beds for conducting the case studies. For example, programs developed and results obtained in multiple marker-based video tracking and analysis of infant limb movements [28], in traffic sign classification and road traffic analysis as well as driver's inattention [19, 25, 24], will be useful for the two minor case studies (in Section 3.3), where only modules related to the programs of newly developed methods need to be replaced for the testing. Further, previously obtained results can be used for comparison purposes. The programs and results from our pre-studies on activity classification [43, 44] will also be useful for setting up tests and comparing results.

Example of results: Figure 1 shows some results from our pre-studies.



Class number	1	2	3	4	5	6	7	Average
Detection rate	87.50	100	100	83.33	100	100	100	95.83
False positive rate	2.12	0.0	0.0	2.82	0.0	0.0	0.0	0.71

Figure 1: Preliminary results/pre-studies: Images in Row-1: activity classification *from static images* in [43]: 7 types of activities: drinking, eating, reading, phone calling, using laptop, vacuum cleaning, and playing guitar; and classification results (table); Images in Row 2: vehicle tracking and analysis in [25]; Row 3: infant limb movement tracking in [28]; Images in Rows 4-5: video frames used in pre-study of activity classification *from videos* in [44].

6 International and National Collaboration

Other main collaborators related to this project are:

- Prof. Hamid Aghajan, Ambient Intelligent Lab., Dept. of Electrical Eng., Stanford University (USA), and Ghent university (Belgium). Prof. Aghajan is a world leading expert on ambient intelligence with an emphasis on activity and behavior modeling. Our research collaboration has led to many joint publications in object tracking and activity classification. Prof. Aghajan is also a co-supervisor of one of our PhD students;
- Prof. Jie Yang, Institute of Image Processing and Pattern recognition, Shanghai Jiao Tong University - SJTU (China). Prof. Yang is an expert on image analysis and pattern recognition, and providing data for elderly care. Our research collaboration has led to many joint publications, and establishment of double degree PhD program between Chalmers and SJTU.
- Prof. Hamid Krim, Dept. of Electrical and Computer Engineering, North Carolina State Univ. (USA). Prof. Krim is a world leading expert on manifolds and geometry in computer vision. Our previous collaboration has led to one conf. publication, some discussions and visits.
- Medical Dr. Anders Flisberg, working at Sahlgrenska University Hospital and Östra Sjukhuset, our research collaboration is on video analysis of abnormal limb movement in infants.

7 Persons in the Project, Project Management, Time Schedule

Persons involved in the project: are summarized in Table 1.

Name	Position	2016 (%)	2017 (%)	2018 (%)	2019 (%)
Student A (to be recruited)	PhD student	100	100	100	100
Irene Gu	Professor (CTH)	20	20	20	20
Hedvig Kjellström	Associate Professor (KTH)	10	10	10	10
Michael Felsberg	Professor (LiU)	10	10	10	10
Magnus Thordstein	Docent (SU)	5	5	5	5
Tomas McKelvey	Professor (CTH)	5	5	5	5
Yixiao Yun	Existing PhD student	80	-	-	-

Table 1: Persons and percentage of time involved in the project

Management: Since this project includes partners from three universities and one university hospital, we shall properly manage the project such that all project partners will work together closely. Our plan is to have quarterly project meetings for all project members to discuss related research issues. More meetings will be arranged whenever needed. The project leader, Irene Gu, will be the main supervisor for the PhD student, Hedvig Kjellström and Michael Felsberg will both be the co-supervisors. The PhD student will mainly sit in Chalmers, however, will also make multiple visits and short-to-medium stays in Linköping University and KTH for conducting research in order to get more interactions with the co-supervisors and their PhD students.

Time schedule: An *approximate* time schedule for research is roughly planed as follows (Noting: the order of items in the list could be changed, also the time overlapping generally exists between items.

- Shape-based manifold methods (in Section 3.1): 6 months;
- Methods for associating shape and appearance manifolds (in Section 3.1): 5 months;
- Feature descriptors (in Section 3.2): 4 months;
- Metrics on manifolds (in Section 3.2): 4 months;
- Manifold-based classifiers (in Section 3.1) and main case study (in Section 3.3): 10 months;
- Minor case studies (in Section 3.3): 6 months;
- Licentiate and PhD thesis writing: 6 months.

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Interdisciplinarity

My application is interdisciplinary

☐

An interdisciplinary research project is defined in this call for proposals as a project that can not be completed without knowledge, methods, terminology, data and researchers from more than one of the Swedish Research Councils subject areas; Medicine and health, Natural and engineering sciences, Humanities and social sciences and Educational sciences. If your research project is interdisciplinary according to this definition, you indicate and explain this here.

Click here for more information

Scientific report

Scientific report/Account for scientific activities of previous project

---

Budget and research resources

Project staff

Describe the staff that will be working in the project and the salary that is applied for in the project budget. Enter the full amount, not in thousands SEK.

Participating researchers that accept an invitation to participate in the application will be displayed automatically under Dedicated time for this project. Note that it will take a few minutes before the information is updated, and that it might be necessary for the project leader to close and reopen the form.

Dedicated time for this project

	Role in the project	Name	Percent of full time
1	Applicant	Irene Yu-Hua Gu	20
2	Participating researcher	Hedvig Kjellström	10
3	Participating researcher	Michael Felsberg	10
4	Participating researcher	Magnus Thordstein	5
5	Participating researcher	Tomas McKelvey	5
6	PhD Student	to be recruited	100

Salaries including social fees

	Role in the project	Name	Percent of salary	2016	2017	2018	2019	Total
1	Applicant	Irene Gu	20	240,000	248,000	257,000	266,000	1,011,000
2	Participating researcher	Hedvig Kjellström	10	97,000	100,000	104,000	108,000	409,000
3	Participating researcher	Michael Felsberg	10	140,000	145,000	150,000	155,000	590,000
4	Participating researcher	Magnus Thordstein	5	73,000	75,000	78,000	81,000	307,000
5	Participating researcher	Tomas McKelvey	5	63,000	65,000	68,000	70,000	266,000
6	Other personnel without doctoral degree	To be reruited	100	544,000	563,000	582,000	602,000	2,291,000
	Total			1,157,000	1,196,000	1,239,000	1,282,000	4,874,000

Other costs

Describe the other project costs for which you apply from the Swedish Research Council. Enter the full amount, not in thousands SEK.

Premises

	Type of premises	2016	2017	2018	2019	Total
1	Office	83,000	86,000	89,000	92,000	350,000
	Total	83,000	86,000	89,000	92,000	350,000

Running Costs

	Running Cost	Description	2016	2017	2018	2019	Total
1	IT-services		25,000	26,000	27,000	28,000	106,000
2	Computer		30,000	0	0	0	30,000
3	Travel		35,000	35,000	35,000	35,000	140,000
	Total		90,000	61,000	62,000	63,000	276,000

Depreciation costs

Depreciation cost	Description	2016	2017	2018	2019

Total project cost

Below you can see a summary of the costs in your budget, which are the costs that you apply for from the Swedish Research Council. Indirect costs are entered separately into the table.

Under Other costs you can enter which costs, aside from the ones you apply for from the Swedish Research Council, that the project includes. Add the full amounts, not in thousands of SEK.

The subtotal plus indirect costs are the total per year that you apply for.

Total budget

Specified costs	2016	2017	2018	2019	Total, applied	Other costs	Total cost
Salaries including social fees	1,157,000	1,196,000	1,239,000	1,282,000	4,874,000		4,874,000
Running costs	90,000	61,000	62,000	63,000	276,000		276,000
Depreciation costs					0		0
Premises	83,000	86,000	89,000	92,000	350,000		350,000
Subtotal	1,330,000	1,343,000	1,390,000	1,437,000	5,500,000	0	5,500,000
Indirect costs	425,000	439,000	455,000	470,000	1,789,000		1,789,000
Total project cost	1,755,000	1,782,000	1,845,000	1,907,000	7,289,000	0	7,289,000

Explanation of the proposed budget

Briefly justify each proposed cost in the stated budget.

