Discrimination of haploid and diploid maize kernels via multispectral imaging

The use of doubled haploids (DHs) in maize has become ubiquitous in maize breeding programmes as it allows breeders to go from cross to evaluation in as little as 2 years. Two important aspects of the in-vivo DH system used in maize are as follows: (i) the identification of haploid progeny and (ii) doubling of the haploid genome to produce fertile inbred lines. This study is focused on the first step. Currently, identification of maize haploid progeny is performed manually using the R1-nj seed colour marker. This is a labour-intensive and time-consuming process; a method for automated sorting of haploids would increase the efficiency of DH line development. In this study, six inbred lines were crossed with the maternal haploid inducer ‘RWS/RWK-76™’ and a sample of seed was sorted manually for each line. Using the VideometerLab 3 system, spectral imaging techniques were applied to discriminate between haploids and hybrids. Using DNA markers to confirm the haploid/diploid state of the tested seed, for the majority of genotypes haploid identification was possible with over 50% accuracy.
Fast, versatile, and non-destructive biscuit inspection system using spectral imaging

A fast, versatile, and non-destructive method for assessing biscuit quality is presented. The method integrates color (or browning) measurement, moisture assessment, compositional and dimensional measurements on a spectral imaging platform using the silicon range 400–1000 nm.

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Identification Of Barley Grain Mycoflora By Next Generation Sequencing And Videometer Multispectral Imaging

Seeds of Barley (Hordeum vulgare) are infected by a high number of fungi, including pathogens such as Fusarium graminearum, F. culmorum, F. poae, F. avenaceum and Pyrenophora teres. Fusarium spp. is a widely distributed fungus causing yield reduction in a range of agricultural crops and many species in the genus produce mycotoxins responsible for serious quality deterioration. In malting barley, Fusarium also has a negative effect by causing gushing in beer. A number of barley seeds (app. 200) assumed to be infected by fungal from different origins and years of cultivation were tested by NGS sequencing the ITS (Internal Transcribed Spacer) region from total DNA. Approximately 2-4000 sequences were obtained from each seed and these were subsequently identified to species level in order to give an exact identification of fungal genera on each seed. The main fungal genera identified were Fusarium, Pyrenophora, Epicoccum, Didymella, Alternaria, Bipolaris and Microdochium. The fungal composition and quantities on each seed varied significantly. Some were infected mainly by a single fungus and some were infected by multiple fungi. All seeds were prior to this evaluated by multispectral imaging on the dorsal and ventral sides by the VideometerLab multispectral imaging system (Videometer A/S, Hørsholm, Denmark). This system is an instrument equipped with 19 different light emitting diodes at wavelengths ranging from 375 to 970nm (ultraviolet, visual and lower wavelength of the near-infrared region) in the reflectance mode (5 Mpix per band, pixel size app. 45 μm x 45 μm). Spectral information over the surface of seeds may be combined with information about size, shape, and texture of the seeds. This information links detection of fungal infection with other seed characteristics known from general seed testing. Analytical separation of the identified fungi was based on mean pixel intensity and a normalized Canonical Discriminant Analysis (nCDA) using the images of infected and healthy seeds. The potential of using spectral characteristics of the fungal species as a way to provide a fast optical screening method for fungal contamination of barley on the fungal species level was investigated by comparing results from the next generation sequencing and multispectral imaging.

General information
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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Carlsberg Forskningscenter, Aarhus University
Authors: Jørgensen, J. R. (Ekstern), Carstensen, J. M. (Intern), Søren, K. (Ekstern), Shrestha, S. (Ekstern), Nicolaisen, M. (Ekstern)
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Barley (Hordeum vulgare L), FUSARIUM, Multispectral imaging, Next generation sequencing, Seed health
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Multispectral UV imaging for determination of the tablet coating thickness

The applicability of off-line multispectral ultraviolet (UV) imaging in combination with multivariate data analysis was investigated to determine the coating thickness and its distribution on the tablet surface during lab scale coating. The UV imaging results were compared with the weight gain measured for each individual tablet and the corresponding coating thickness and its distribution measured by terahertz pulsed imaging (TPI). Three different tablet formulations were investigated, two of which contained UV active tablet cores. Three coating formulations were applied: Aquacoat® ECD (a mainly translucent coating) and Eudragit® NE (a turbid coating containing solid particles). It was shown that UV imaging is a fast and non-destructive method to predict individual tablet weight gain as well as coating thickness. The coating thickness distribution profiles determined by UV imaging correlated to the results of the TPI measurements. UV imaging appears to hold a significant potential as a PAT tool for determination of the tablet coating thickness and its distribution resulting from its high measurement speed, high molar absorptivity and a high scattering coefficient, in addition to relatively low costs.

General information
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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, University of Hamburg, University of Cambridge, University of Copenhagen
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Number of pages: 1,560
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State estimation of the performance of gravity tables using multispectral image analysis

Gravity tables are important machinery that separate dense (healthy) grains from lighter (low yielding varieties) aiding in improving the overall quality of seed and grain processing. This paper aims at evaluating the operating states of such tables, which is a critical criterion required for the design and automation of the next generation of gravity separators. We present a method capable of detecting differences in grain densities, that as an elementary step forms the basis for a related optimization of gravity tables. The method is based on a multispectral imaging technology, capable of capturing differences in the surface chemistry of the kernels. The relevant micro-properties of the grains are estimated using a Canonical Discriminant Analysis (CDA) that segments the captured grains into individual kernels and we show that for wheat, our method correlates well with control measurements (R² =0.93).
UV imaging of Multiple Unit Pellet System (MUPS) tablets: A case study of acetylsalicylic acid stability

The applicability of multispectral ultraviolet (UV) imaging in combination with multivariate image analysis was investigated to monitor API degradation within multiple unit pellet system (MUPS) tablets during storage. For this purpose, acetylsalicylic acid (ASA) layered pellets were coated with Eudragit® RL PO and compressed to MUPS tablets. These tablets were stored under four different conditions with different levels of relative humidity (0 and 75%) and temperature (21 and 40 °C) and analysed at seven storage time points (0, 15, 40, 140, 165, 265, and 330 d). The UV imaging results for estimation of the salicylic acid (SA) concentration as degradation product of ASA in the tablets were compared to the SA concentration measured by high performance liquid chromatography with a partial least squares regression resulting in an RMSEP of 4.86% and an R² of 0.9812. The estimation of the SA concentration based on mean UV reflectance spectra was possible even through the coating of the API pellets and at low concentration levels. In addition, the distribution of the SA concentration on the tablet surfaces for different storage time periods was visualized. UV imaging as fast and non-destructive method appears to offer significant potential for monitoring of API degradation during stability studies.

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Multispectral UV imaging for fast and non-destructive quality control of chemical and physical tablet attributes

Monitoring of tablet quality attributes in direct vicinity of the production process requires analytical techniques that allow fast, non-destructive, and accurate tablet characterization. The overall objective of this study was to investigate the applicability of multispectral UV imaging as a reliable, rapid technique for estimation of the tablet API content and tablet hardness, as well as determination of tablet intactness and the tablet surface density profile. One of the aims was to establish an image analysis approach based on multivariate image analysis and pattern recognition to evaluate the potential of UV imaging for automatized quality control of tablets with respect to their intactness and surface density profile. Various tablets of different composition and different quality regarding their API content, radial tensile strength, intactness, and surface density profile were prepared using an eccentric as well as a rotary tablet press at compression pressures from 20MPa up to 410MPa. It was found, that UV imaging can provide both, relevant information on chemical and physical tablet attributes. The tablet API content and radial tensile strength could be estimated by UV imaging combined with partial least squares analysis. Furthermore, an image analysis routine was developed and successfully applied to the UV images that provided qualitative information on physical tablet surface properties such as intactness and surface density profiles, as well as quantitative information on variations in the surface density. In conclusion, this study demonstrates that UV imaging combined with image analysis is an effective and non-destructive method to determine chemical and physical quality attributes of tablets and is a promising approach for (near) real-time monitoring of the tablet compaction process and formulation optimization purposes.
Multispectral UV imaging, Multivariate image analysis, PLS, SIMCA, Tablet quality attributes, Enzyme tablets
Multispectral UV imaging for surface analysis of MUPS tablets with special focus on the pellet distribution

In the present study the applicability of multispectral UV imaging in combination with multivariate image analysis for surface evaluation of MUPS tablets was investigated with respect to the differentiation of the API pellets from the excipients matrix, estimation of the drug content as well as pellet distribution, and influence of the coating material and tablet thickness on the predictive model. Different formulations consisting of coated drug pellets with two coating polymers (Aquacoat® ECD and Eudragit® NE 30 D) at three coating levels each were compressed to MUPS tablets with various amounts of coated pellets and different tablet thicknesses. The coated drug pellets were clearly distinguishable from the excipients matrix using a partial least squares approach regardless of the coating layer thickness and coating material used. Furthermore, the number of the detected drug pellets on the tablet surface allowed an estimation of the true drug content in the respective MUPS tablet. In addition, the pellet distribution in the MUPS formulations could be estimated by UV image analysis of the tablet surface. In conclusion, this study revealed that UV imaging in combination with multivariate image analysis is a promising approach for the automatic quality control of MUPS tablets during the manufacturing process.

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Scopus rating (2014): SJR 1.324 SNIP 1.555 CiteScore 4.13
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Scopus rating (2013): SJR 1.376 SNIP 1.618 CiteScore 4.17
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BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.542 SNIP 1.655 CiteScore 4.1
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.489 SNIP 1.628 CiteScore 4.01
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Non-destructive Quality control of tablets and blister packs by UV imaging

Quality control of tablets and its primary packing material within the manufacturing line requires analytical routines that allow monitoring of the desired product attributes with high efficiency. The aim of this study was to evaluate the suitability of multispectral UV imaging combined with multivariate image analysis for verification of blister pack filling, differentiation of tablets of varying composition therein, as well as detection of imprint defects and surface cracks of bulk tablets. Moreover, the influence of polymer sealing foils on tablet characterization within blister cavities was investigated. Several tablets of different composition were imaged either as bulk, within unsealed blister packs, or within blister packs that were manually sealed with three different types of either PVC or PCTFE foils. It was demonstrated that UV imaging is a fast and reliable technique for counting and differentiation of tablets within the blister packs. The sealing foils did not prevent characterization of the blister packs with regard to the tablets within the cavities. However, the polymer foils were found to cause changes in the multispectral UV image data set that allow to distinguish the blister packs based on the used polymer. Classification of the blister packs according to the composition of the tablets and the sealing foil was achieved. Furthermore, UV imaging was successfully applied to the detection of defects on imprinted codes and cracks on the surface of bulk tablets. Multispectral UV imaging is a powerful tool for quality control of tablets. Considering the high-speed of non-destructive image acquisition, this technique is promising for implementation in the tablet manufacturing process.
Surface topography, in the context of surface smoothness/roughness, was investigated by the use of an image analysis technique, MultiRay™, related to photometric stereo, on different tablet batches manufactured either by direct compression or roller compaction. In the present study, oblique illumination of the tablet (darkfield) was considered and the area of cracks and pores in the surface was used as a measure of tablet surface topography; the higher a value, the rougher the surface. The investigations demonstrated a high precision of the proposed technique, which was able to rapidly (within milliseconds) and quantitatively measure the obtained surface topography of the produced tablets. Compaction history, in the form of applied roll force and tablet punch pressure, was also reflected in the measured smoothness of the tablet surfaces. Generally it was found that a higher degree of plastic deformation of the microcrystalline cellulose resulted in a smoother tablet surface. This altogether demonstrated that the technique provides the pharmaceutical developer with a reliable, quantitative response parameter for visual appearance of solid dosage forms, which may be used for process and ultimately product optimization.
Rapid Assessment of Tablet Film Coating Quality by Multispectral UV Imaging
Chemical imaging techniques are beneficial for control of tablet coating layer quality as they provide spectral and spatial information and allow characterization of various types of coating defects. The purpose of this study was to assess the
applicability of multispectral UV imaging for assessment of the coating layer quality of tablets. UV images were used to
detect, characterize, and localize coating layer defects such as chipped parts, inhomogeneities, and cracks, as well as to
evaluate the coating surface texture. Acetylsalicylic acid tablets were prepared on a rotary tablet press and coated with a
polyvinyl alcohol-polyethylene glycol graft copolymer using a pan coater. It was demonstrated that the coating intactness
can be assessed accurately and fast by UV imaging. The different types of coating defects could be differentiated and
localized based on multivariate image analysis and Soft Independent Modeling by Class Analogy applied to the UV
images. Tablets with inhomogeneous texture of the coating could be identified and distinguished from those with a
homogeneous surface texture. Consequently, UV imaging was shown to be well-suited for monitoring of the tablet coating
layer quality. UV imaging is a promising technique for fast quality control of the tablet coating because of the high data
acquisition speed and its nondestructive analytical nature.

