9:00 a.m.	K. Rosenbauer, K.-H. Franke, R. Nestler (DE-Ilmenau)

An Insight of Current Frame and Sequence Based Non-Uniformity Correction Methods Related to Different Application Scenarios

The spatial non-uniformities in infrared focal plane arrays (IR-FPA) due to different sensitivities of the detectors are a still not satisfactorily resolved problem on thermal imaging. Furthermore, depending on unknown environmental parameters like thermal instability of IR-FPA or dust on detector respectively lens surface the non-uniformities also vary in time. The resulting temporally non stationary fixed pattern noise (FPN) yields to degrading spatial resolution, radiometric accuracy and temperature resolvability. Due to the temporal drift a single initial calibration does not provide a permanent solution. Other calibration methods which need to interrupt periodically the thermal camera's normal operation are also less suitable. However, scene and image based non-uniformity correction (NUC) methods operate on single image or image sequences based on camera motion respectively changes in scene, and allow a continuous imaging process. This paper gives an overview of the state of the art of scene and image based non-uniformity correction methods for fixed pattern noise reduction. The presented methods derive comprehensive studies of primarily adaptive techniques based on constant statistics, kalman filter, least mean square (LMS) and recursive least square (RLS) algorithm, function interpolation and more. In particular, the applicability of the algorithms to the non-uniformity characteristic of a selected infrared camera is discussed and evaluated on real infrared data by different performance metrics published in the literature. Thereby different application scenarios like static scene and camera motion, static camera and scene changes and more are considered.

9:20 a.m.	C. Lucht, K.-H. Franke, R. Jahn, R. Nestler (DE-Ilmenau)

Resolution Enhancement and Noise Reduction of Infrared Video Streams

The images of thermographic (IR) cameras suffer from relatively small resolution and strong stochastic noise. Hence it is recommended to improve the image quality by subsequent processing steps. The so-called super-resolution is a well suited approach for image improvement of video streams. It exploits the fact, that adjacent images of a video stream contain the same object scene but they differ in "microscopic" details. These small differences can be used to multiply the image resolution. A super-resolution technique generates a new image from every few (typically four to ten) adjacent video images and consists of roughly three steps: image registration, alignment, and fusion. We have reworked and implemented some variants of super-resolution. The algorithms were tested with an IR camera of new generation. Among the above mentioned steps, the image fusion is the most flexible. Besides the merging of aligned original images, the fusion step can also implement filter mechanisms. These filters are intended to mitigate some influences of image degradation, for instance optical aberrations, diffraction, noise, and sampling. Also without such additions, the image fusion leads to considerably noise-reduced images, however the effect of resolution enhancement will be questionable. Unfortunately, it was stated that

real-time ability can only be achieved without any complex filtering in the fusion step. Nevertheless we have tested some algorithms that include an image restoration component. The gist of this component is to invert a simplified image generation process called "discrete observation model". Because the inversion without modification would result in an ill-conditioned equation system, it must be regularized. A deterministic regularization method that based on a damping term was investigated. Even without regarding the optical PSF, the restoration algorithm leads to more detailed images than the simple image fusion. Furthermore we have tested some modifications in order to improve the reduction of fixed-pattern noise.

9:40 a.m.	P. Prinke, R. Nestler, K.-H. Franke (DE-Ilmenau)

Speckle Reduction by an Adapted Geometric Filter Princple

The importance of sonographical examination rises during the last years. Ultrasound imaging is used in novel medical fields of application because of its real-time-capability and its noninvasive, nearly unharmful character compared to imaging procedures of diagnostic radiology. Some serious progress is achieved in the field of the image quality enhancement by conditioning the ultrasound-signal (e.g. THI, Focusing) for enhancing the contrast and resolution, etc.. Nevertheless an existing problem in this field of application is the appearance of the so called speckle noise pattern – a pattern caused by random interference between scattered ultrasonic waves received from inhomogeneous scattering tissue. To support the visual interpretation and the quantitative measurement of body tissues while the medical examination, real-time restoration of the ultrasound data is needed.

While many known approaches take an approximation of the speckle distribution as a basis for a mostly time-consuming data restoration step, this paper presents a novel and efficient approach based on the principle of geometric filtering. This approach is independent from a specific speckle distribution, involving simply the typical speckle appearance. Based on the powerful method of an adaptive and rapid stepwise convergence of each data point suitable to the estimated convex hull from its neighbours, many other cases of application with similiar conditions are conceivable, e.g. fixed pattern noise reduction in infrared imaging. Medical images processed by the proposed filter-method are speckle reduced and fine-grained images with preserved texture.