Explanation of the proposed budget*

Salary cost items in the form:

Monthly salary (L) (in 2014):
Irene Gu: 62kkr
Hedvig Skjellström: 50 kkr
Michael Felsberg: 72kkr
Magnus Thordstein: 75kkr
Tomas McKelvey: 66kkr
PhD student: 28kkr

- Salary above is according to 2014 values, salary increase is the calculated according to 1,9% in 2015, 3.3% in 2016, 3,5% in 2017, and 3.5% in 2018 (according to Chalmers formula)

- "Salary including social fees" above is then calcualted according to: salary (L) in the corresponding year + LKP 53,7%

Indiretkostnad:

- is computed according to 36,7% of salary (according to Chalmers formula)

Driftkostnad:
IT-services: is calculated according to 2,2% of the salary
travel cost: is calculated according to one person attending to one conference trip (25000kr/yr), plus travel within Sweden (8000kr/yr) for project meetings, estimated total is 35000 kr/yr.
2016: first year of the project include buying one compter and related accessories 30000 kr.

Lokaler Kostnad: is claculated according to 7,2% of the salary

Remark: Chalmers OH cost is 46,1% of salary = Drift cost (IT-services) 2,2% + Indirect cost 36,7% + Office cost 7,2%

Other funding

Describe your other project funding for the project period (applied for or granted) aside from that which you apply for from the Swedish Research Council. Write the whole sum, not thousands of SEK.

Other funding for this project

Funder	Applicant/project leader	Type of grant	Reg no or equiv.	2016	2017	2018	2019

CV

Curriculum Vitae: Professor Irene Yu-Hua Gu

Personal details

Current Position and Employment: Full Professor, Chalmers Univ. of Technology, Göteborg, Sweden
Website: http://www.chalmers.se/en/staff/Pages/Irene-Yu-Hua-Gu.aspx Email: irenegu@chalmers.se

Current Main Research Areas

- Stochastic image/video processing and modeling;
- Pattern classification and machine learning;
- Visual activity / behavior analysis and modeling;
- Visual information-based traffic analysis for vehicle safety;
- Video object tracking and surveillance;
- dMRI brain image analysis;
- Signal processing for analysis and diagnosis of power system disturbances

Education and Degrees

Docent, March 2000 Chalmers University of Technology, Gothenburg, Sweden.

Ph.D. in Technical Science, Sept. 1992. Dept. of Electrical Eng., Eindhoven Univ. of Technology, Netherlands.
Thesis: "Linear and nonlinear adaptive filtering and their application to speech intelligibility enhancement", Supervisor: Prof. dr. ir. Wim M.G. van Bokhoven.

Post dr.: Vision Group, (Philips) Inst. for Perception Research, Eindhoven, Netherlands. Oct. 1992 - Oct. 1993:
Post dr., School of Engineering, Staffordshire Univ., Stafford, U.K. Jan. 1994 - Aug. 1995:

M.Sc. in Electronics, Dec. 1984, Dept. of Physics, East China Normal Univ. (ECNU), Shanghai, China.

B.Sc. in Electronics and Computer Applications, Jan. 1982, Dept. of Physics, ECTU, Shanghai, China.

Employment:

Current employment: Full professor, Dept. of Signals and Systems, Chalmers Univ. of Technology, Sweden, 70% research, Since June 2008 -

Previous employment:

- Biträdande Professor, Oct.2004 - May 2008, Dept. of Signals and Systems, Chalmers Univ of Technology, Sweden;
-Associate Professor, June 2000- Sept. 2004, Dept. of Signals and Systems, Chalmers Univ of Technology, Sweden;
+ Assistant Professor, Sept.1996 - June 2000, Dept. of Signals and Systems, Chalmers Univ of Technology, Sweden;
- Lecturer, Sept. 1995 - August 1996, School of Electronic and Electrical Eng., the University of Birmingham, UK, .
- Post dr. Research Fellow, Jan. 1994 - Aug. 1995, School of Engineering, Staffordshire Univ., Stafford, U.K.
- Research Fellow, Oct. 1992 - Oct. 1993, Vision Group, (Philips) Inst. for Perception Research, Eindhoven, Netherlands.
- Research Associate, Sept. 1988 - Sept. 1992, Dept. of Electrical Eng., Eindhoven Univ. of Technology, the Netherlands.

Visiting/Guest professors:

- Visiting professor, March 2010; June, 2009; June 2008; June 2007, Dept. of Signal Theory and Communications, University of Alcalá, Spain (under 'Visiting Scholarships for Distinguished Professors in Postgraduate Programs' sponsored by the Spanish Ministry of Science and Education).
- Guest Professor, Jan 2006 - , Shanghai Jiao Tong Univ. (SJTU), China (appointed by the rector of SJTU).

Graduated PhD /Licentiate Students

- Main supervisor of 5 students till *PhD degree*: Emmanouil Styvaktakis (June 2002); Magnus Lundberg (August 2003); Peter Axelberg (Feb 2008), Andrew Backhouse (Feb 2010), Zulfikar Khan (Feb 2012).
- Main supervisor of 9 students till *Licentiate degree*: E Styvaktakis (March 2000); M Lundberg (March 2001); R Flores (Nov 2003); A Backhouse (Nov 2005), ZH Khan (Feb 2010), C Le (April 2011), Y Yun (Dec 2013), M Alipoor (Jan 2014), K Fu (Nov 2014).
- Examiner of 2 PhD students in Halmstad Univ.: Hartwig Fronthaler (May 2008), Klaus Kollreider (May 2008).

Current PhD Students

- Main supervisor and examiner of 3 PhD students: Mohammad Alipoor, Yixiao Yun, Keren Fu.

Learned Societies and Other Scientific Committees

- Member of CHIST-ERA evaluation panel on 2014 EU project proposals (on Resilient Trustworthy Cyber-Physical Systems, ICT area), Feb. and April, 2015.
- Member of the Evaluation panel ('beredningsgroup') for *Signals and Systems*, (NT-T), The Swedish Research Council ('Vetenskapsrådet', VR) in 2002, 2003 and 2008.
- Editorial Board, Journal on Ambient Intelligence and Smart Environments (JAISE), IOS Press, Jan 2012- .
- Associate Editor, EURASIP journal on Advances in Signal Processing (JASP), July 2005 - .
- Associate Editor, IEEE transactions on Systems, Man, and Cybernetics (Part B and C), Jan.2000 -July 2005.
- Guest Editor, special issue on *Emerging Signal Processing Techniques for Power Quality Applications*, EURASIP Journal on Advances in Signal Processing, 2006.

- Chair-Elect, Jan. 2002 - Dec. 2004, IEEE Swedish Signal Processing Chapter, Sweden.
- Senior Member of the IEEE.

Conference committees:

- Member, Organization committee (special sessions co-chair) & Programme committee, IEEE int'l conf. ICIP 2013.
- Reviewer, IEEE Int'l Conf. Image Processing (ICIP), annually, Since 2004 - ; 2 session chairs ICIP 2013.
- Reviewer, IEEE Int'l Conf. Acoustics, Speech and Signal Processing (ICASSP), annually, Since 2008 - .
- Member, Organization & Program committee, ACM/IEEE Int'l conf. ICDSC 2012; TPC member, Since 2013 -.
- TPC member, Int'l Conf. on Information Fusion (FUSION), Since 2006 -.
- Member, Program committee, 9th Workshop on Artificial Intell. Techniques for Ambient Intell (AITAmI), 2014.
- Reviewer, IEEE Int'l conf. IEEE Int'l Symposium on Biomedical Imaging (ISBI), Since 2014 -.
- Reviewer, IEEE Int'l Conf. Multimedia and Expo, yearly 2010-2013; session chair, ICME 2006.
- Planary/Invited speaker, Session chair, IEEE int'l conf SPIN 2014.
- Program committee member (Tutorial Sessions Co-Chairs), European Signal Processing Conf. (EUSIPCO), 2010.
- TPC member, European Signal Processing Conf. (EUSIPCO), 2011-2012.
- Reviewer, IEEE Int'l Geoscience and Remote Sensing Symposium (IGARSS), yearly 2008-2011.
- TPC member, Int'l symposium on computational models for life sciences (SMLS-13), 2013.
- Program committee member, 5th FTRA Int'l Conf on Computer Science and its Applications (CSA-13), 2013.
- Reviewer, Scandinavian conf. Image Analysis (SCIA), 2011.
- TPC member, IEEE Asian computer vision conference (ACCV), 2010-2012.
- Program Committee member, Int'l Workshop on Advanced Multimedia Technology and Application(AMTA), 2006.
- Program Committee member, Parcific-RIM Conf. on Multimedia (PCM), 2005-2006.
- Technical Committee member, IEEE Int'l Conf. Systems, Man and Cybernetics (SMC'04), 2004.
- Member, Program Committee & Technical Committee, 2 Session Chairs, IEEE Int'l conf SMC'03, 2003.
- Program Co-chair, EUDEM2-SCOT Conference (Int'l Conf. Requirements & Technologies for Detection, Removal and Neutralization of Landmines and UXO), 2003.
- Session Chair (EO/IR III), in Detection and Remediation Technologies for Mines and Minelike Targets VI, SPIE AeroSense Conf., 2001.