**General information**
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.678 SNIP 1.027 CiteScore 2.1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.764 SNIP 1.194 CiteScore 2.28
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.797 SNIP 1.261 CiteScore 2.34
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.788 SNIP 1.134 CiteScore 2.1
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.682 SNIP 0.837 CiteScore 1.78
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.711 SNIP 0.958
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.544 SNIP 0.908
BFI (2008): BFI-level 1
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Scopus rating (2007): SJR 0.458 SNIP 0.839
Scopus rating (2006): SJR 0.377 SNIP 0.709
Scopus rating (2005): SJR 0.324 SNIP 0.362
Scopus rating (2004): SJR 0.277 SNIP 0.378
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SIMCA, Multispectral UV imaging, Multivariate image analysis, Tablet coating quality, Tablet quality attributes
A virtual seed file: the use of multispectral image analysis in the management of genebank seed accessions

We present a method for multispectral seed phenotyping as a fast and robust tool for managing genebank accessions. A multispectral vision system was used to take images of the seeds of 20 diverse varieties of rice (approximately 30 seeds for each variety). This was followed by extraction of feature information from the images. Multivariate analysis of the feature data was used to classify seed phenotypes according to accession. The proportion of correctly classified rice seeds was 93%. We conclude that the multispectral image analysis could play a role in comparing incoming seeds against existing accessions, identifying different seed types within a sample of seeds and/or in checking whether regenerated seeds match the original seeds.

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Authors: Adsetts Edberg Hansen, M. (Ekstern), R. Hay, F. (Ekstern), Carstensen, J. M. (Intern)
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.276 SNIP 0.337 CiteScore 0.49
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.321 SNIP 0.554 CiteScore 0.75
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.416 SNIP 0.541 CiteScore 1.03
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.397 SNIP 0.494 CiteScore 0.79
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.366 SNIP 0.564 CiteScore 0.75
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.446 SNIP 0.743
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.349 SNIP 0.61
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.391 SNIP 0.705
Scopus rating (2007): SJR 0.467 SNIP 0.712
Scopus rating (2006): SJR 0.23 SNIP 0.369
Scopus rating (2005): SJR 0.161 SNIP 0.407
Scopus rating (2004): SJR 0.123 SNIP 0.355
Scopus rating (2003): SJR 0.174 SNIP 0.26
Scopus rating (2002): SJR 0.181 SNIP 0.379
Scopus rating (2001): SJR 0.243 SNIP 0.221
Scopus rating (2000): SJR 0.264 SNIP 0.63
Comparison of a multispectral vision system and a colorimeter for the assessment of meat color

The color assessment ability of a multispectral vision system is investigated by a comparison study with color measurements from a traditional colorimeter. The experiment involves fresh and processed meat samples. Meat is a complex material; heterogeneous with varying scattering and reflectance properties, so several factors can influence the instrumental assessment of meat color. In order to assess whether two methods are equivalent, the variation due to these factors must be taken into account. A statistical analysis was conducted and showed that on a calibration sheet the two instruments are equally capable of measuring color. Moreover the vision system provides a more color rich assessment of fresh meat samples with a glossier surface, than the colorimeter. Careful studies of the different sources of variation enable an assessment of the order of magnitude of the variability between methods accounting for other sources of variation leading to the conclusion that color assessment using a multispectral vision system is superior to traditional colorimeter assessments. (C) 2014 Elsevier Ltd. All rights reserved.
Chemical imaging and solid state analysis at compact surfaces using UV imaging

Fast non-destructive multi-wavelength UV imaging together with multivariate image analysis was utilized to visualize distribution of chemical components and their solid state form at compact surfaces. Amorphous and crystalline solid forms of the antidiabetic compound glibenclamide, and microcrystalline cellulose together with magnesium stearate as excipients were used as model materials in the compacts. The UV imaging based drug and excipient distribution was in good agreement with hyperspectral NIR imaging. The UV wavelength region can be utilized in distinguishing between glibenclamide and excipients in a non-invasive way, as well as mapping the glibenclamide solid state form. An exploratory data analysis supported the critical evaluation of the mapping results and the selection of model parameters for the chemical mapping. The present study demonstrated that the multi-wavelength UV imaging is a fast process analytical technique with the potential for real-time monitoring of critical quality attributes.

General information
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Potential of multispectral imaging technology for rapid and non-destructive determination of the microbiological quality of beef filets during aerobic storage

The performance of a multispectral imaging system has been evaluated in monitoring aerobically packaged beef filet spoilage at different storage temperatures (0, 4, 8, 12, and 16°C). Spectral data in the visible and short wave near infrared area (405–970nm) were collected from the surface of meat samples and correlated with microbiological data (log counts),

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for total viable counts (TVCs), Pseudomonas spp., and Brochothrix thermosphacta. Qualitative analysis (PLS-DA) was employed for the discrimination of meat samples in three microbiological quality classes based on the values of total viable counts, namely Class 1 (TVC ≤ 7.0 log10 CFU/g). Furthermore, PLS regression models were developed to provide quantitative estimations of microbial counts during meat storage. In both cases model validation was implemented with independent experiments at intermediate storage temperatures (2 and 10°C) using different batches of meat. Results demonstrated good performance in classifying meat samples with overall correct classification rate for the three quality classes ranging from 91.8% to 80.0% for model calibration and validation, respectively. For quantitative estimation, the calculated regression coefficients between observed and estimated counts ranged within 0.90–0.93 and 0.78–0.86 for model development and validation, respectively, depending on the microorganism. Moreover, the calculated average deviation between observations and estimations was 11.6%, 13.6%, and 16.7% for Pseudomonas spp., B. thermosphacta, and TVC, respectively. The results indicated that multispectral vision technology has significant potential as a rapid and non-destructive technique in assessing the microbiological quality of beef fillets.

**General information**
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ISI indexed (2013): ISI indexed yes
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A Comparison of Meat Colour Measurements From a Colorimeter and Multispectral Images

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Analysis of the Indented Cylinder by the use of Computer Vision
The research summarised in this PhD thesis took advantage of methods from computer vision to experimentally analyse the sorting/separation ability of a specific type of seed sorting device – known as an "indented cylinder". The indented cylinder basically separates incoming seeds into two sub-groups:
(1) "long" seeds and (2) "short" seeds (known as length-separation). The motion of seeds being physically manipulated inside an active indented cylinder was analysed using various computer vision methods. The data from such analyses were used to create an overview of the machine's ability to separate certain species of seed from each other. Seeds are processed in order to achieve a high-quality end product: a batch of a single species of crop seed. Naturally, farmers need processed clean crop seeds that are free from non-seed impurities, weed seeds, and non-viable or dead crop seeds. Since the processing is based on physical manipulation of the seeds themselves, their individual shape and size becomes very relevant. The problem of modelling such physical parameters for various species of seed, grown under various environmental circumstances, is a very complex one. The general problem of modelling and controlling seed processing equipment can be expected to be complex. Due to the involvement of seeds, the problem will naturally inherit all their biological complexities. In addition to this, because of the very large number of individual seeds, the problem also involves a granular media and thus inherits all the complexities related to that as well.
The project arrived at a number of results of high scientific and practical value to the area of applied computer vision and seed processing and agricultural technology in general. The results and methodologies were summarised in one conference paper and two journal papers. These three papers, referred to as Paper I, Paper II, and Paper III can be found in Appendix A, B, and C, respectively. These three papers represent the very first examples of published/submitted work that thoroughly analyse and verify the separation ability of the indented cylinder by the use of computer vision (or image analysis). Moreover, the imagery data sets, generated as a result of actual recordings of sorting experiments using the indented cylinder, are novel by their high dimensionality and size. Paper II in Appendix B makes one of these data sets available online as a cite-aware imagery data set. The work summarised in this thesis is very much related to the task of constructing models from observed data. This field is known as empirical model development or more specifically as "system identification". System v identification deals specifically with estimating mathematical models from observed dynamic states (time series) of inputs and outputs to and from some physical system under investigation. The contribution of the work is to be found primarily within the problem domain of experimentation for system identification. Computer vision techniques were used to acquire observations of a measure of separation efficiency of the indented cylinder. Such techniques for observation are likely to be very relevant for experimentation in a laboratory for system identification purposes. This work should therefore be seen as an important step towards future research in system identification of the indented cylinder. The technical solutions developed are currently novel and represent an ideal platform for future applied research into empirical model development. Finally, this work should also be considered as an early step toward a paradigm shift where the best parameters for the indented cylinder are not mainly determined by "rule of thumb" and other forms of heuristics, but are instead optimized parameters tied to an actual theory of seed separation in the indented cylinder.
Using Multispectral Imaging for Spoilage Detection of Pork Meat

The quality of stored minced pork meat was monitored using a rapid multispectral imaging device to quantify the degree of spoilage. Bacterial counts of a total of 155 meat samples stored for up to 580 h have been measured using conventional laboratory methods. Meat samples were maintained under two different storage conditions: aerobic and modified atmosphere packages as well as under different temperatures. Besides bacterial counts, a sensory panel has judged the spoilage degree of all meat samples into one of three classes. Results showed that the multispectral imaging device was able to classify 76.13% of the meat samples correctly according to the defined sensory scale. Furthermore, the multispectral camera device was able to predict total viable counts with a standard error of prediction of 7.47%. It is concluded that there is a good possibility that a setup like the one investigated will be successful for the detection of spoilage degree in minced pork meat.

General information

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Utilization of Multispectral Images for Meat Color Measurements

This short paper describes how the use of multispectral imaging for color measurement can be utilized in an efficient and descriptive way for meat scientists. The basis of the study is meat color measurements performed with a multispectral imaging system as well as with a standard colorimeter. It is described how different color spaces can enhance the purpose of the analysis - whether that is investigation of a single sample or a comparison between samples. Moreover the study describes how a simple segmentation can be applied to the multispectral images in order to reach a more descriptive measure of color and color variance than what is obtained by the standard colorimeter.

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Classification of parasite eggs used as an active pharmaceutical ingredient (API)

The aim of the project is to describe the developmental stages of parasite eggs using digital image analysis of multispectral imagery. The primary focus is to identify and count eggs of different developmental stages and distinguish them from unrelated particles. This information is used to assess the pharmaceutical potency of eggs from the parasite Trichuris suis (pig whipworm), used as an active pharmaceutical ingredient in medicine against chronic autoimmune diseases of the intestines such as Crohn's disease and Ulcerative colitis. The analysis will combine spectral and morphological characteristics in order to first detect and then classify the parasite eggs based on a set of biologically inspired, quantitative features. The egg classification is currently done manually using transmitted light microscopy, but to allow for validation of this process and to reduce the operator bias, an automated system is being developed. The developed procedure should be robust, non-invasive and fast, and could potentially have applications in description of other organisms. An initial analysis was carried out as a proof of concept. The detection of embryonated eggs was done using matched filtering and the classification was based on the orientation of the larva inside the egg: The ratio of longitudinal vs. latitudinal 'lines' inside the egg is higher for eggs containing a larva.