10:00 a.m.	A. Loos (DE-Ilmenau), H. Kuehl (DE-Leipzig)

SAISBECO – A Semi-Automated Audiovisual Species and Individual Identification System for Behavioral Ecological Research and Conservation

The current biodiversity crisis and the accompanied catastrophical declining of species populations is startling. Therefore autonomous monitoring techniques become more and more important. However, the manual annotation of the accruing data is an enormous time consuming and tedious work. This paper briefly presents the current research project SAISBECO, which aims at the identification of species and individuals of great apes like gorillas and chimpanzees. A pre-study on gorilla face recognition shows the feasibility of human face recognition algorithms to identify also primate faces. Though, linear models are not intrinsically equipped to deal with variations in lighting, viewpoint and expression for in-

stance. Therefore multilinear techniques based on the Higher-Order Singular Value Decomposition *HOSVD* promise to be more robust against suchlike variations.

10:20 – 10:40 a.m. Coffee Break

10:40 a.m.	A. Mitsiukhin, V. Nikalayenka (BY-Minsk)

Application of Hartley Descriptors

The paper presents the possible solution of the problem of description of the image object boundary by means of the discrete Hartley transform (DHT). Such problems appear when identifying and/or recognizing individual objects on the images (objects "of interest"). To reduce the volume of the array of data describing the object in certain applications (topography, ecological monitoring, analysis of medical images, etc.), it is desirable to replace a set of pixels depicting the object by the description of its boundary. Linear (one-dimensional) and two-dimensional objects can be presented in the form of dotted closed external and internal contours. For describing the object (boundary of the area – after segmentation of the images) and its external and internal characteristics (attributes) at the stage of selection of the attributes, the input counts are transformed by means of the discrete Fourier transform (DFT). In case of high dimensionality of the spatial data describing the object boundary, the processing complexity increases considerably. Unlike the DFT, the DHT kernel is expressed by real numbers. In respect to the real data of the image, all the computations are performed with real numbers. In comparison with the DFT, the finding of coordinates of the points describing the boundary by means of the DHT requires half as many real multiplicative operations to be performed. It saves the computational costs and makes the signal processing easier. One of the ways for reducing the computational complexity consists in eliminating the spatial redundancy and reducing the number of attributes to be analyzed. The DHT has been also used for reducing the dimensionality of transform. It provides even more practical gain in computational and temporal resources. The transform dimensionality reduction is implemented based on the dispersion (zonal) or threshold principle of filtration of the Hartley transforms [1]. Restoring the object area boundaries is implemented by means of the inverse DHT from the truncated sequences of transforms. After performing the rounding operation, we obtain the values of the coordinates describing the boundary shape. The comparative results for comparison of the accuracy of description of the object boundary are presented.

11:00 a.m.	U. Fohry (DE-Jena)

A Method of Nonlinear System Optimization Based on Hybrid Evolutionary Computation Techniques and Its Application for Image Classification
This paper presents a general method using a hybrid evolutionary search strategy to support design and optimization of nonlinear systems. Depending on the task like system identification, classification or process control a defined quality criterion of the system is gradually improved in an experimental manner. The optimization variables consist of chosen parameters and structure elements of the system. The objective function may be topographically complex and containing local suboptima. Therefore a global search methode is used, that incorporates gradient-based optimization algorithms and derivativefree local search strategies into a evolutionary algorithm. The aim of the hybridization is to improve the efficiency in local finetuning, while maintaining the global search behaviour. It is shown, how the introduced method can be used for databased learning systems especially to solve a recognition problem. Therefor examples of objects and its right classification are available. Thus the parameter of the recognition system can be determined by gradient-based optimization according to the principle of supervised learning. The extraction of relevant features of the object as well as the determination of structure and initial parameters of the recognition system are realized by a superordinate evolution-based search method. Using this concept for image classification, the feature vector are chosen by the algorithm from a set of calculated parameters based on gray-level values and texture of the image. Experimental results are presented and it is refered, how this method was used for aliveness detection of fingerprints using multiple static features.

11:20 a.m.	T. Koch, R. Nestler, T. Kubertschak (DE-Ilmenau)

The Advantage of Segment-Based Classification of Multi-Modal, Multi-Temporal and High-Resolution Satellite Images
The automatic generation of land use / land cover information from multimodal satellite image data is a high challenging task. Due to the high temporally variability of several phenological and biological parameters between different vegetation types, a multitemporal investigation arise better discernibility among various classes. Furthermore, the synergetic use of information of various modalities reaches into more increase of classification quality. Only related to the classification step the level of difficulty results from complex shaped class regions in feature spaces of high dimension. This requires classification algorithms with a high degree of freedom regarding to the class definition or the shaping of separation planes (in the feature domain). In addition a limited amount of training samples per class must be considered. The approach, presented in this paper, based on a persegment classification. Asuitable classification method is closely connected with an efficient and powerful algorithm for the foregoing segmentation. Those segmentation and classification methods are components of the automated processing-pipeline, which will be developed inside the project ENVILAND-2.The interim results, arises from that project, where presented and discussed.

12:00 noon – 1:30 p.m. Lunch