Served as a reviewer for many journals:

IEEE Trans PAMI; IEEE Trans IP; CVIU (Elsevier Journal); IEEE Trans on SMC; IEEE Trans Geoscience and Remote Sensing; EURASIP JASP; Pattern Analysis and Applications Journal; Journal of Mathematical Imaging and Vision; IEE Electronics Letters; Int'l Journal of Systems Science; Automatica; Electric Power Systems Research; IEEE Commun. Letters; Journal of Electronic Imaging; Fluctuation and Noise Letters, and many more.

Miscellaneous

- External examiner/examination committee member for 20 PhD degrees: Linus Sväm (Lund Univ), Erik Lindgren (CTH), Marcus Bjök (UU), Olov Rosen (UU), Andreas Kårsnäs (UU), Ulrich Minnaar (Univ. Cape Town, SA), Mahziar Namedanian (LIU), Prabhu Babu (UU), Ermin Kozica (KTH), Daniel Persson (CTH), Björn Holmberg (UU), Roberto Chouhy Leborgne (CTH), Daniel Malmodin (GU), Roberto Gil Pita (Alcalá, Spain), Tu Luan (GU), Emad Abd-Elrady (UU), Jacob Ström (LiU), Li Liyuan (NTU, Singapore), Anna Rydbergs (UU), Chang Lanlan (NTU, Singapore).
- External reviewer for Professorship/Associate prof/Reader/Lecturer Position:
  NTU, Singapore (prof); Warwick Univ. UK (reader); Monash Univ., Australia (Prof); Ohio Univ. USA (prof); Mittuniversiteit (prof), Umeå university (associate prof), Lund University (prof), Tsinghua Univ, China (assistant prof), KTH (associate + assistant + Adjunct prof), Aalborg Univ. Denmark (prof.)
- External reviewer for 2 project proposals for the Research Council in Singapore, 1 project proposal for Swiss National Science Foundation (Switzerland), one project proposal for VR post dr.
- Research grants obtained since 1997 (Principal investigator): VR 2.4M (2011-2013, visual tracking); Vinnova FFI 2.25M (09-11); VR 2.025Mkr (07-09, visual tracking); VR 2.292Mkr (07-09, power disturbance); SIDA 450kkr (06-08); TFR 1.9Mkr (97-02, NT-T); FOI 2.0Mkr (97-02); Elektra 2.625Mkr (97-02); CTH 1.65Mkr (00-03); VINNOVA 7.26Mkr (02-05); Göteborg Energi AB, 1.375Mkr (01-04), Chalmers (transport AoA), 350kkr (2015), 350kkr (2014), 350kkr (2013), 250kkr (2012); Volvo Cars AB, 108kkr (2014).
- Supervised and examined over 70 MSc theses.
- Teaching numerous undergraduate courses and PhD courses since 1995.
- Published 1 co-authored book, 3 book chapters, 40+ refereed journal papers, 130+ refereed conference papers
- Number of citations (Google Scholar: IYH Gu, 2015-03-26):
  citations: 3726 (Since 2010: 2497); H-index: 26 (Since 2010: 19); i10.index 53 (Since 2010: 37).

Curriculum Vitae: Associate Professor Hedvig Kjellström

1. Masters Degree

MSc Engineering Physics (Civilingenjör Teknisk Fysik) KTH, SWEDEN 1997

2. Doctorate Degree

PhD Computer Science (Teknologie Doktor Datalogi) KTH, SWEDEN 2001

3. Pre- and Post-Doctoral Visits

Visiting Scientist MIT, MA, USA March, October 2006
Supervisor: Trevor Darrell, Computer Science and Artificial Intelligence Lab

Visiting Researcher BROWN UNIVERSITY, RI, USA October 2000 – January 2001
Supervisor: Michael Black, Department of Computer Science

Visiting Researcher XEROX PARC, CA, USA March – October 1999
Supervisor: Michael Black, Digital Video Analysis Group

4. Docent Degree

Docent Computer Science (Docent Datalogi) KTH, SWEDEN 2009

5. Present Position

Associate Professor (Universitetslektor) KTH, SWEDEN since October 2009
Computer Vision and Active Perception Lab (CVAP), School of Computer Science and Communication (CSC), 50% research

6. Previous Positions

Researcher KTH, SWEDEN January 2007 – September 2009
CVAP, CSC

Researcher KTH, SWEDEN April 2004 – May 2006
Interaction and Presentation Lab (IPLab), CSC, part time 30%

Scientist FOI, SWEDEN January 2002 – December 2006
Division of Sensor Technology & Division of Command and Control Systems

Doctoral Student KTH, SWEDEN August 1997 – December 2001
CVAP, Department of Numerical Analysis and Computer Science (NADA)

Teacher KTH, SWEDEN October 1994 – December 2001
NADA, part time 20%

7. Leave of Absence

Maternity Leave February – September 2010

Maternity Leave May – December 2007

8. Supervision

PhD Students

Cheng Zhang (ongoing) PhD estimated May 2016
Alessandro Pieropan PhD May 2015

PostDocs

David Geronimo March 2013 – December 2014

MSc Students

Amelia Andersson, Luca Giovagnoli, Kelly Karipidou, Adam Knutsson, Jimmy Larsson, Matteo Poletti, Weilun Zhong (ongoing) 2015
32 earlier 2001 – 2014

9. Other

2010 Koenderink Prize for Fundamental Contributions in Computer Vision for the paper *Hedvig Sidenbladh, Michael J. Black and David J. Fleet. Stochastic tracking of 3D human figures using 2D image motion. In European Conference on Computer Vision, 2000*.
The Koenderink Prize is awarded each year at the European Conference on Computer Vision (one of the most prestigious conferences in Computer Vision) for a paper published ten years ago at that conference which has withstood the test of time.

Research Grants PI of the VR project FOVIAL 2013-2016; Passed on to the second round of evaluations for ERC Starting Grant 2011; Co-PI of the EU FP7 project TOMSY 2011-2014; PI of the VR project HumanAct 2010-2012.

Commissions at KTH Head of CVAP since 2015; Member of Dekanus Förtroenderåd since 2011; Member of the CSC Ledningsgrupp since 2011; Member of the CSC/ICT Appointment Committee since 2011.

Assignments as External Expert External expert in 1 Associate Professor appointment 2013; Chairman of 4 PhD defenses since 2011; Member of 3 Docent committees since 2011; Member of 13 PhD committees since 2009; External Reviewer of 2 PhD theses since 2008.

Program Committee Member IAPR International Conference on Pattern Recognition 2014 (publicity chair); IEEE International Conference on Robotics and Automation 2014 (assistant editor); IEEE/RSJ International Conference on Intelligent Robots and Systems 2014 (assistant editor); Swedish Symposium for Image Analysis 2012 (general chair); IEEE International Conference on Computer Vision 2009, 2011, 2013; European Conference on Computer Vision 2008, 2012, 2014; IEEE Conf. Computer Vision and Pattern Recognition 2007–2009, 2011–2013.