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Classification of parasite eggs used as an active pharmaceutical ingredient (API)
Detection and classification of parasite eggs for use in helminthic therapy
Eggs from the small, intestinal pig whipworm Trichuris suis constitute the active pharmaceutical ingredient in a novel type of medicine for chronic autoimmune diseases like Crohn's disease. The pharmaceutical potency of such an egg suspension can be assessed by microscopic inspection, as only eggs containing a viable, infective larva provoke the wanted immune reaction. Thus, a precise and objective estimate of the concentration of infective eggs is crucial for dosing the new medicine. In this paper, a vision-based method for detecting and classifying T. suis parasite eggs is described. The detection is based on matched filters and the classification is done using linear and quadratic discriminant analysis on a set of biologically inspired features, including the autocorrelation-based longitudinal anisotropy and the mean scattering intensity under dark field illumination. Despite the presence of impurities and overlapping eggs, the proposed method achieves cross-validated classification rates around 93%.

Imaging Food Quality
Imaging and spectroscopy have long been established methods for food quality control both in the laboratories and online. An ever increasing number of analytical techniques are being developed into imaging methods and existing imaging methods to contain spectral information. Images and especially spectral images contain large amounts of data which should be analysed appropriately by techniques combining structure and spectral information.

This dissertation deals with how different types of food quality can be measured by imaging techniques, analysed with appropriate image analysis techniques and finally use the image data to predict or visualise food quality.

A range of different food quality parameters was addressed, i.e. water distribution in bread throughout storage, time series analysis of chocolate milk stability, yoghurt glossiness, graininess and dullness and finally structure and meat colour of dry fermented sausages. The imaging techniques ranged from single wavelength images, multispectral to hyperspectral images. The effect of different light geometries were utilised in measuring the light reflection of yoghurt surfaces.

What the best imaging technique for a given problem is, should be addressed by visually evaluation of a detectable difference between known samples. While doing image analysis, it was found to be advantageous to combine several small models. The combined model was used for extraction of object relevant information, i.e. spectral, texture or size. The data extracted was used for explorative or predictive data analysis.
Monitoring structure development in milk acidification using diffuse reflectance profiles

The structure of dairy products is important for the consumer, and milk acidification plays a central role for structural development. To ensure the best possible consumer experience, it is important that a product's structural properties are stable. Therefore process and quality control tools are needed so that the production can be carried out consistently, regardless of day-to-day variations in the raw materials.

Casein micelles aggregate during milk acidification, which leads to formation of a gel network. This change of structure is important for the development of a range of dairy products. It is therefore essential to monitor these structural changes and a variety of methods have been proposed to continuously follow this coagulation of milk [1]. Especially non-invasive methods for in situ production line application have been of interest.

We propose a method for analyzing structural changes in milk based on hyper-spectral light scattering. Our approach is motivated by Carstensen and Møller [2]. They demonstrated the correlation between diffuse reflectance profiles and rheology of a milk sample during acidification. In this work we employ a super-continuum laser light source coupled with an acousto-optical tuneable filter to illuminate the sample. The generated beam is spectrally narrow and can be tuned in the spectral range from 450-1050 nm. This system is described in detail in [3]. It is a research platform, which is constantly developed and adjusted according to research needs. Besides providing a non-invasive method, the system also has potential as a design platform for creating specialized and cost-efficient vision systems.

Our preliminary results are highly encouraging and show a clear relation between rheology and diffuse reflectance. A factorial experiment studying the effects of the content of fat, protein, and temperature in the acidification process is conducted. The purpose of the experiment is to investigate how the change of these parameters affects the diffuse reflectance properties as well as to demonstrate the relation between the optical parameters and structure formation in milk acidification. These measurements are compared to conventional methods such as pH, oscillatory rheology, confocal laser scanning microscopy, and sensory data.

Monitoring the change in colour of meat: A comparison of traditional and kernel-based orthogonal transformations

Currently, no objective method exists for estimating the rate of change in the colour of meat. Consequently, the purpose of this work is to develop a procedure capable of monitoring the change in colour of meat over time, environment and ingredients. This provides a useful tool to determine which storage environments and ingredients a manufacturer should add to meat to reduce the rate of change in colour. The procedure consists of taking multi-spectral images of a piece of meat as a function of time, clustering the pixels of these images into categories, including several types of meat, and extracting colour information from each category. The focus has primarily been on achieving an accurate categorisation since this is crucial to develop a useful method. The categorisation is done by applying an orthogonal transformation followed by k-means clustering. The purpose of the orthogonal transformation is to reduce the noise and amount of data while enhancing the difference between the categories. The orthogonal transformations principal components analysis, minimum noise fraction analysis and kernel-based versions of these have been applied to test which produce the most accurate categorisation.
Analysis of Seed Sorting Process by Estimation of Seed Motion Trajectories

Seed sorting is a mechanical process in which the goal is to achieve a high level of purity and quality in the final product. Prediction and control of such processes are generally considered very difficult. One possible solution is a systems identification approach in which the seeds and their movement are directly observed and data about important process parameters extracted. Image analysis was used to extract such data from the internal sorting process in one particular seed sorting device - the so-called “indented cylinder”. Twenty high speed image sequences were recorded of the indented cylinder in action, sorting a batch of barley with both whole and broken kernels. The motion trajectories and angle of escape for each seed in each frame were estimated. Motion trajectories and frequency distributions for the angle of escape are shown for different velocities and pocket sizes. A possible linear relationship is shown to exist between velocity and the angle. The temporal stability of certain parameters in the sorting process were also analysed and is shown to be quite stable for lower velocities.
Classification of Parasite Eggs used as an Active Pharmaceutical Ingredient (API)

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In Depth Analysis of Food Structures: Hyperspectral Subsurface Laser Scattering
In this paper we describe a computer vision system based on SLS (Subsurface Laser Scattering) for industrial food inspection. To obtain high and uniform quality, in for example dairy products like yoghurt and cheese, it is important to monitor the change in size and shape of microscopic particles over time. In this paper we demonstrate the usefulness of our SLS system for characterizing food items. We use a laser source that can be tuned to any wavelength in the range of 455 nm - 1020 nm by applying an AOTF (Acousto-Optical Tunable Filter) to an optical beam generated by a SuperK (supercontinuum) laser system. In our experiments we show how the system can be used for discriminating dairy products with different structure and how the structural change of a foam can be monitored over time. Time stability of the system is essential for measurements over several hours, and we demonstrate the time stability by measuring the reflectance profile of an inorganic phantom. The SLS technique is a very promising technique for non-intrusive food inspection, especially for homogenous products where particle size and shape are important parameters.

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Kernel based pattern analysis methods using eigen-decompositions for reading Icelandic sagas
We want to test the applicability of kernel based eigen-decomposition methods, compared to the traditional eigen-decomposition methods. We have implemented and tested three kernel based methods methods, namely PCA, MAF and MNF, all using a Gaussian kernel. We tested the methods on a multispectral image of a page in the book 'huaksbok', which contains Icelandic sagas.
Multi spectral imaging analysis for meat spoilage discrimination

In the present study, fresh beef fillets were purchased from a local butcher shop and stored aerobically and in modified atmosphere packaging (MAP, CO2 40%/O2 30%/N2 30%) at six different temperatures (0, 4, 8, 12, 16 and 20°C). Microbiological analysis in terms of total viable counts (TVC) was performed in parallel with videometer image snapshots and sensory analysis. Odour and colour characteristics of meat were determined by a test panel and attributed into three pre-characterized quality classes, namely Fresh; Semi Fresh and Spoiled during the days of its shelf life. So far, different microbiological and (bio)chemical methods are employed to assess meat spoilage, the majority of which are slow, time-consuming and expensive procedures and thus, it would be most preferable to be replaced by faster and directly applicable methods. Therefore developing a procedure by associating image data with corresponding sensory data would be of great interest. The purpose of this research was to produce a method capable of quantifying and/or predicting the spoilage status (e.g. express in TVC counts as well as on sensory evaluation) using a multi spectral image of a meat sample and thereby avoid any time-consuming microbiological tests. To accomplish this, the images were converted into values that were comparable to the corresponding data, using the Minimum Noise Fraction (MNF) transformation and simple thresholding. Moreover, association of image data with sensory data was undergone using three different classification methods: Naive Bayes Classifier as a reference model, Canonical Discriminant Analysis (CDA) and Support Vector Classification (SVC). As the final step, generalization of the models was performed using k-fold validation (k=10). Results showed that image analysis provided good discrimination of meat samples regarding the spoilage process as evaluated from sensory as well as from microbiological data. The support vector classification (SVC) model outperformed other models. Specifically, the misclassification error rate (MER), derived from odour characteristics, was 18% for both aerobic and MAP meat samples. In the case where all data were taken together the misclassification error amounted to 16%. When spoilage status was based on visual sensory data, the model produced a MER of 22% for the combined dataset. These results suggest that it is feasible to employ a multi spectral image for the quantitative determination of meat spoilage status during storage in different conditions.

Multispectral imaging as a potential tool for seed health testing of spinach (Spinacia oleracea L.)

Seed health tests are time consuming and require substantial training for characterization of pathogenic fungi on seed. A new approach to use a multispectral vision system for identifying surface properties of different fungal infections has been tested in spinach (Spinacia oleracea L.) at Aarhus University. Our study demonstrates that multispectral imaging with wavelengths ranging from 395-970 nm can be used to distinguish between uninfected spinach seeds and seeds infected with Verticillium spp., Fusarium spp., Stemphylium botryosum, Cladosporium spp. and Alternaria alternata. Analytical
separation based on mean pixel intensity, Canonical Discriminant Analysis (CDA) and classification by Jeffries-Matusita (JM) distance illustrates that a combination of Near Infrared spectra (NIR) and Visual spectra (VIS) is able to identify uninfected seeds from infected seeds ranging from 80-100%. Classification using only NIR gave a separation of 26-88% between uninfected and Fusarium spp. infected seeds. 

Alternaria alternata and Fusarium spp. could be distinguished from each other and from Cladosporium spp., Verticillium spp. and Stemphylium spp. Separation of Cladosporium spp., Verticillium spp. and Stemphylium spp. needs further development before practical application.
Supercontinuum Light Sources for Hyperspectral Subsurface Laser Scattering: Applications for Food Inspection

A materials structural and chemical composition influences its optical scattering properties. In this paper we investigate the use of subsurface laser scattering (SLS) for inferring structural and chemical information of food products. We have constructed a computer vision system based on a supercontinuum laser light source and an Acousto-Optic Tunable Filter (AOTF) to provide a collimated light source, which can be tuned to any wavelength in the range from 480 to 900 nm. We present the newly developed hyperspectral vision system together with a proof-of-principle study of its ability to discriminate between dairy products with either similar chemical or structural composition. The combined vision system is a new way for industrial food inspection allowing non-intrusive online process inspection of parameters that is hard with existing technology.

Kernel based eigenvalue-decomposition methods for analysing ham

Every consumer wants fresh ham and the way we decide whether the meat is fresh or not is by looking at the color. The producers of ham want a long shelf life, meaning they want the ham to look fresh for a long time. The Danish company Danisco is therefore trying to develop optimal storing conditions and finding useful additives to hinder the color to change rapidly. To be able to prove which methods of storing and additives work, Danisco wants to monitor the development of the color of meat in a slice of ham as a function of time, environment and ingredients. We have chosen to use multi-spectral images to monitor the change in color. We therefore have to be able to segment the ham into the different categories of which the ham consists. These categories include fat, gristle and two different types of meat. This segmentation is difficult when using the traditional orthogonal transformation methods, such as PCA, MAF or MNF. We therefore investigated the applicability of kernel based versions of these transformation. This meant implementing the kernel based methods and developing new theory, since kernel based MAF and MNF is not described in the literature yet. The traditional methods only have two factors that are useful for segmentation and none of them can be used to segment the two types of meat. The kernel based methods have a lot of useful factors and they are able to capture the subtle differences in the images. This is illustrated in Figure 1. You can see a comparison of the most useful factor of PCA and kernel based PCA respectively in Figure 2. The factor of the kernel based PCA turned out to be able to segment the two types of meat and in general that factor is much more distinct, compared to the traditional factor. After the orthogonal transformation a simple thresholding is enough to segment the ham and to detect the color of a type of meat can be done by averaging the pixels that is categorised as that type of meat. Graphs of the change of color in ham as well as more images of the segmentation is included in the article found on www.student.dtu.dk/~s062211/.
Multispectral colormapping using penalized least square regression

The authors propose a novel method to map a multispectral image into the device independent color space CIE-XYZ. This method provides a way to visualize multispectral images by predicting color values from spectral values while maintaining interpretability and is tested on a light emitting diode based multispectral system with a total of 11 channels in the visible area. To obtain interpretable models, the method estimates the projection coefficients with regard to their neighbors as well as the target. This results in relatively smooth coefficient curves which are correlated with the CIE-XYZ color matching functions. The target of the regression is a well known color chart, and the models are validated using leave one out cross validation in order to maintain best possible generalization ability. The authors compare the method with a direct linear regression and see that the interpretability improves significantly but comes at the cost of slightly worse predictability.
New vision technology for multidimensional quality monitoring of continuous frying of meat
The potential of using multi-spectral vision technology for quality control in a continuous frying process was investigated. Canonical discriminant analysis of the multi-spectral images of samples of fried minced meat and diced turkey could clearly visualise the effect of different heat treatments. The vision technology can also detect even slight increases in the agglutination of the fried minced meat during the process. This agglutination is undesirable, but very difficult to measure on-line. The results indicate that multi-spectral vision technology may partially or totally substitute visual inspection by an operator as a means of assessing product quality during processing. (C) 2009 Elsevier Ltd. All rights reserved.

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Seed health in spinach seed by multispectral imaging

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The hyperspectral imaging trade-off
Although it has no clear-cut definition, hyperspectral imaging in the UV-Visible-NIR wavelength region seems to mean spectral image sampling in bands from 10 nm width or narrower that enables spectral reconstruction over some wavelength interval. For non-imaging spectral applications, this will be the standard situation, and it enables the detection of small spectral features like peaks, valleys and shoulders for a wide range of chemistries. Everything else being equal this is what you would wish for, and hyperspectral imaging is often used in research and in remote sensing because of the needs and cost structures in these projects. However, hyperspectral imaging is a sampling choice within spectral imaging that typically will impose some trade-offs, and these trade-offs will not be optimal for many applications. The purpose of this presentation is to point out and increase the awareness of these trade-offs to provide a requirement-balanced sampling choice for close-range spectral imaging applications. In close-range imaging we have more degrees of freedom in the design of a spectral imaging system e.g. in terms of sample preparation, sample presentation, illumination, image acquisition, and control. The choice of spectral imaging system will influence many system parameters like 1. Spectral resolution 2. Spatial resolution 3. Time of acquisition and processing 4. Flexibility of acquisition and processing 5. Spectral dynamic range 6. Feasibility of high dynamic range (HDR) imaging 7. Need for movement during acquisition 8. System price Spectral resolution has an obvious interest, but it is the experience of the author, that the vast majority of real spectral imaging applications only need to unmix 2-5 different components. This should be possible with a sensible choice of 10-20 wavelengths. This presentation will show how spectral resolution in these situations can be traded off with improvements in the parameters above.

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A rapid non-destructive method for quantification of fungal infection on barley and malt
Description of topic: Barley harvest 2007 in Europe has seen the resurgence of crops highly infected by filamentous fungi. Hence the evaluation of fungal infection on barley and malt kernels by conventional optical measurement methods lacks accuracy and can be tedious. Here we are presenting a new vision system to rapidly perform this task using the VideometerLab®. This system provides a rapid colour, shape and texture measurement, ideal to analyze kernels surfaces. The principle employed is a high-intensity sphere illuminated by light emitting diodes together with a high-resolution black and white camera. The digital image is acquired in less than 10 seconds, over an 18 bands spanning ranging from the ultra-blue (430 nm) to the near-infrared (970 nm) and then analyzed by the VideometerLab® statistical analysis software. Materials and methods for data collection: Sixty European barley samples from harvest 2004, 2007 and 2008 were collected and screened for their degree of fungal infection using the VideometerLab® equipment. In parallel these samples were analyzed for their Fusarium and hydrophobins content using real-time PCR and/or competitive ELISA. As reference samples, kernels with low content of Fusarium and hydrophobins were selected and highly infected kernels, artificially inoculated with F. culmorum or F. graminearum, were produced. Results: A good correlation between competitive ELISA tests, real-time PCR experiments and VideometerLab® prediction was found (R2=0.75). The results obtained indicate that the videometerlab® equipment can accurately evaluate the percentage of global fungal infection in kernels. Discussion: We believe that this system will be able to discriminate between kernels infected from non-infected ones in mixed samples. This system will allow to quantify the level of infection and indirectly the level of fungal mycotoxins in barley and malt crops. This equipment has the potential of becoming an efficient tool for screening the quality of barley and malt kernels to be used in malteries and breweries.

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Efficient Incorporation of Markov Random Fields in Change Detection

Many change detection algorithms work by calculating the probability of change on a pixel-wise basis. This is a disadvantage since one is usually looking for regions of change, and such information is not used in pixel-wise classification - per definition. This issue becomes apparent in the face of noise, implying that the pixel-wise classifier is also noisy. There is thus a need for incorporating local homogeneity constraints into such a change detection framework. For this modelling task Markov Random Fields are suitable. Markov Random Fields have, however, previously been plagued by lack of efficient optimization methods or numerical solvers. We here address the issue of efficient incorporation of local homogeneity constraints into change detection algorithms. We do this by exploiting recent advances in graph based algorithms for Markov Random Fields. This is combined with an IR-MAD change detector, and demonstrated on real data with good results.

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Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Online monitoring of food processes using subsurface laser scattering
Online monitoring of physical parameters during food production is not a trivial task, but promising results can often be obtained with Subsurface Laser Scattering (SLS). The first SLS instruments are on the market today, and studies are needed to assess the potential of the technology. SLS can monitor particle changes and gelation formation in a fast and non-invasive manner during production of most food products. SLS is correlated to classical particle sizing parameters, i.e. size, number of light scatters and refractive index, as well as sensoric parameters like mouthfeel. The background of the SLS technology is explained, and results from yoghurt fermentation and foaming of a dairy dessert product is presented.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern), Møller, F. (Intern)
Publication date: 2009
Event: Abstract from Advances in process analytics and control technologies, Glasgow, United Kingdom.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256189
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2009

Optimal Color Mapping of Multispectral Images

General information
State: Published
Quantifying graininess of glossy food products
The sensory quality of yoghurt can be altered when changing the milk composition or processing conditions. Part of the sensory quality may be assessed visually. It is described how a non-contact method for quantifying surface gloss and grains in yoghurt can be made. It was found that the standard deviation of the entire image evaluated at different scales in a Gaussian Image Pyramid was a measure for graininess of yoghurt. This methodology is used to predict graininess (or grittiness) and to evaluate effect of yoghurt composition and processing.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Møller, F. (Intern), Carstensen, J. M. (Intern)
Publication date: 2009
Event: Abstract from The International Symposium on Food Rheology and Structure, Zürich, Switzerland.
Main Research Area: Technical/natural sciences
yoghurt, visual quality, light reflection, image quantification
Source: orbit
Source-ID: 256192
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2009

Quantitative analysis of meat spoilage using VIS/NIR spectral imaging
Spectral imaging is a technique with a big potential for surface chemistry mapping of heterogeneous samples. It works by making a spectrum in every pixel of an image, and this spectrum may under the right circumstances be transformed into abundance maps for chemical components. One important application of the technique is finding anomalies I supposedly homogeneous matter or homogeneous mixtures. This application occurs frequently in the food industry when different types of contamination are to be detected. Contaminants could be e.g. foreign matter, process-induced toxins, and microbiological spoilage. Many of these contaminants may be detected in the wavelength range visible to normal silicium-based camera sensors i.e. 350-1050 nm with proper care during sample preparation, sample presentation, image acquisition and analysis. This presentation will give an introduction to the techniques behind the VideometerLab instrument, that implements the thoughts above, and show examples including fusarium detection in barley, measuring microbial meat spoilage, and making humidity maps. It will also illustrate methodology for spectral image analysis.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Carstensen, J. M. (Intern)
Publication date: 2009
Unsupervised and supervised canonical discriminants in multispectral image analysis

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Links:
http://www.impublications.com/imaging/component/content/article/164-easim-09-hyperspectral-imaging

Use of VIS-NIR system combined with multispectral image analysis in spinach seeds

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, Aarhus University
Authors: Olesen, M. H. (Ekstern), Carstensen, J. M. (Intern), Boelt, B. (Ekstern)
Publication date: 2009
Event: Abstract from 14th International Conference on Near Infrared Spectroscopy (NIR 2009), Bangkok, Thailand.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256205
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2009

Billedanalyse sikrer kvaliteten

General information
State: Published
Organisations: Division of Food Production Engineering, National Food Institute, Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, DLF-TRIFOLIUM A/S
Authors: Jørgensen, S. B. (ed.) (Intern), Vittrup, D. (Ekstern), Carstensen, J. M. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: FoodDTU Midt i Ugen
Original language: Danish
Source: orbit
Source-ID: 258301
Publication: Communication › Journal article – Annual report year: 2008

Automatic change detection and quantification of dermatological diseases with an application to psoriasis images

Change monitoring in skin lesion analysis has proven to be a useful adjunct in their assessment. This article presents a comparative study of the available change detection techniques applied to change visualization and quantification in bi-temporal psoriasis images. The chosen methods are evaluated on a time series of psoriasis images and results are compared with dermatologists’ scores.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Gomez, D. D. (Intern), Butakoff, C. (Ekstern), Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern)
Pages: 1012-1018
Precise acquisition and unsupervised segmentation of multi-spectral images

In this work, an integrated imaging system to obtain accurate and reproducible multi-spectral images and a novel multi-spectral image segmentation algorithm are proposed. The system collects up to 20 different spectral bands within a range that vary from 395 nm to 970 nm. The system is designed to acquire geometrically and chromatically corrected images in homogeneous and diffuse illumination, so images can be compared over time. The proposed segmentation algorithm combines the information provided by all the spectral bands to segment the different regions of interest. Three experiments are conducted to show the ability of the system to acquire highly precise, reproducible and standardized multi-spectral images and to show its applicabilities in different situations.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Gomez, D. D. (Intern), Clemmensen, L. K. H. (Intern), Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern)
Pages: 183-193
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Computer Vision and Image Understanding
Volume: 106
Issue number: 2-3
ISSN (Print): 1077-3142
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.82 SJR 1.524 SNIP 2.091
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.165 SNIP 2.215 CiteScore 3.33
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.834 SNIP 1.985 CiteScore 2.83
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.102 SNIP 2.631 CiteScore 3.39
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.845 SNIP 2.466 CiteScore 2.91
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.352 SNIP 4.421 CiteScore 4.82
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.412 SNIP 3.775
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.45 SNIP 3.427
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.44 SNIP 2.92
Scopus rating (2007): SJR 1.846 SNIP 3.101
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.497 SNIP 3.104
Scopus rating (2005): SJR 1.187 SNIP 2.696
Scopus rating (2004): SJR 1.322 SNIP 3.527
Scopus rating (2003): SJR 2.492 SNIP 3.161
Scopus rating (2002): SJR 1.778 SNIP 2.652
Collecting highly reproducible images to support dermatological medical diagnosis