Referee for International Journals International Journal of Robotics Research since 2011; Journal of Web Semantics since 2011; ACM Computing Surveys since 2009; International Journal of Computer Vision since 2008; IEEE Transactions on Audio, Speech and Language Processing since 2008; IEEE Transactions on Multimedia since 2008; IEEE Transactions on Image Processing since 2004; Journal of Computer Vision and Image Understanding since 2003; IEEE Transactions on Pattern Analysis and Machine Intelligence since 2002; IEEE Transactions on Aerospace and Electronic Systems 2006–2007; IEE Proceedings Radar, Sonar and Navigation 2004–2007.

Curriculum Vitae: Professor Michael Felsberg

1. Diploma degree

1998, Diploma in engineering, Christian-Albrechts-Universität zu Kiel, Germany

2. PhD degree

2002, PhD in engineering, "Low-Level Image Processing with the Structure Multivector", Christian-Albrechts-Universität zu Kiel, Germany
supervisors Gerald Sommer and Ulrich Heute
fellowships of the DFG and the German National Merit Foundation
awarded as best thesis of the Faculty of Engineering 2002

3. Postdoc experience

2002–2004, Computer Vision Laboratory, Linköping University, DFG fellowship

4. Docent competence

2005, Docent in Computer Vision, Linköping University

5. Current employment

since 2008, Professor in Computer Vision and head of division, 85% on research

6. Previous employments

2004–2008, universitetslektor at the CVL, permanent employment

7. Exemptions to dedication

2000–2006, paternal leave, totally about 6 months for my three children

8. Graduated PhD students

Main supervisor for graduated PhD students:

- Erik Jonsson (PhD 2008),
- Johan Skoglund (Lic 2007),
- Johan Sunnegårdh (PhD 2009),
- Fredrik Larsson (PhD 2011),
- Johan Hedborg (PhD 2012),
- Kristoffer Öfjäll (Lic 2014),
- Freddie Åqström (PhD 2015),
- Bertil Grelsson (Lic 2014)

Postdocs:

- Vasileios Zografos,
- Liam Ellis,
- Fahad Shahbaz Khan,
- Johan Hedborg

Ongoing PhD students:

- Kristoffer Öfjäll (PhD scheduled 2015),
- Tommaso Piccini,
- Martin Danelljan,
- Amanda Berg,
- Mikael Persson,
- Giulia Meneghetti,
- Andreas Robinson

Awards

2014, Winner of the Visual Object Tracking challenge at ECCV
2014, Best paper award Fourth IEEE Workshop on Mobile Vision at CVPR
2013, Ranked as 3rd in the Visual Object Tracking challenge at ICCV
2011, Honorable mention of contribution at Fusion 2011
2010, Paper award of the Swedish Society for Automated Image Analysis (SSBA)
2007, Paper award of the Swedish Society for Automated Image Analysis (SSBA)
2005, Olympus award of the German Pattern Recognition Society (DAGM)
2004, paper awards from the DAGM
2000, paper awards from the DAGM

Invited speaker

2012, Computational Vision Summer School
2012, GS Workshop on Computer Vision and Perception
2011, ENUMATH mini symposium Parameter Estimation in Image Processing
2009, European Workshop on Advanced Predictive Sensor-Motor Control
2008, EURANDOM workshop *Locally Adaptive Filters in Signal and Image Proc.*
2006, EURANDOM workshop *Image Analysis and Inverse Problems*

Organization scientific meetings

Publication chair ICPR 2014
General and program co-chair DAGM symposium 2011
Organizer of Swedish Symposium on Image Analysis 2011
Organizer of SCIA Workshop on Cognitive Systems 2007
Co-organizer of Swedish Symposium on Image Analysis 2007

Projects since 2010

since 2015, PI in H2020 project CENTAURO
since 2015, VR frame project Energy Minimization for Computational Cameras (PI)
since 2015, FORMAS project on thermal imaging of viruses on plants (co-investigator)
since 2014, industrial projects with Daimler, SICK IVP, and Termisk Systemteknik
since 2014, VR industrial student project with Termisk Systemteknik
since 2013, FFI project iQmatic (Scania, co-investigator)
since 2013, VR project on visualization driven diffusion (PI)
2012–2014, Vinnova project on image-lab platform (co-investigator)
since 2012, SSF project on virtual photo sets (co-investigator)
since 2012, Member of Linnaeus environment CADICS
2011–2014, NFFP5 industrial student project with SAAB Dynamis
since 2011, SSF project on collaborative unmanned areal systems (co-investigator)
2011–2014, VR project on extended target tracking (co-investigator)
since 2010, SFO ELLIIT navigation and perception project
2010–2013, PI in ICT FP7 project GARNICS (completed successfully)
2010–2012, VR project on non-linear processing of color images

Leadership and administrative responsibilities

2013–2014, member of PPG for new engineering program *mjukvaruteknik*
since 2012, member of CADICS council
2010–2013, member of CMIVs scientific council
2010–2011, vice-president of SSBA
since 2009, member of institution board
since 2008, head of division (avdelningschef) CVL, Linköpings universitet

Reviewer / editorship

Associate editor:

- Journal of Mathematical Imaging and Vision
- Image and Vision Computing
- J. Real-Time Image Processing
- Frontiers Robotics and AI: Vision Systems Theory, Tools and Applications

Reviewer for:
IEEE Trans. Signal Proc., Trans. Pattern Analysis Machine Intelligence, Trans. Image Proc., Signal Proc. Letters, Trans. Circuits and Systems for Video Techn., Pattern Recognition Letters, Signal Processing, Inter. J. Computer Vision, Machine Vision and Applications J., J. Visual Communication & Image Representation, J. Optical Society of America A, Sensors, Computers & Electrical Engineering, Inter. J. Robotics Research, EURASIP J. Advances in Signal Proc.

PC member / reviewer

ECCV (since 2004), ICPR (since 2004, area chair), ICCV (since 2005), SSVM (since 2005), ICVW (since 2006), ECAI (2006), EUSIPCO (2007, 2008), COGSYS (2008), CVPR (since 2009), SIGGRAPH (since 2009), EMM-CVPR (since 2009), RIVF (2009), DAGM (since 2010, area chair), SCIA (since 2011, area chair), IFAC (2011)

Curriculum Vitae: Senior Lecturer Magnus Thordstein (Överläkare)

1 Higher education qualifications

- 1986 Bachelor of science (läkarexamen,), University of Gothenburg (GU)
- 1994 Medical license (Leg. läk.), Göteborgs sjukvård
- 1999 Specialist, Clinical Neurophysiology, Sahlgrenska University Hospital

2 Degree of doctor

1991: PhD, Physiology, University of Gothenburg, "Cerebral effects of intrauterine growth retardation. An experimental study", main supervisor professor Ingemar Kjellmer.

3 Postdoctoral positions

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4 Qualifications required for appointments as a docent

2007: Clinical Neurophysiology, Sahlgrenska Academy at University of Gothenburg

5 Current appointment

2006- : University Hospital Senior Lecturer (Universitetssjukhus-överläkare) at Dept. Of Clinical Neurophysiology, Sahlgrenska University Hospital. The amount of time dedicated to research is approximately 30 %.