In this article, an integrated imaging system for acquisition of accurate standardized images is proposed. The system also aims at making highly reproducible images over time, so images taken at different times can be compared. The system is made up of an integrating intensity sphere illumination together with a high resolution 3CCD color camera. The well-defined and diffuse illumination of the optically closed scene enhances the true color and avoids effects from specular reflections, shading and shadows. Two experiments are conducted to show the precision of the system and the suitability of the collected images to track dermatological diseases. Results indicate that the developed equipment is an excellent tool for getting high quality digital images. Furthermore, the images collected with the equipment turn out to be a good source to characterize dermatological images.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Gomez, D. D. (Intern), Carstensen, J. M. (Intern), Erbsøll, B. K. (Intern)
Pages: 186-191
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication Information
Journal: Image and Vision Computing
Volume: 24
Issue number: 2
ISSN (Print): 0262-8856
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 1.087 SNIP 1.733 CiteScore 3.31
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.264 SNIP 1.987 CiteScore 3.36
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.787 SNIP 2.172 CiteScore 2.8
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.157 SNIP 3.451 CiteScore 3.92
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.014 SNIP 3.519 CiteScore 3.83
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.861 SNIP 2.755 CiteScore 3.16
ISI indexed (2011): ISI indexed yes
Creating surface chemistry maps using multispectral vision technology

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, Department of Physics
Publication date: 2006

Host publication information
Title of host publication: 9th MICCAI - Workshop on Biophotonics Imaging for Diagnostics and Treatment
Publisher: IMM-Technical Report-2006-17
Main Research Area: Technical/natural sciences
Workshop: 9th MICCAI - Workshop on Biophotonics Imaging for Diagnostics and Treatment, Lyngby, Denmark, 06/10/2006
redundancy imaging, color image analysis, multiray imaging, LED imaging, multispectral imaging
Source: orbit
Source-ID: 200440
Publication: Research › Article in proceedings – Annual report year: 2006

Design of a vision-based sensor for autonomous pighouse cleaning
Current pig house cleaning procedures are hazardous to the health of farm workers, and yet necessary if the spread of disease between batches of animals is to be satisfactorily controlled. Autonomous cleaning using robot technology offers salient benefits. This paper addresses the feasibility of designing a vision-based system to locate dirty areas and subsequently direct a cleaning robot to remove dirt. Novel results include the characterisation of the spectral properties of real surfaces and dirt in a pig house and the design of illumination to obtain discrimination of clean from dirty areas with a low probability of misclassification. A Bayesian discriminator is shown to be efficient in this context and implementation of a prototype tool demonstrates the feasibility of designing a low-cost vision-based sensor for autonomous cleaning.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation, Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Braithwaite, I. D. (Intern), Blanke, M. (Intern), Zhang, G. (Ekstern), Carstensen, J. M. (Intern)
Pages: 2005-2018
Development of an image based system to objectively score the severity of phoriasis

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Gomez, D. D. (Intern), Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern)
Publication date: 2005

Publication information
Original language: English
Series: IMM-PHD-2005-152
Main Research Area: Technical/natural sciences
Links:
http://www2.imm.dtu.dk/pubdb/p.php?4013
Source: orbit
Source-ID: 185922
Publication: Research › Ph.D. thesis – Annual report year: 2005

Estimation of Critical Parameters in Concrete Production Using Multispectral Vision Technology

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Hansen, M. E. (Intern), Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern), Nielsen, A. A. (Intern)
Pages: 1228-1237
Publication date: 2005

Host publication information
Title of host publication: Lecture Notes in Computer Science
Volume: 3540
Publisher: Springer
Main Research Area: Technical/natural sciences
Links:
http://www2.imm.dtu.dk/pubdb/p.php?3653
Source: orbit
Source-ID: 185692
Publication: Research - peer-review › Article in proceedings – Annual report year: 2005
IDENTIFICATION OF ENCODED BEADS
The present invention relates to methods for the identification of spatially encoded beaded or granulated matrices comprising a plurality of immobilized particles. The identification is based on a distance matrix determination or based on a set of geometrical figures, such as triangles, on the basis of which individual matrices can be determined.

General information
State: Published
Organizations: Department of Chemical and Biochemical Engineering, Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Christensen, S. F. (Intern), Johansen, I. (Ekstern), Carstensen, J. M. (Intern), Kuhlmann, L. (Ekstern)
Publication date: 2005

Publication information
Patent number: WO2005061094
Date: 07/07/2005
Original language: English

Bibliographical note
International application published under the World Intellectual Property Organization (WIPO)
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 202519
Publication: Research › Patent – Annual report year: 2005

Indexing and Analysis of Fungal Phenotypes Using Morphology and Spectrometry

General information
State: Published
Organizations: Center for Microbial Biotechnology, Department of Systems Biology, Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Hansen, M. A. E. (Intern), Carstensen, J. M. (Intern), Frisvad, J. C. (Intern)
Publication date: 2005

Publication information
Original language: English
Series: IMM-PHD-2005-151
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 185924
Publication: Research › Ph.D. thesis – Annual report year: 2005

An image based system to automatically and objectively score the degree of redness and scaling in psoriasis lesions.
In this work, a combined statistical and image analysis method to automatically evaluate the severity of scaling in psoriasis lesions is proposed. The method separates the different regions of the disease in the image and scores the degree of scaling based on the properties of these areas. The proposed method provides a solution to one of the present problems in dermatology: the lack of suitable methods to assess the lesion and to evaluate the changes during the treatment. An experiment over a collection of psoriasis images is conducted to test the performance of the method. Results show that the obtained scores are highly correlated with scores made by doctors. This and the fact that the obtained measures are continuous indicate the proposed method is a suitable tool to evaluate the lesion and to track the evolution of dermatological diseases.

General information
State: Published
Organizations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Gomez, D. D. (Intern), Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern)
Publication date: 2004

Host publication information
Title of host publication: Proceedings of the 13. Danish conference in pattern recognition and image analysis
Automatic scoring of the severity of psoriasis scaling
In this work, a combined statistical and image analysis method to automatically evaluate the severity of scaling in psoriasis lesions is proposed. The method separates the different regions of the disease in the image and scores the degree of scaling based on the properties of these areas. The proposed method provides a solution to the lack of suitable methods to assess the lesion and to evaluate changes during the treatment. An experiment over a collection of psoriasis images is conducted to test the performance of the method. Results show that the obtained scores are highly correlated with scores made by doctors. This and the fact that the obtained measures are continuous indicate the proposed method is a suitable tool to evaluate the lesion and to track the evolution of dermatological diseases.

Density-based retrieval from high-similarity image databases
Many image classification problems can fruitfully be thought of as image retrieval in a "high similarity image database" (HSID) characterized by being tuned towards a specific application and having a high degree of visual similarity between entries that should be distinguished. We introduce a method for HSID retrieval using a similarity measure based on a linear combination of Jeffreys-Matusita distances between distributions of local (pixelwise) features estimated from a set of automatically and consistently defined image regions. The weight coefficients are estimated based on optimal retrieval performance. Experimental results on the difficult task of visually identifying clones of fungal colonies grown in a petri dish and categorization of pelts show a high retrieval accuracy of the method when combined with standardized sample preparation and image acquisition.
Multispectral Vision Technology

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, Center for Microbial Biotechnology, Videometer A/S
Authors: Carstensen, J. M. (Intern), Lassen, N. C. K. (Intern), Hansen, P. W. (Ekstern), Hansen, M. E. (Intern)
Pages: 1
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Materiale Nyt
Volume: 1
Original language: English
Source: orbit
Source-ID: 186458
Precise Multi-Spectral Dermatological Imaging
In this work, an integrated imaging system to obtain accurate and reproducible multi-spectral dermatological images is proposed. The system is made up of an integrating sphere, light emitting diodes and a generic monochromatic camera. The system can collect up to 10 different spectral bands. These spectral bands vary from ultraviolet to near infrared. The well-defined and diffuse illumination of the optically closed scene aims to avoid shadows and specular reflections. Furthermore, the system has been developed to guarantee the reproducibility of the collected images. This allows for comparative studies of time series of images. Two experiments are conducted to show the ability of the system to acquire highly precise and standardized multi-spectral images. The first experiment aims to show the capacity of the system to collect reproducible images. The second experiment demonstrates that the multi-spectral images provide more information than the classical thri-chromatic images and that this information is enough to segment lesions easily. These two facts together indicate the suitability of the system to collect images and to summarize and track the evolution of dermatological diseases.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Gomez, D. D. (Intern), Carstensen, J. M. (Intern), Ersbøll, B. K. (Intern)
Publication date: 2004

S.H.A.R.P: A smart Hierarchical Algorithm to Register Psoriasis
In this work, an automatic algorithm for registering psoriasis images is proposed. The algorithm, made up of two stages, takes advantages of the behavior of the disease. In the first stage, the diseased area is segmented in the image. The second stage uses this information to align the image based on the two first statistical moments of the area. The algorithm is compared with other existing methods. One of these methods was developed specifically to register psoriasis images. Results show the suitability of the proposed algorithm from the point of view of accuracy, parameter dependency and speed.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Gomez, D. D. (Intern), Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern)
Pages: 43-46
Publication date: 2004

Building an Image-Based System to automatically Score psoriasis
Nowadays the medical tracking of dermatological diseases is imprecise. The main reason is the lack of suitable objective methods to evaluate the lesion. The severity of the disease is scored by doctors just through their visual examination. In this work, a system to take accurate images of dermatological lesions has been developed. Mathematical methods can be applied to these images to obtain values that summarize the lesion and help to track its evolution. The system is composed of two elements. A precise image acquisition equipment and a statistical procedure to extract the lesions from
the images. The system is tested on patients with the dermatological disease psoriasis. Temporal series of images are
taken for each patient and the lesions are automatically extracted. Results indicate that to the images obtained are a good
source for obtaining derived variables to track the lesion.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Gømez, D. D. (Ekstern), Carstensen, J. M. (Intern), Ersbøll, B. K. (Intern)
Pages: 557-564
Publication date: 2003

Host publication information
Title of host publication: Proceedings of the 13th Scandinavian conference in image analysis
Main Research Area: Technical/natural sciences
Conference: 13th Scandinavian Conference in Image Analysis, Gothenburg, Sweden, 29/06/2003 - 29/06/2003
Source: orbit
Source-ID: 200106
Publication: Research - peer-review › Article in proceedings – Annual report year: 2003

Color-Based Image Retrieval from High-Similarity Image Databases
Many image classification problems can fruitfully be thought of as image retrieval in a "high similarity image database"
(HSID) characterized by being tuned towards a specific application and having a high degree of visual similarity between
entries that should be distinguished. We introduce a method for HSID retrieval using a similarity measure based on a
linear combination of Jeffreys-Matusita (JM) distances between distributions of color (and color derivatives) estimated from
a set of automatically extracted image regions. The weight coefficients are estimated based on optimal retrieval
performance. Experimental results on the difficult task of visually identifying clones of fungal colonies grown in a petri dish
and categorization of pelts show a high retrieval accuracy of the method when combined with standardized sample
preparation and image acquisition.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Hansen, M. A. E. (Intern), Carstensen, J. M. (Intern)
Publication date: 2003

Host publication information
Title of host publication: 13th Scandinavian Conference on Image Processing : Lecture Notes in Computer Science
Volume: Volume 2749
Publisher: Springer
Main Research Area: Technical/natural sciences
Conference: 13th Scandinavian Conference in Image Analysis, Gothenburg, Sweden, 29/06/2003 - 29/06/2003
Source: orbit
Source-ID: 58522
Publication: Research - peer-review › Article in proceedings – Annual report year: 2003

Multispectral vision technology

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern), Lassen, N. C. K. (Intern), Hansen, P. W. (Ekstern), Hansen, M. E. (Ekstern)
Pages: 153-158
Publication date: 2003

Host publication information
Title of host publication: Proceedings of the 5th European Symposium on Near Infrared Spectroscopy
Main Research Area: Technical/natural sciences
Conference: Proceedings of the 5th European Symposium on Near Infrared Spectroscopy, 01/01/2003
Source: orbit
Source-ID: 200005
Publication: Research - peer-review › Article in proceedings – Annual report year: 2003

Visual clone identification of penicillium commune isolates
Chemical Image Analysis (CIA): Distance based identification

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Center for Microbial Biotechnology, Department of Systems Biology, Image Analysis and Computer Graphics
Authors: Hansen, M. A. E. (Intern), Smedsgaard, J. (Intern), Larsen, T. O. (Intern), Carstensen, J. M. (Intern), Frisvad, J. C. (Intern)
Publication date: 2002
Event: Poster session presented at 10th International Congress of Mycology, Paris, :
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 201192
Publication: Research › Poster – Annual report year: 2002

Factorization with Contaminated Data

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Aanæs, H. (Intern), Fisker, R. (Intern), Åström, K. (Ekstern), Carstensen, J. M. (Intern)
Publication date: 2002
Host publication information
Title of host publication: Presentation and abstract at Eleventh International Workshop on Matrices and Statistics, EIWMS-2002, Lyngby, August 29-31
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 58234
Publication: Research › Article in proceedings – Annual report year: 2002

Factorization with Erroneous Data

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Aanæs, H. (Intern), Fisker, R. (Intern), Åström, K. (Ekstern), Carstensen, J. M. (Intern)
Number of pages: 8
Publication date: 2002
Host publication information
Title of host publication: Proceedings of Photogrammetric Computer Vision, PCV02, Graz, Austria
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 58145
Fuzz and pills evaluated on knitted textiles by image analysis

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Jensen, K. L. (Ekstern), Carstensen, J. M. (Intern)
Pages: 34-38
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: Textile Research Journal
Volume: 72
Issue number: 1
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.552 SNIP 1.06 CiteScore 1.42
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.718 SNIP 1.191 CiteScore 1.48
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.743 SNIP 1.557 CiteScore 1.84
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.959 SNIP 1.709 CiteScore 1.6
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.858 SNIP 1.284 CiteScore 1.29
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.996 SNIP 1.618 CiteScore 1.36
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.714 SNIP 1.422
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.964 SNIP 1.25
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.984 SNIP 1.415
Scopus rating (2007): SJR 0.962 SNIP 1.392
Scopus rating (2006): SJR 0.527 SNIP 1.403
Scopus rating (2005): SJR 0.396 SNIP 1.217
Scopus rating (2004): SJR 0.676 SNIP 1.525
Scopus rating (2003): SJR 0.482 SNIP 1.252
Scopus rating (2002): SJR 0.39 SNIP 1.217
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.389 SNIP 1.446
Scopus rating (2000): SJR 0.385 SNIP 1.856
Scopus rating (1999): SJR 0.356 SNIP 1.599
Original language: English
Links:
Source: orbit
Source-ID: 58088
Publication: Research - peer-review › Journal article – Annual report year: 2002
Identification of basidiomycetes using image analysis of pigments and colony morphology

Robust factorization

Factorization algorithms for recovering structure and motion from an image stream have many advantages, but they usually require a set of well-tracked features. Such a set is in generally not available in practical applications. There is thus a need for making factorization algorithms deal effectively with errors in the tracked features. We propose a new and computationally efficient algorithm for applying an arbitrary error function in the factorization scheme. This algorithm enables the use of robust statistical techniques and arbitrary noise models for the individual features. These techniques and models enable the factorization scheme to deal effectively with mismatched features, missing features, and noise on the individual features. The proposed approach further includes a new method for Euclidean reconstruction that significantly improves convergence of the factorization algorithms. The proposed algorithm has been implemented as a modification of the Christy-Horaud factorization scheme, which yields a perspective reconstruction. Based on this implementation, a considerable increase in error tolerance is demonstrated on real and synthetic data. The proposed scheme can, however, be applied to most other factorization algorithms.
Three-dimensional glacier surface motion maps at the Gjalp eruption site, Iceland, inferred from combining InSAR and other ice-displacement data

We use topographically corrected interferograms, repeated global positioning system observations of locations of stakes and time series of elevation data to produce time series of high-resolution three-dimensional (3-D) ice surface motion maps for the infilling of the ice depression created by the 1996 subglacial eruption at the Gjalp volcano in Vatnajökull, Iceland. The ice inflow generated uplift in the central parts of the depression. During the first months, the uplift was much reduced by basal melting as the subglacial volcano cooled. For those motions surface-parallel ice flow cannot be assumed. The 3-D motion maps are created by an optimization process that combines the complementary datasets. The optimization is based on a Markov random-field regularization and a simulated annealing algorithm. The 3-D motion maps show the pattern of gradually diminishing ice flow into the depression. They provide a consistent picture of the 3-D motion field, both spatially and with time, which cannot be seen by separate interpretation of the complementary observations. The 3-D motion maps were used to calculate the cooling rate of the subglacial volcano for the first year after the eruption. First an uplift rate resulting solely from the inflow of ice was calculated from inferred horizontal motions. Basal melting was then estimated as the difference between the calculated uplift generated by the inflow of ice, and the observed uplift that was the combined result of ice inflow and basal melting. The basal melting was found to decline from 55 m$^3$ s$^{-1}$ (due to power of 18 GW) in January 1997 to 5 m$^3$ s$^{-1}$ (2 GW) in October 1997.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Gudmundsson, S. (Ekstern), Gudmundsson, M. T. (Ekstern), Bjornsson, H. (Ekstern), Sigmundsson, F. (Ekstern), Rott, H. (Ekstern), Carstensen, J. M. (Intern)
Pages: 315-322
Publication date: 2002
Main Research Area: Technical/natural sciences
Three-dimensional surface motion maps estimated from combined insar and gps data

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Gudmundsson, S. (Ekstern), Sigmundsson, F. (Ekstern), Carstensen, J. M. (Intern)
Pages: ETG13-1-14
Publication date: 2002
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Journal of Geophysical Research
Volume: 107
Issue number: B10
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.36 SJR 1.996 SNIP 1.313
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.288 SNIP 1.362 CiteScore 3.39
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.324 SNIP 1.349 CiteScore 3.27
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.357 SNIP 1.44 CiteScore 3.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.365 SNIP 1.35 CiteScore 2.93
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.239 SNIP 1.301 CiteScore 3.03
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.449 SNIP 1.324
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.347 SNIP 1.359
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.101 SNIP 1.296
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.054 SNIP 1.26
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.166 SNIP 1.351
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.159 SNIP 1.228
Web of Science (2005): Indexed yes
Unwrapping ground displacement signals in satellite radar interferograms with aid of gps data and mrf regularization

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Gudmundsson, S. (Ekstern), Sigmundsson, F. (Ekstern), Carstensen, J. M. (Intern)
Pages: 1743-1754
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Volume: 40
Issue number: 8
ISSN (Print): 0196-2892
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.29 SJR 2.461 SNIP 3.102
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.559 SNIP 3.241 CiteScore 4.7
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.486 SNIP 3.582 CiteScore 4.71
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.467 SNIP 3.355 CiteScore 4.22
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.382 SNIP 3.806 CiteScore 4.26
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.29 SNIP 3.049 CiteScore 3.85
ISI indexed (2011): ISI indexed yes
Image analysis, vision, and computer graphics

A general scheme for training and optimization of the Grenander deformable template model
General deformable models have reduced the need for hand crafting new models for every new problem, but still most of the general models rely on manual interaction by an expert, when applied to a new problem, e.g. for selecting parameters and initialization. We propose a full and unified scheme for applying the general deformable template model proposed by (Grenander et al., 1991) to a new problem with minimal manual interaction, beside supplying a training set, which can be done by a non-expert user. The main contributions compared to previous work are a supervised learning scheme for the model parameters, a very fast general initialization algorithm and an adaptive likelihood model based on local means. The
model parameters are trained by a combination of a 2D shape learning algorithm and a maximum likelihood based criteria. The fast initialization algorithm is based on a search approach using a filter interpretation of the likelihood model.

A general scheme for training and optimization of the grenander derofmable template model

Direct identification of pure penicillium species using image analysis

This paper presents a method for direct identification of fungal species solely by means of digital image analysis of colonies as seen after growth on a standard medium. The method described is completely automated and hence objective once digital images of the reference fungi have been established. Using a digital image it is possible to extract precise information from the surface of the fungal colony. This includes color distribution, colony dimensions and texture measurements. For fungal identification, this is normally done by visual observation that often results in a very subjective data recording. Isolates of nine different species of the genus Penicillium have been selected for the purpose. After incubation for 7 days, the fungal colonies are digitized using a very accurate digital camera. Prior to the image analysis each image is corrected for self-illumination, thereby gaining a set of directly corresponding images with respect to illumination. A Windows application has been developed to locate the position and size of up to three colonies in the digitized image. Using the estimated positions and sizes of the colonies, a number of relevant features can be extracted for further analysis. The method used to determine the position of the colonies will be covered as well as the feature selection. The texture measurements of colonies of the nine species were analyzed and a clustering of the data into the correct species was confirmed. This indicates that it is indeed possible to identify a given colony merely by macromorphological features. A classifier (in the normal distribution) based on measurements of 151 colonies incubated on yeast extract sucrose agar (YES) was used to discriminate between the species. This resulted in a correct classification rate of 100% when used on the training set and 96% using cross-validation. The same methods applied to 194 colonies incubated on Czapek yeast extract agar (CYA) resulted in a correct classification rate of 98% on the training set and 71% using cross-validation.
Estimation of Nanoparticle Size Distributions by Image Analysis

Knowledge of the nanoparticle size distribution is important for the interpretation of experimental results in many studies of nanoparticle properties. An automated method is needed for accurate and robust estimation of particle size distribution from nanoparticle images with thousands of particles. In this paper, we present an automated image analysis technique based on a deformable ellipse model that can perform this task. Results of using this technique are shown for both nearly spherical particles and more irregularly shaped particles. The technique proves to be a very useful tool for nanoparticle research.
Robust structure and motion

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Aanæs, H. (Intern), Fisker, R. (Intern), Carstensen, J. M. (Intern)
Pages: 1-9
Publication date: 2000

Host publication information
Title of host publication: The 9th Danish Conference on Pattern Recognition and Image Analysis
Place of publication: Aalborg
Main Research Area: Technical/natural sciences
Conference: Proceedings of the 9th Danish Conference on Pattern recognition and image analysis, 01/01/2000
Source: orbit
Source-ID: 176445
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000

Unsupervised classification of x-ray mapping images of polished section

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Hilger, K. B. (Intern), Nielsen, A. A. (Intern), Carstensen, J. M. (Intern)
Pages: 44-47
Publication date: 2000

Host publication information
Title of host publication: Proceedings of MVA2000, IAPR Workshop on Machine Vision Applications
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200146
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000

A General Polygon-based Deformable Model for Object Recognition
We propose a general scheme for object localization and recognition based on a deformable model. The model combines shape and image properties by warping a arbitrary prototype intensity template according to the deformation in shape. The
shape deformations are constrained by a probabilistic distribution, which combined with a match of the warped intensity template and the image form the final criteria used for localization and recognition of a given object. The chosen representation gives the model an ability to model an almost arbitrary object. Beside the actual model a full general scheme for applying the model is proposed. The scheme includes general methods for initialization, optimization and validation. Experimental results for real data are shown. Compared to related work the proposed model and the methods for initialization and validation contains a number of interesting features and improved abilities.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Jensen, R. F. (Intern), Carstensen, J. M. (Intern)
Pages: 28-35
Publication date: 1999

Host publication information
Title of host publication: Proceedings from The 8th Danish Conference on Pattern Recognition and Image Analysis
Place of publication: Copenhagen
Publisher: DIKU TRYK
Main Research Area: Technical/natural sciences
Conference: The 8th Danish Conference on Pattern Recognition and Image Analysis, Copenhagen, 01/01/1999
Source: orbit
Source-ID: 172453
Publication: Research › Article in proceedings – Annual report year: 1999

AN APPARATUS AND A METHOD OF RECORDING AN IMAGE OF AN OBJECT
The invention relates to a method of recording an image of an object (103) using an electronic camera (102), one or more light sources (104), and means for light distribution (105), where light emitted from the light sources (104) is distributed to illuminate the object (103), light being reflected to the camera (102). In the light distribution, an integrating cavity (106) is used to whose inner side (107) a light reflecting coating has been applied, and which is provided with first and second openings (109, 110). The camera (102) is placed in alignment with the first opening (109) so that the optical axis of the camera extends through the first and second openings (109, 110). The object (103) is received in the second opening (110), and the interior of the integrating cavity is illuminated using the one or more light sources (104). The invention also relates to an apparatus for performing the method.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern), Folm-Hansen, J. (Intern)
Publication date: 1999