2014- : Guest researcher at NBE (Neuroscience and Biomedical Engineering), Aalto University, Helsingfors

6 Previous positions and periods of appointment

1986-1992: Research assistant (amanuens) at the Department of Physiology, University of Gothenburg

7 Supervision

Master students

- 2005: Karlsson A: Investigation of new methods for analysis of EEG activity in awake infants. Master thesis in Biomedical Laboratory Science, Sahlgrenska academy at University of Gothenburg. (Co-supervisor)
- 2006: Björkenor A: Evaluation of new diagnostic tools and techniques for transcranial magnetic stimulation of the human motor system. Master thesis in Biomedical Laboratory Science, Sahlgrenska academy at GU. (Supervisor)
- 2009: Cansby A: Planning of a complex study. Mapping and treatment of overactivity in the auditory cortex of patients with tinnitus. Student thesis, Sahlgrenska academy at University of Gothenburg. (Supervisor)
- 2010: Cansby A: Neurovascular coupling in the human motor cortex. Master thesis in Biomedical Laboratory science, Sahlgrenska academy at University of Gothenburg. (Supervisor)
- 2010: Berglund K: Effect of characterizing stimulation parameters for motor mapping in humans. Master thesis in Biomedical Laboratory science, Sahlgrenska academy at University of Gothenburg. (Supervisor)

Technical licentiate student:

- 2007: Löfhede J: Classification of burst and suppression in the neonatal EEG. Lic.-avhandling, Chalmers, (Co-supervisor.)

PhD students:

- 2009: Löfhede J: The EEG of the neonatal brain-Classification of background activity. Thesis, Chalmers Tekniska Högskola, (Co-supervisor.)
- 2010: Flisberg A: EEG based methods for the detection of cerebral dysfunction in neonates. (Main supervisor)
- Ongoing: Antonsson M "Language ability and functional language reorganization in patients with low grade glioma undergoing awake surgery" (co supervisor)

8 Other information of relevance to the application Grants

- 2013-2015: Swedish Child Cancer Foundation, Project support: 913 000:-,"Non-invasive evaluation of brain function. New technique for optimization of the treatment of brain tumors in children."
- 2013-2015: Swedish Child Cancer Foundation, Own salary: 700 000:-,"Non-invasive evaluation of brain function. New technique for optimization of the treatment of brain tumors in children."
- 2013-2015: Swedish Child Cancer Foundation, Post doc position, 1 241 000:-,"Non-invasive evaluation of brain function. New technique for optimization of the treatment of brain tumors in children."
- 2015: Research Development Office West, Project support: 200 000:-, "Productification of neonatal EEG monitoring device."
- 2015: Sahlgrenska University Hospital, 430 000:-, Investment: "New equipment for intraoperative monitoring of central nervous function during awake surgery.)

9 Editorial roles and reviewer for scientific journals

- 1991- : Reviewer for Acta Pediatrica, Neurology, Clinical Neurophysiology, Brain Stimulation, approximately five per year

Curriculum vitae: Professor Tomas McKelvey

Department of Signals and System
Chalmers University of Technology, SE-412 96 Göteborg
phone: +31 772 8061, fax: +46 31 772 1782
email: tomas.mckelvey@chalmers.se

1. Higher education qualification: 1991, Master of Science in Electrical Engineering (Civilingenjör, Elektroteknik), Lund Institute of Technology, Lund, Sweden.

2. Doctoral degree: 1995, Automatic Control, Linköping university, Linköping Sweden. Dissertation title: *Identification of State-Space Models from Time and Frequency Data*. Supervisor: Prof. Lennart Ljung.

3. Postdoctoral positions:

January 1998 – March 1998: Postdoc visit at Department of Electrical Engineering, University of Newcastle, NSW, Australia

July 1999 – July 2000: Postdoc visit at Department of Electrical Engineering, University of Newcastle, NSW, Australia

4. Qualification required for appointments as a docent: 1999, Automatic Control, April 20, 1999, Linköping university, Linköping Sweden

5. Current Position: From December 2006 Professor in Signal Processing, Department of Signals and Systems, Chalmers University of Technology, Sweden. 40% Research.

6. Previous employments

June 1985 – July 1986: Software engineer, Cosab AB, Svalöv, Sweden

1988 – 1991: Teaching assistant at the Department of Computer Science and Department of Information Theory, Lund Institute of Technology, Sweden

Jan. 1990 – July 1990: Software engineer, Exomatic AB, Teckomatorp, Sweden

June 1991 – Sept. 1991: Project employment at SAAB Military Aircraft AB, Linköping, Sweden

Oct. 1991 – May 1995: PhD student, Automatic Control, Dept. of Electrical Engineering, Linköping University, Sweden

June 1995 – Jan. 1997: Assistant Professor, Automatic Control, Dept. of Electrical Engineering, Linköping University, Sweden

Feb. 1997 – June 2000: Associate Professor, Automatic Control, Dept. of Electrical Engineering, Linköping University, Sweden

Aug. 2000 – Dec. 2006: Associate Professor (Docent), Signal processing, Dept. of Signals and Systems, Chalmers University of Technology, Göteborg, Sweden

8. Supervision:

Ingemar Andersson (PhD main supervisor), 2005

Joakim Gunnarsson (PhD main supervisor), 2007

Per Sjövall (PhD co-supervisor), 2007

Sima Shahsavari (PhD, main supervisor), 2011

Mikael Thor (PhD, co-supervisor), 2012

Markus Grahn, (PhD main supervisor) 2013

Ayca Ozcelikkale, (Post-Doc), 2014-15

9. Commissions of trust etc.

Oct. 1999 – present: Member of Program committee of IFAC Symposium on System Identification (SYSID), a triennial conference.

Jan. 2000 – July 2002: Vice-Chairman of International Federation of Automatic Control's (IFAC) Technical Committee on Modelling, Identification and Signal Processing.

Sept. 2001 – Nov. 2002: Member of Chalmers education committee for Electrical Engineering undergraduate studies. (Linjekommitte E)

March 2002 – March 2005: Associate editor for Automatica, a Journal of the International Federation of Automatic Control.

July 2002 – July 2005: Chair of the International Federation of Automatic Control's (IFAC) Technical Committee on Modelling, Identification and Signal Processing.

July 2004 – July 2005: Member of program committee of the 16th IFAC World Congress 2005.

Oct. 2002 – present: Member of the international review committee of the VOLVO Car Corporation industrial Ph.D. program (VIPP).

Jan. 2005 – Sep. 2011: Vice head of Department undergraduate education (Viceprefekt med ansvar för grundutbildningen), Department of Signals and Systems, Chalmers University of Technology, Sweden

March 2006 – Jan. 2015: Associate editor for Journal of Control Science and Engineering.

Jan. 2008 – Dec. 2010: Member of the Chalmers board for undergraduate education (GUN).

Jan. 2008 – Dec. 2010: Vice chair of the Chalmers committee for quality assurance in undergraduate education.

Sept. 2011– present: Member of the steering group of "Stroke Centrum Väst" at Sahlgrenska Akademin, Göteborgs Universitet.

Jan. 2012 – present: Member of Executive Board of CHASE, (Chalmers Antenna Systems, a VINN Excellence Center)

Sept. 2012 – present: Member of the advisory board of the Electrical Engineering undergraduate program, Chalmers.

Jan 2014 – present:. Member of the board for Combustion Engine Research Center (CERC) at Chalmers.

From April 2011: Head of Signal Processing group.

From Jan 2014: Head of Signal Processing group including responsibilities for personnel.

From Jan 2015: Vice head of department of Signals and Systems (Pro-prefekt)

Publication list

PUBLICATIONS: IRENE YU-HUA GU

CITATIONS FROM GOOGLE SCHOLAR: IYH GU (viewed March 26, 2015).

Total citations: 3726 (Since 2010: 2497)
H-index: 26 (Since 2010: 19)
i10.index: 53 (Since 2010: 37)

All citation numbers below are obtained from Google scholar.

Five Most Cited Publications

1. L Li, W Huang, IYH Gu, Q Tian, "Statistical modeling of complex backgrounds for foreground object detection", IEEE Trans on Image Processing, Vol.13 (11), 1459-1472, 2004
   Number of citations: 613
2. MH Bollen, IYH Gu , Signal processing of power quality disturbances, Wiley-IEEE Press, 862 pages, 2006.
   Number of citations: 577
3. L Li, W Huang, IYH Gu, Q Tian, "Foreground object detection from videos containing complex background", Proceedings of the eleventh ACM international conference on Multimedia, pp.2-10, 2003
   Number of citations: 392
4. YH Gu, MHJ Bollen, "Time-frequency and time-scale domain analysis of voltage disturbances", IEEE Transactions on Power Delivery, Vol.15 (4), pp.1279-1284, 2000.
   Number of citations: 204
5. E Styvaktakis, MHJ Bollen, IYH Gu, "Expert system for classification and analysis of power system events" IEEE Transactions on Power Delivery, Vol.17 (2), pp.423-428, 2002.
   Number of citations: 193

Book and Book Chapters

1. M.H.J.Bollen, I.Y.H. Gu, Signal Processing of Power Quality Disturbances, John Wiley & Sons - IEEE Press, 862 pages, August 2006. (# Citations: 577)
2. Irene Y.H. Gu and Zulfiqar H. Khan, Book chapter 5: "Online Learning and Robust Visual Tracking using Local Features and Global Appearances of Objects", Book chapter in Edited Book: Object Tracking, edited book by H Goszczynska, pp. 89-118. ISBN/ISSN: 978-953-307-360-6, March 2011.
3. Irene Y.H. Gu, T. Wang, T.Tjahjadi, Chapter 10 in Part 2: "Detecting Landmine Fields from Low-Resolution Aerial Infrared Images" pp.244-268, in edited book: Using robots in hazardous environments: Landmine detection, demining and other applications, edited by Y Baudoin and M K Habib, Woodhead Publishing Limited, (ISBN 1 84569 786 3, ISBN-13: 978 1 84569 786 0), 2011, 704 pages. (# citations: 1)
4. Irene Y.H.Gu, Vasile Gui, chapter VI: Joint space-time-range mean shift-based image and video segmentation, pp.113-139, in Advances in Image and Video Segmentation, edited by Yu-Jin Zhang, Idea Group Inc. Publishing (ISBN: 1-59140-753-2), May 2006.

Peer-Reviewed Journal Publications (2007-2015)

1. (**) Z.H. Khan, IYH GU, "Online Domain-Shift Learning and Object Tracking based on Nonlinear Dynamic Models and Particle Filters on Riemannian Manifolds", Computer Vision and Image Understanding, (Elsevier Journal), Vol. 125, pp.97-114, 2014.
2. Sonja Berlijn, Igor Gutman, Irene Y.H.Gu, "Practical Applications of Automatic Image Analysis of Overhead Power Lines", INMR (Independent Transmission and Distribution Information Resource), Issue 103, Q1, pp. 72-75, 2014.

3. (**) Y Yun, IYH Gu, H Aghajan, "Multi-View ML Object Tracking with Online Learning on Riemannian Manifolds by Combining Geometric Constraints", IEEE Journal on Emerging and Selected Topics in Circuits and Systems, Volume: 3, Issue: 2, pp.185-197, 2013. (# citations: 3)

4. (*) Keren Fu, Chen Gong, Yu Qiao, Jie Yang, Irene Y.H. Gu, "One-class support vector machine-assisted robust tracking", (SPIE) Journal of Electronic Imaging, 22 (2), 11 pages, 2013. (# citations: 4)

5. (*) Keren Fu, Chen Gong, Jie Yang, Yue Zhou, Irene Yu-Hua Gu. "Superpixel based color contrast and color distribution driven salient object detection", Signal processing: Image Communication (Elsevier), 28(10), pp.1448-1463, 2013. (# citations: 6)

6. Tomas Bengtsson, Tomas Mckelvey, Irene Y.H.Gu, "Super-Resolution Reconstruction of High Dynamic Range images in a Perceptually Uniform domain", (SPIE) journal of Optical Engineering, Vol 52, No. 10, 102003, 10 pages, Oct. 2013. (# citations: 1)

7. (**) Z.H.Khan, I.Y.H. Gu, "Nonlinear Dynamic Model for Visual Object Tracking on Grassmann Manifolds with Partial Occlusion Handling", in print, IEEE Transactions on SMC - part B: Cybernetics, Volume: 43, Issue: 6, pp. 2005-2019, 2013 (# citations:3).

8. Farzaneh E. Fasaee, Mahdieh Mir Hashemi, Mos R. Avendi, and Irene Y.H. Gu, "An Enhanced Segmentation Method by Combining Super Resolution and Level Set", Journal of Medical and Bioengineering (ISSN 2301-3796), 4 pages, Vol. 2, No. 1, March 2013.

9. A Bracale, G Carpinelli, IYH Gu, MHJ Bollen, "A new joint sliding-window ESPRIT and DFT scheme for waveform distortion assessment in power systems", Electric Power Systems Research Journal, pp.112-120, Vol.88, 2012 (# Citations:16).

10. (*) ZH Khan, IYH Gu, A Backhouse, "Robust Visual Object Tracking using Multi-Mode Anisotropic Mean Shift and Particle Filters", IEEE trans. Circuits and Systems for Video Technology, Vol. 21, No.1, pp.74-87, 2011. (# Citations: 57)

11. (*) ZH Khan, IYH Gu, A Backhouse, "A Robust Particle Filter-Based Method for Tracking Single Visual Object through Complex Scenes using Dynamical Object Shape and Appearance Similarity", Journal of Signal Processing Systems, Vol.65, Issue 1, pp.63-67, 2011 (# Citations:10).

12. (*) ZH Khan, Irene Yu-Hua Gu, Andrew Backhouse, "Robust Visual Object Tracking using Multi-Mode Anisotropic Mean Shift and Particle Filters", IEEE trans. Circuits and Systems for Video Technology, Vol. 21, No.1, pp.74-87, 2011. (# citations: 82)

13. (*) ZH Khan, Irene Yu-Hua Gu, Andrew Backhouse, "A Robust Particle Filter-Based Method for Tracking Single Visual Object through Complex Scenes using Dynamical Object Shape and Appearance Similarity", Journal of Signal Processing Systems, Vol.65, Issue 1, 63-79, 2011. (# citations: 15)

14. (*) ZH Khan, IYH Gu, "Joint Feature Correspondences and Appearance Similarity for Robust Visual Object Tracking", IEEE Trans on Information Forensics and Security, Vol.5, No.3, pp.591-606, 2010 (# Citations:28).

15. (*) IYH Gu, H Andersson, R Vicen, "Wood Defect Classification based on Image Analysis and Support Vector Machine", (Springer journal) Wood Science and Technology, pp.693-704, No.4, Vol. 44., 2010 (# Citations:13).

16. MHJ Bollen, P Ribeiro, IYH Gu, CA Duque, "Trends, Challenges and Opportunities in Power Quality Research", European Transactions on Electrical Power, Vol. 20, Issue 1, pp.3-18, Aug.2010 (# Citations:12).

17. MHJ Bollen, IYH. Gu, S Santoso, MF McGranaghan, Peter A. Crossley, Moisés V. Ribeiro, Paulo F. Ribeiro, "Bridge the gap between signal and power: assessing power system quality using signal processing techniques", IEEE SP Magazine, pp.12-31, Vol.26, No.4, 2009. (# Citations: 50)

18. Z.Xu, I. Y.H. Gu, P.Shi, "Recursive error-compensated dynamic eigenbackground learning and adaptive background subtraction in video" , Optical Engineering, Vol. 47, No.5, 11 pages, 2008 (# citations:5).