Publication information
Patent number: WO1999042900
Date: 26/08/1999
Original language: English

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Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 202520
Publication: Research › Patent – Annual report year: 1999

Direct identification of fungi using image analysis

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Department of Biotechnology
Authors: Dørge, T. C. (Intern), Carstensen, J. M. (Intern), Frisvad, J. C. (Intern)
Pages: 267-268
Publication date: 1999

Host publication information
Title of host publication: Abstract book
Place of publication: Sydney
Main Research Area: Technical/natural sciences
Conference: 9th International congress of bacteriology and applied microbiology, and the 9th. International congress of mycology., Sydney, 01/01/1999
Source: orbit
Source-ID: 172437
Publication: Research › Article in proceedings – Annual report year: 1999

High-throughput screening in biotechnology

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Proceedings of the NOBIM industry seminar on image analysis
Main Research Area: Technical/natural sciences
Seminar: NOBIM Industry Seminar on Image Analysis, Oslo, Norway, 01/01/1999
Source: orbit
Source-ID: 172523
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Identification of Fungi by Machine Vision

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Dørge, T. C. (Intern), Carstensen, J. M. (Intern)
Pages: 1-12
Publication date: 1999

Host publication information
Title of host publication: Proceedings from the 8th Danish Conference on Pattern Recognition and Image Analysis
Place of publication: Copenhagen
Publisher: DIKU TRYK
Main Research Area: Technical/natural sciences
Conference: The 8th. Danish Conference on Pattern Recognition and Image Analysis, Copenhagen, 01/01/1999
Source: orbit
Source-ID: 172434
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Initialization and Optimization of Deformable Models

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Jensen, R. F. (Intern), Carstensen, J. M. (Intern), Madsen, K. (Intern)
Pages: 295-302
Publication date: 1999

Host publication information
Title of host publication: Proceedings from The 11th Scandinavian Conference on Image Analysis
Main Research Area: Technical/natural sciences
Conference: 11th Scandinavian Conference on Image Analysis (SCIA), Kangerlussuaq, Greenland, 07/06/1999 - 07/06/1999
Source: orbit
Source-ID: 172454
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Initialization and optimization of deformable models

General information
Machine Vision and Advanced Image Processing in Remote Sensing

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern), Jensen, R. F. (Intern), Schultz, N. (Intern), Dørge, T. C. (Intern)
Publication date: 1999

Publication information
Publisher: Springer
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
I. Kanellopoulos, G.G. Wilkinson and T. Moons, Editors
Source: orbit
Source-ID: 172521
Publication: Research - peer-review › Book – Annual report year: 1999

Structural Inference Using Deformable Models

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, CICT
Authors: Carstensen, J. M. (Intern), Fisker, R. (Intern), Schultz, N. (Intern), Dorge, T. (Ekstern)
Publication date: 1999

Publication information
Publisher: Springer
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200893
Publication: Research - peer-review › Report – Annual report year: 1999

Structural Inference Using Deformable Models

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, CICT
Authors: Carstensen, J. M. (Intern), Fisker, R. (Intern), Schultz, N. (Intern), Dorge, T. (Ekstern)
Pages: 61-71
Publication date: 1999

Host publication information
Title of host publication: Machine Vision and Advanced Image Processing in Remote Sensing
Main Research Area: Technical/natural sciences
Links:
http://www2.imm.dtu.dk/pubdb/p.php?4294
Vision-based surface inspection: laboratory and in-line prototypes.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Proceedings of the NOBIM industry seminar on image analysis
Publisher: Norwegian Society for Image Processing and Pattern Recognition
Main Research Area: Technical/natural sciences
Seminar: NOBIM Industry Seminar on Image Analysis, Oslo, Norway, 01/01/1999
Source: orbit
Source-ID: 172522
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Aligning of single and multiple wavelength chromatographic
The use of chemometric data processing is becoming an important part of modern chromatography. Most chemometric analyses are performed on reduced data sets using areas of selected peaks detected in the chromatograms, which means a loss of data and introduces the problem of extracting peak data from the chromatographic profiles. These disadvantages can be overcome by using the entire chromatographic data matrix in chemometric analyses, but it is necessary to align the chromatograms, as small unavoidable differences in experimental conditions causes minor changes and drift. Previous aligning methods either fail to utilise the entire data matrix or rely on peak detection, thus having the same limitations as the commonly used chemometric procedures. The method presented uses the entire chromatographic data matrices and does not require any preprocessing e.g., peak detection. It relies on piecewise linear correlation optimised warping (COW) using two input parameters which can be estimated from the observed peak width. COW is demonstrated on constructed single trace chromatograms and on single and multiple wavelength chromatograms obtained from HPLC diode detection analyses of fungal extracts. A copy of the C program containing the COW implementation used in this work may be obtained at http://www.imm.dtu.dk/~jmc/papers/cow/cow.html

General information
State: Published
Organisations: Department of Biotechnology, Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, Center for Microbial Biotechnology, Department of Systems Biology
Authors: Nielsen, N. V. (Intern), Carstensen, J. M. (Intern), Smedsgaard, J. (Intern)
Pages: 17-35
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Chromatography A
Volume: 805
Issue number: 1-2
ISSN (Print): 0021-9673
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.97 SJR 1.462 SNIP 1.295
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.713 SNIP 1.395 CiteScore 4.03
Web of Science (2015): Indexed Yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.825 SNIP 1.509 CiteScore 4.28
Web of Science (2014): Indexed Yes
BFI (2013): BFI-level 1
Aligning on single and multiple wavelength chromatographic profiles for chemometric data analysis using correlation optimised warping

General information
State: Published
Organisations: Department of Biotechnology, Department of Informatics and Mathematical Modeling
Authors: Nielsen, N. V. (Intern), Carstensen, J. M. (Intern), Smedsgaard, J. (Intern)
Pages: 17-35
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of chromatography
Volume: A
Issue number: 805
Original language: English
On parameter estimation in deformable models
Deformable templates have been intensively studied in image analysis through the last decade, but despite its significance the estimation of model parameters has received little attention. We present a method for supervised and unsupervised model parameter estimation using a general Bayesian formulation of deformable templates. In the supervised estimation the parameters are estimated using a likelihood and a least squares criterion given a training set. For most deformable template models the supervised estimation provides the opportunity for simulation of the prior model. The unsupervised method is based on a modified version of the EM algorithm. Experimental results for a deformable template used for textile inspection are presented.

Use of image processing tools for texture analysis of high energy x-ray synchrotron data

Bibliographical note
Copyright 1998 IEEE. Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyrighted component of this work in other works must be obtained from the IEEE.
Use of image-processing tools for texture analysis of high-energy X-ray synchrotron data

The introduction of synchrotron beamlines for high-energy X-ray diffraction raises new possibilities for texture determination of polycrystalline materials. The local texture can be mapped out in three dimensions and texture developments can be studied in situ in complicated environments. However, it is found that a full alignment of the two-dimensional detector used in many cases is impractical and that data-sets are often partially subject to geometric restrictions. Estimating the parameters of the traces of the Debye-Scherrer cones on the detector therefore becomes a concern. Moreover, the background may vary substantially on a local scale as a result of inhomogeneities in the sample environment etc. A set of image-processing tools has been employed to overcome these complications. An automatic procedure for estimating the parameters of the traces (taken as ellipses) is described, based on a combination of a circular Hough transform and nonlinear least-squares fitting. Using the estimated ellipses the background is subtracted and the intensity along the Debye-Scherrer cones is integrated by a combined fit of the local diffraction pattern. The corresponding algorithms are presented together with the necessary coordinate transform for pole-figure determination. The image-processing tools may be useful for the analysis of noisy or partial powder diffraction data-sets in general, provided flat two-dimensional detectors are used.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Risø National Laboratory for Sustainable Energy, Risø National Laboratory
Authors: Fisker, R. (Intern), Poulsen, H. F. (Intern), Schou, J. (Intern), Carstensen, J. M. (Intern), Garbe, S. (Ekstern)
Pages: 647-653
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Applied Crystallography
Volume: 31
Issue number: Part 5
ISSN (Print): 0021-8898
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BFI (2018): BFI-level 2
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.51 SJR 1.242 SNIP 1.234
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.322 SNIP 2.588 CiteScore 3.97
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.585 SNIP 4.371 CiteScore 4.76
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.921 SNIP 6.392 CiteScore 6
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.572 SNIP 4.687 CiteScore 4.67
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Automated visual inspection of textile

A method for automated inspection of two types of textile is presented. The goal of the inspection is to determine defects in the textile. A prototype is constructed for simulating the textile production line. At the prototype the images of the textile are acquired by a high speed line scan camera. The vertical threads are located using a vertical projection of the image. It is thereby possible to identify the defects in the vertical threads. A structural model of the horizontal threads is formulated. The model consists of a Markov random field which represents a priori knowledge about the position and structure of the horizontal threads and an observation model that incorporates knowledge about the visual appearance of the threads given their position and structure. Using this model the horizontal threads are located. Features are calculated from the located threads to identify the defects. To go from the prototype to a production line system we only need to gain a speed factor of 4.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Jensen, R. F. (Intern), Carstensen, J. M. (Intern)
Pages: 173-179
Publication date: 1997

Host publication information
Title of host publication: Proceedings of the 10th Scandinavian Conference on Image Analysis
Main Research Area: Technical/natural sciences
Conference: 10th Scandinavian Conference on Image Analysis (SCIA), Lappeenranta, Finland, 01/01/1997
Source: orbit
Bimodal Histogram Transformation Based on Maximum Likelihood Parameter Estimates in Univariate Gaussian Mixtures

**General information**
State: Published
Organisations: CICT, Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Schultz, N. (Intern), Carstensen, J. M. (Intern), Bimbo, A. D. (ed.) (Ekstern)
Pages: 532-543
Publication date: 1997

**Host publication information**
Title of host publication: Proceedings of Image Analysis and Processing, ICIAP'97
Publisher: Springer
ISBN (Print): 3-540-63508-4
Series: Lecture Notes in Computer Science
Volume: 2
ISSN: 0302-9743
Main Research Area: Technical/natural sciences
Conference: Image Analysis and Processing, ICIAP'97, 01/01/1997
Source: orbit
Source-ID: 200375
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

Kalibrering af farvekameraer

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics
Authors: Folm-Hansen, J. (Intern), Carstensen, J. M. (Intern)
Publication date: 1997

**Host publication information**
Title of host publication: Proceedings fra Den 6. Danske Konference om Mønstergenkeldelse og Billedanalyse
Main Research Area: Technical/natural sciences
Conference: Den 6. Danske Konference om Mønstergenkendelse og Billedanalyse, Copenhagen, 01/01/1997
Source: orbit
Source-ID: 168606
Publication: Research › Article in proceedings – Annual report year: 1997

On Optical Flow Estimation in Radar Images for Precipitation Forecasting

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Tamstorf, R. P. (Intern), Madsen, H. (Intern), Carstensen, J. M. (Intern)
Pages: 65-72
Publication date: 1997

**Host publication information**
Title of host publication: Operational Water Management, Refsgaard & Karalis (eds)
Place of publication: Rotterdam
Publisher: Balkema Publishers, A.A. / Taylor & Francis The Netherlands
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 168654
Publication: Research - peer-review › Book chapter – Annual report year: 1997

An Active Lattice Model in a Bayesian Framework

A Markov Random Field is used as a structural model of a deformable rectangular lattice. When used as a template prior in a Bayesian framework this model is powerful for making inferences about lattice structures in images. The model assigns maximum probability to the perfect regular lattice by penalizing deviations in alignment and lattice node distance.
The Markov random field represents prior knowledge about the lattice structure, and through an observation model that incorporates the visual appearance of the nodes, we can simulate realizations from the posterior distribution. A maximum a posteriori (MAP) estimate, found by simulated annealing, is used as the reconstructed lattice. The model was developed as a central part of an algorithm for automatic analysis of genetic experiments, positioned in a lattice structure by a robot. The algorithm has been successfully applied to many images, and it seems to be a fast, accurate, and robust solution to the problem. Several possible extensions of the model are described.