19. (*) L.Li, W.Huang, I.Y.H. Gu, R.Luo, Q.Tian, "An efficient sequential approach to tracking multiple objects through crowds for real-time intelligent CCTV systems", IEEE trans. Systems, Man and Cybernetics, part B, vol.38, No.5, pp.1254-1269, 2008. (# Citations:35)

20. Irene Y.H. Gu, Math H.J. Bollen, "Estimating Interharmonics by using Sliding-Window ESPRIT", IEEE trans. Power delivery, Vol.23, No.1, pp.13-23, 2008. (# Citations: 99)
21. P.G.V.Axelberg, M.H.J.Bollen, I.Y.H.Gu, "Trace of flicker sources by using the quantity of flicker power", IEEE Trans. on Power delivery, vol.23, No.1, pp.465-471, 2008 (# Citations: 35).
22. M.V.Bibeirom, J.Szczupak, M.R.Iravani, I.Y.H.Gu, P.K.Dash, A.V.Mamishev, "Emerging signal processing techniques for power quality applications", Editorial, EURASIP journal JASP, 2007(# Citations:6).
23. MHJ Bollen, IYH Gu, PGV Axelberg, E Styvaktakis, "Classification of Underlying Causes of Power Quality Disturbances using Deterministic and Statistical Signal Processing Methods", in EURASIP Journal on Advances in Signal Processing, 2007.(# Citations: 67)
24. K Hur, S Santoso, IYH Gu, "On Empirical Estimation of Utility Distribution Damping Parameters using Power Quality Waveform Data", in EURASIP Journal JASP, 2007 (# Citations:6).
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4. (*) Keren Fu, Irene Y.H.Gu, Anders Ödblom, "Automatic Traffic Sign Recognition based on Saliency-Enhanced Features and SVMs from Incrementally Built Dataset", proc. IEEE ICCVE 2014.
5. (**) Y Yun, K Fu, IYH Gu, H Aghajan, J Yang, "Human Activity Recognition in Images using SVMs and Geodesics on Smooth Manifolds", proc. of 8th ACM/IEEE int'l conf. ICDSC 2014.
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7. (*) Y Yun, K Fu, IYH Gu, J Yang, "Visual object tracking with online learning on Riemannian manifolds by one-class support vector machines", IEEE int'l conf. ICIP 2014.
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17. (*) Irene Y.H. Gu, Mikhail Bolbat, "Road Traffic Tracking and Parameter Estimation based on Visual Information Analysis using Self-Calibrated Camera Views", proc. 7th ACM/IEEE Int'l Conf. on Distributed Smart Cameras (ICDSC'13), Oct 29 - Nov 1, 2013 (# citations:1).
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2. I.Y.H. Gu, Z.H. Khan, "Domain-Shift Manifold Online Learning and Tracking of Video Objects", Swedish Symposium on image analysis (SSBA'13), Göteborg, Sweden, March 14-15,2013.

3. M. Alipoor, I.Y.H. Gu, A.J.H. Mehnert, Y. Lilja, D. Nilsson, "A Novel framework for high order tensor-based diffusivity profile estimation", Swedish symposium on image analysis (SSBA'13), Göteborg, Sweden, March 14-15, 2013.
4. Irene Y.H. Gu, Mikhail Bolbat, Y.Yun, "Road Traffic Analysis and Parameter Estimation based on Visual Information Analysis and Self-Calibrated Camera Views", 2nd National conf. in transport research, Sweden,Oct. 22-23, 2013.

Papers under Reviews

Journals

1. M Alippor, IYH Gu, S Maier, G Starck, A Mehnert, "Optimal gradient encoding schemes for diffusion tensor imaging: A unified Approach", under revision, IEEE trans. on Medical Imaging, Jan. 2015.
2. K Fu, C Gong, IYH Gu, J Yang, "Normalized Cut Saliency by Adaptive Multi-Level Region Merging", submitted to IEEE trans. on image processing, Jan. 2015.
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Conferences

1. Yixiao Yun, Irene Yu-Hua Gu, "HUMAN FALL DETECTION VIA SHAPE ANALYSIS ON RIEMANNIAN MANIFOLDS WITH APPLICATIONS TO ELDERLY CARE", submitted to ICIP 2015.
2. Keren Fu, Chen Gong, Irene Y.H. Gu, Jie Yang, Pengfei Shi, "SALIENT OBJECT DETECTION USING NORMALIZED CUT AND GEODESICS", Submitted to IEEE int'l conf. on image processing (ICIP), 2015.
3. Keren Fu, Irene Y.H. Gu, Anders Ödblom, "SIMULTANEOUS DETECTION AND SEGMENTATION FOR TRAFFIC SIGN LOCATION", submitted to ICIP 2015.
4. Long Xu, Irene Yu-Hua Gu, Anders Flisberg, Magnus Thordstein, "VIDEO-BASED TRACKING AND QUANTIFIED ASSESSMENT OF SPONTANEOUS LIMB MOVEMENTS IN NEONATES", submitted to ICIP 2015.
5. Keren Fu, Irene Y.H. Gu, Anders Ödblom, "Traffic Sign Recognition: A Novel Learning-based Coarse-to-Fine Scheme", submitted to IEEE Int'l Intelligent Vehicle Symposium (IV 2015).
6. M Alippor, IYH Gu, S Maier, G Starck, A Mehnert, "A new model-matched optimal gradient encoding scheme with non-uniform distribution of directions", Submitted to MICCAI 2015

List of Publications: Hedvig Kjellström

Main publications from the last 5 years are listed below. Citation counts are taken from Google Scholar as of March 25, 2015. Scientific impact according to Google Scholar: **h-index = 21**, **total # citations = 2902**.
My publications can be downloaded from www.csc.kth.se/∼hedvig/publications.html.

1. Six most cited papers

[1] H Sidenbladh (Kjellström), MJ Black, DJ Fleet, "Stochastic tracking of 3D human figures using 2D image motion", European Computer Vision conf. ECCV 2000, pp. 702-718. (# Citations 748)

[2] H Sidenbladh (Kjellström), MJ Black, L Sigal, "Implicit probabilistic models of human motion for synthesis and tracking", European Computer Vision Conf. ECCV 2002, pp.784-800, (# Citations 356)

[3] H Sidenbladh (Kjellström), "Multi-target particle filtering for the probability hypothesis density" International Conference on Information Fusion, 2003. (# Citations 246)

[4] H Sidenbladh (Kjellström), MJ Black, "Learning the statistics of people in images and video", proc. of IEEE International Journal of Computer Vision, ICCV, 54 (1-3), 183-209, 2003 (# Citations 153)

[5] H Sidenbladh (Kjellström), MJ Black, "Learning image statistics for Bayesian tracking", Proceedings. Eighth IEEE International conf. on Computer Vision, ICCV 2001. (# Citations 144)

[6] D Ormoneit, H Sidenbladh (Kjellström), MJ Black, T Hastie, "Learning and tracking cyclic human motion", Advances in Neural Information Processing Systems, 894-900, 2001 (# Citations 103)

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[7] Javier Romero, Hedvig Kjellström, Carl Henrik Ek and Danica Kragic. Non-parametric hand pose estimation with object context. *Image and Vision Computing*, 31(8):555–564, 2013.
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[17] David Geronimo and Hedvig Kjellström. Unsupervised surveillance video retrieval based on human action and appearance. In *IAPR International Conference on Pattern Recognition* 2014.

[18] Cheng Zhang, Carl Henrik Ek, Xavi Gratal, Florian Pokorny and Hedvig Kjellström. Supervised hierarchical Dirichlet process with variational inference. In *ICCV 2013 Workshop on Inference for Probabilistic Graphical Models* 2013.
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[19] Cheng Zhang, Dan Song and Hedvig Kjellström. Contextual modeling with labeled multi-LDA. In *IEEE/RSJ International Conference on Intelligent Robots and Systems* 2013.
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Patents

- One patent on method described in [69], registration date August 10, 2007.
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- One patent on method described in [23], pending.

Publicly available Computer Programs

- method published in [**?**] available in Dlib (third part implementation)
- Matlab Toolbox: monogenic scale-space v2.0
  `http://www.cvl.isy.liu.se/research/ima/monogenic.zip`
- OpenCV C++/Python Toolbox: ChannelCodingToolbox beta3
  available on request

Popular scientific articles and presentations

- September 2014, news items on ICPR 2014 and on winning VOT 2014
- February 2013, TV broadcast, news item on CDIO project in *Östnytt*
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- March 2012, radio broadcast *Nu kommer vardagsrobotarna*, SR Östergötland
- December 2011, TV broadcast, lecture in *Kunskapskanalen*
- November 2011, feature in *Vetenskapens Värld*
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- March 2008, two ICT Results features on COSPAL, `http://cordis.europa.eu/ictresults/`

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4. Johan Löfhede, Magnus Thordstein, Nils Löfgren, Anders Flisberg, Manuel Rosa-Zurera, Ingemar Kjellmer and Kaj Lindecrantz1, "Automatic classification of background EEG activity in healthy and sick neonates", Journal of Neural Engineering, 7(1), 2010. (# citations:27)
5. Flisberg A, Kjellmer I, Löfhede J, , Löfgren N, Rosa-Zurera M, Lindecrantz K, Thordstein M. "Does indomethacin for closure of patent ductus arteriosus affect cerebral function? ", Acta Pediatr 99: 1493-1497, 2010 (# citations:3)
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31. Eriksson S, Sandsjö L, Löfhede J, Lindholm H, Thordstein M, "3D Weaving Technique Applied in Long Term Monitoring of Brain Activity", Fourth world conference on 3D fabrics and their applications. Aachen, Germany, 2012.

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43. Thordstein M, "Cerebral neuromodulering- Möjlighet vid central neuropatisk smärta? Navigerad, repetitiv transkraniell magnetstimulering inför implantation av kronisk epidural stimulator", Inbjudet föredrag, Västsvenska smärtmötet, Borås lasarett, 22 maj, 2014.

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[1] S. Shahsavari, T. McKelvey, T. Skoglund, and C. Eriksson Ritzen. A comparison between the transfer function of ABP to ICP and compensatory reserve index in TBI. In Manley, Hemphill, and Stiver, editors, *Intracranial Pressure and Brain Monitoring XIII - Mechanisms and Treatment*, number 102 in Acta Neurochirurgica Supplementum, pages 9–13. Springer, 2009. Number of citations:-.

Five most cited publications

[1] T. McKelvey, H. Akçay, and L. Ljung. Subspace-based multivariable system identification from frequency response data. *IEEE Trans. on Automatic Control*, 41(7):960–979, July 1996. Number of citations: 330.

[2] L. Ljung and T. McKelvey. Subspace identification methods for closed loop input-output data. *Signal Processing - EURASIP*, 52(2):209–215, 1996. Number of citations: 165.

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[4] T. McKelvey. *Identification of State-Space Models from Time and Frequency Data.* Phd thesis, Linköping University, May 1995. Number of citations: 99.

[5] P. Stoica, T. McKelvey, and J. Mari. MA estimation in polynomial time. *IEEE Trans. on Signal Processing*, 48(7):1999–2012, July 2000. number of citations: 85.

CV

Name: Irene Yu-Hua Gu	**Doctorial degree:** 1992-09-15
Birthdate: 19530519	**Academic title:** Professor
Gender: Female	**Employer:** Chalmers tekniska högskola

Research education

Dissertation title (swe)

Linear and nonlinear adaptive filtering and their application to speech intelligibility enhancement

Dissertation title (en)

Linear and nonlinear adaptive filtering and their application to speech intelligibility enhancement

Organisation	Unit	Supervisor
Eindhoven University of Technology, Netherlands Not Sweden - Higher Education institutes	Dept. of Electrical Engineering	Wim Van Bokhoven

Subject doctors degree	ISSN/ISBN-number	Date doctoral exam
20205. Signalbehandling		1992-09-15

CV

Name: Tomas McKelvey	**Doctorial degree:** 1995-05-05
Birthdate: 19660407	**Academic title:** Professor
Gender: Male	**Employer:** Chalmers tekniska högskola

Research education

Dissertation title (swe)
Identifiering av tillståndsmodeller from tid- och frekvensdata

Dissertation title (en)
Identification of State-Space Models from Time and Frequency Data

Organisation	Unit	Supervisor
Linköpings universitet, Sweden Sweden - Higher education Institutes	Institutionen för systemteknik (ISY)	Lennart Ljung

Subject doctors degree	ISSN/ISBN-number	Date doctoral exam
20202. Reglerteknik	ISBN:91-7871-531-8 ISSN:0345-7524	1995-05-05

CV

Name: Magnus Thordstein	**Doctorial degree:** 1991-11-29
Birthdate: 19600820	**Academic title:** Docent
Gender: Male	**Employer:** Västra Götalandsregionen

Research education

Dissertation title (swe)

Dissertation title (en)

Cerebral vulnerability in intrauterine growth retardation. An experimental study.

Organisation	Unit	Supervisor
Göteborgs universitet, Sweden Sweden - Higher education Institutes	Fysiologi	Ingemar Kjellmer

Subject doctors degree	ISSN/ISBN-number	Date doctoral exam
30106. Fysiologi	91-628-0458-8	1991-11-29

CV

Name: Michael Felsberg	**Doctorial degree:** 2002-02-12
Birthdate: 19741112	**Academic title:** Professor
Gender: Male	**Employer:** Linköpings universitet

Research education

Dissertation title (swe)
only English

Dissertation title (en)
Low-level image processing with the structure multivector

Organisation	Unit	Supervisor
University of Kiel, Germany Not Sweden - Higher Education institutes	stipendium	Gerald Sommer

Subject doctors degree	ISSN/ISBN-number	Date doctoral exam
21199. Övrig annan teknik	N/A	2002-02-12

CV

Name: Hedvig Kjellström	**Doctorial degree:** 2001-12-20
Birthdate: 19730517	**Academic title:** Docent
Gender: Female	**Employer:** Kungliga Tekniska högskolan

Research education

Dissertation title (swe)

Probabilistisk följning och rekonstruktion av mänsklig 3D-rörelse i monokulära videosekvenser

Dissertation title (en)

Probabilistic Tracking and Reconstruction of 3D Human Motion in Monocular Video Sequences

Organisation	Unit	Supervisor
Kungliga Tekniska Högskolan, Sweden Sweden - Higher education Institutes	CVAP, Datorseende och robotik	Jan-Olof Eklundh

Subject doctors degree	ISSN/ISBN-number	Date doctoral exam
21199. Övrig annan teknik	91-7283-169-3	2001-12-20

Publications

Name: Irene Yu-Hua Gu	**Doctorial degree:** 1992-09-15
Birthdate: 19530519	**Academic title:** Professor
Gender: Female	**Employer:** Chalmers tekniska högskola

Gu, Irene Yu-Hua has not added any publications to the application.

Publications

Name: Tomas McKelvey	**Doctorial degree:** 1995-05-05
Birthdate: 19660407	**Academic title:** Professor
Gender: Male	**Employer:** Chalmers tekniska högskola

McKelvey, Tomas has not added any publications to the application.

Publications

Name: Magnus Thordstein	**Doctorial degree:** 1991-11-29
Birthdate: 19600820	**Academic title:** Docent
Gender: Male	**Employer:** Västra Götalandsregionen

Thordstein, Magnus has not added any publications to the application.

Publications

Name: Michael Felsberg	**Doctorial degree:** 2002-02-12
Birthdate: 19741112	**Academic title:** Professor
Gender: Male	**Employer:** Linköpings universitet

Felsberg, Michael has not added any publications to the application.

Publications

Name: Hedvig Kjellström	**Doctorial degree:** 2001-12-20
Birthdate: 19730517	**Academic title:** Docent
Gender: Female	**Employer:** Kungliga Tekniska högskolan

Kjellström, Hedvig has not added any publications to the application.

Register

Terms and conditions

The application must be signed by the applicant as well as the authorised representative of the administrating organisation. The representative is normally the department head of the institution where the research is to be conducted, but may in some instances be e.g. the vice-chancellor. This is specified in the call for proposals.

The signature*from the applicant*confirms that:

- the information in the application is correct and according to the instructions form the Swedish Research Council
- any additional professional activities or commercial ties have been reported to the administrating organisation, and that no conflicts have arisen that would conflict with good research practice
- that the necessary permits and approvals are in place at the start of the project e.g. regarding ethical review.

The signature *from the administrating organisation* confirms that:

- the research, employment and equipment indicated will be accommodated in the institution during the time, and to the extent, described in the application
- the institution approves the cost-estimate in the application
- the research is conducted according to Swedish legislation.

The above-mentioned points must have been discussed between the parties before the representative of the administrating organisation approves and signs the application.

Project out lines are not signed by the administrating organisation. The administrating organisation only sign the application if the project outline is accepted for step two.

Applications with an organisation as applicant is automatically signed when the application is registered.