**General information**
- **State**: Published
- **Organisations**: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
- **Authors**: Carstensen, J. M. (Intern)
- **Pages**: pp. 380-387
- **Publication date**: 1996
- **Main Research Area**: Technical/natural sciences

**Publication information**
- **Journal**: Computer Vision and Image Understanding
- **Volume**: 63
- **Issue number**: 2
- **ISSN (Print)**: 1077-3142
- **Ratings**:
  - BFI (2018): BFI-level 2
  - BFI (2017): BFI-level 2
  - Web of Science (2017): Indexed Yes
  - BFI (2016): BFI-level 2
  - Scopus rating (2016): CiteScore 3.82 SJR 1.524 SNIP 2.091
  - BFI (2015): BFI-level 2
  - Scopus rating (2015): SJR 1.165 SNIP 2.215 CiteScore 3.33
  - BFI (2014): BFI-level 2
  - Scopus rating (2014): SJR 0.834 SNIP 1.985 CiteScore 2.83
  - BFI (2013): BFI-level 2
  - Scopus rating (2013): SJR 1.102 SNIP 2.631 CiteScore 3.39
  - ISI indexed (2013): ISI indexed yes
  - BFI (2012): BFI-level 2
  - Scopus rating (2012): SJR 0.845 SNIP 2.466 CiteScore 2.91
  - ISI indexed (2012): ISI indexed yes
  - BFI (2011): BFI-level 2
  - Scopus rating (2011): SJR 1.352 SNIP 4.421 CiteScore 4.82
  - ISI indexed (2011): ISI indexed yes
  - BFI (2010): BFI-level 2
  - Scopus rating (2010): SJR 1.412 SNIP 3.775
  - Web of Science (2010): Indexed yes
  - BFI (2009): BFI-level 2
  - Scopus rating (2009): SJR 1.45 SNIP 3.427
  - BFI (2008): BFI-level 1
  - Scopus rating (2008): SJR 1.44 SNIP 2.92
  - Scopus rating (2007): SJR 1.846 SNIP 3.101
  - Web of Science (2007): Indexed yes
  - Scopus rating (2006): SJR 1.497 SNIP 3.104
  - Scopus rating (2005): SJR 1.187 SNIP 2.696
  - Scopus rating (2004): SJR 1.322 SNIP 3.527
  - Scopus rating (2003): SJR 2.492 SNIP 3.161
  - Scopus rating (2002): SJR 1.778 SNIP 2.652
  - Scopus rating (2001): SJR 2.279 SNIP 2.935
  - Scopus rating (2000): SJR 0.758 SNIP 1.776
  - Scopus rating (1999): SJR 0.848 SNIP 1.799
- **Original language**: English
- **Source**: orbit
Bacterial growth on surfaces: Automated image analysis for quantification of growth rate-related parameters

A fast routine method for estimating bacterial cell growth rates by using the metachromatic dye acridine orange is described. The method allows simultaneous estimates of cellular RNA and DNA contents of single cells. Acridine orange staining can be used as a nonspecific supplement to quantitative species-specific hybridizations with fluorescence-labelled ribosomal probes to estimate the single-cell concentration of RNA. By automated analysis of digitized images of stained cells, we determined four independent growth rate-related parameters: cellular RNA and DNA contents, cell volume, and the frequency of dividing cells in a cell population. These parameters were used to compare physiological states of liquid-suspended and surfacegrowing Pseudomonas putida KT2442 in chemostat cultures. The major finding is that the correlation between substrate availability and cellular growth rate found for the free-living cells was not observed for the surfacebound cells; in contrast, the data indicate an almost constant growth rate for attached cells which was independent of the dilution rate in the chemostat.
Indledende Billedbehandling

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (ed.) (Intern)
Publication date: 1995

Publication information
Publisher: Informatics and Mathematical Kodelling, Technical University of Denmark
Original language: English
Multiresolution texture analysis of four classes of mice liver cells using different cell cluster representation

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Schulerud, H. (Ekstern), Carstensen, J. M. (Intern), Danielsen, H. E. (Ekstern)
Pages: 121-129
Publication date: 1995

Host publication information
Title of host publication: The 9th Scandinavian Conference on Image Analysis, Uppsala, Sweden
Main Research Area: Technical/natural sciences
Conference: 9th Scandinavian Conference on Image Analysis (SCIA), Uppsala, Sweden, 01/01/1995
Source: orbit
Source-ID: 200374
Publication: Research - peer-review › Article in proceedings – Annual report year: 1995

Morphological Markov random fields

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern)
Pages: 321-326
Publication date: 1994
Main Research Area: Technical/natural sciences

Publication information
Journal: Statistics and Probability Letters
Volume: 20
Issue number: 4
ISSN (Print): 0167-7152
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.697 SNIP 0.859 CiteScore 0.62
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.715 SNIP 0.882 CiteScore 0.65
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.754 SNIP 0.852 CiteScore 0.67
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.738 SNIP 0.953 CiteScore 0.67
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.731 SNIP 0.971 CiteScore 0.69
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.768 SNIP 0.93 CiteScore 0.62
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Progress Report on EC Funded Project BRE2-CT201

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Conradsen, K. (Intern), Nielsen, A. A. (Intern), Ersbøll, B. K. (Intern), Larsen, R. (Intern), Hartelius, K. (Intern), Carstensen, J. M. (Intern)
Publication date: 1994

Analysing confocal laser scanning micrographs of pulp fibres

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, CICT
Authors: Carstensen, J. M. (Intern), Schultz, N. (Intern)
Pages: 63-67
Publication date: 1993

Host publication information
Title of host publication: The 2nd European Research Symposium on Image Analysis for Pulp and Paper Research and Production
Main Research Area: Technical/natural sciences
Conference: the 2nd European Research Symposium on Image Analysis for Pulp and Paper Research and Production, Darmstadt, Germany, 01/01/1993
Source: orbit
Source-ID: 200010
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993

Cooccurrence feature performance in texture classification

General information
Towards integration of voxel models and object models in the simulation of geological sequences

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, Department of Environmental Engineering
Authors: Carstensen, J. M. (Intern), Frykman, P. (Intern)
Pages: 30-35
Publication date: 1993

Host publication information
Title of host publication: The International Workshop: Statistics of Spatial Processes: Theory and applications, Bari, Italy
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200009
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993

Description and Simulation of Visual Texture

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern)
Number of pages: 234
Publication date: 1992

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Jens.pdf
Source: orbit
Source-ID: 200774
Publication: Research › Ph.D. thesis – Annual report year: 1992

Measurement of enzymatic treatment effect on textile using digital image analysis

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern), Grunkin, M. (Intern), Conradsen, K. (Intern)
Pages: 277-280
Publication date: 1992

Host publication information
Title of host publication: MVA '92, IAPR Workshop on Machine Vision Applications, Tokyo, Japan
Main Research Area: Technical/natural sciences
Conference: MVA '92, IAPR Workshop on Machine Vision Applications, Tokyo, Japan, 01/01/1992
Source: orbit
Øvelser i Statistisk Billedbehandling

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern)
Number of pages: 28
Publication date: 1991

Publication information
Publisher: Institute of Mathematical Statistics and Operations Research, Technical University of Denmark
Original language: English
Main Research Area: Technical/natural sciences
Links:
http://www2.imm.dtu.dk/pubdb/p.php?991
Source: orbit
Source-ID: 200562
Publication: Education › Compendium/lecture notes – Annual report year: 1991

Spin-flip alternatives to spin-exchange Markov random field simulation implemented on a SIMD massively parallel computer

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Carstensen, J. M. (Intern), Conradsen, K. (Intern)
Pages: 104-117
Publication date: 1991

Host publication information
Title of host publication: Visiondag på AUC
Main Research Area: Technical/natural sciences
Conference: Visiondag på AUC, 01/01/1991
Source: orbit
Source-ID: 200441
Publication: Research › Article in proceedings – Annual report year: 1991

Test Bed for Experimental Computer Vision. VIPWOB-memo 9003

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Christensen, H. I. (Ekstern), Melsen, P. (Ekstern), Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern), Kjærulff, M. (Ekstern), Nielsen, M. (Ekstern)
Publication date: 1990

Publication information
Publisher: Aalborg
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200895
Publication: Research - peer-review › Report – Annual report year: 1990

VIPWOB-konceptet anvendt på IMSOR

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Ersbøll, B. K. (Intern), Carstensen, J. M. (Intern)
Projects:

**Computer Vision based geometrical and textural control for 3D print and injection moulding processes**

Department of Applied Mathematics and Computer Science  
Period: 01/12/2013 → 29/09/2017  
Number of participants: 6  
Phd Student:  
Eiríksson, Eyþór Rúnar (Intern)  
Supervisor:  
Pedersen, David Bue (Intern)  
Main Supervisor:  
Aanæs, Henrik (Intern)  
Examiner:  
Carstensen, Jens Michael (Intern)  
Krüger, Norbert (Ekstern)  
Taylor, John (Ekstern)

**Financing sources**

Source: Internal funding (public)  
Name of research programme: Offentlig finansiering

**Relations**

Publications:  
Computer Vision for Additive Manufacturing.  
Project: PhD

**A statistical Take on Computer Graphics - Automatic Radiometric Modelling of Real World Objects**

Department of Applied Mathematics and Computer Science  
Period: 01/07/2013 → 18/01/2017  
Number of participants: 7  
Phd Student:  
Nielsen, Jannik Boll (Intern)
Supervisor:
Conradsen, Knut (Intern)
Frisvad, Jeppe Revall (Intern)
Main Supervisor:
Aanæs, Henrik (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Lensch, Hendrik Peter Asmus (Ekstern)
Unger, Jonas (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.

Relations
Publications:
On Practical Sampling of Bidirectional Reflectance
Project: PhD

Computer Vision Assisted Motion Correction in Medical Imaging
Department of Applied Mathematics and Computer Science
Period: 01/09/2012 → 31/03/2016
Number of participants: 7
Phd Student:
Wilm, Jakob (Intern)
Supervisor:
Højgaard, Liselotte (Intern)
Paulsen, Rasmus Reinhold (Intern)
Main Supervisor:
Aanæs, Henrik (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Vogiatzis, George (Ekstern)
Åström, Kalle (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Towards Plug-n-Play robot guidance: Advanced 3D sensors and pose estimation in Robotic applications
Department of Applied Mathematics and Computer Science
Period: 01/04/2012 → 12/12/2016
Number of participants: 7
Phd Student:
Sølund, Thomas (Intern)
Supervisor:
Beck, Anders Billesø (Intern)
Kruger, Norbert (Ekstern)
Main Supervisor:
Aanæs, Henrik (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Gramkow, Claus (Intern)
Kämäräinen, Joni-Kristian (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU

Relations
Publications:
Towards Plug-n-Play robot guidance: Advanced 3D estimation and pose estimation in Robotic applications
Project: PhD

A Grand Challenge: Large Scale Event Recognition and Tracking
Department of Applied Mathematics and Computer Science
Period: 01/09/2011 → 21/11/2014
Number of participants: 6
Phd Student:
Vestergaard, Jacob Schack (Intern)
Supervisor:
Nielsen, Allan Aasbjerg (Intern)
Main Supervisor:
Larsen, Rasmus (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Benediktsson, Jón Ali (Ekstern)
Jenssen, Robert (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Non-contact assessment of food quality using optical imaging methods
Department of Photonics Engineering
Period: 15/01/2011 → 20/08/2015
Number of participants: 5
Phd Student:
Kamran, Faisal (Intern)
Main Supervisor:
Andersen, Peter E. (Intern)
Examiner:
Petersen, Paul Michael (Intern)
Carstensen, Jens Michael (Intern)
Spigulis, Janis (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Towards the Interactive ESS-Food Catalogue
Department of Informatics and Mathematical Modeling
Period: 01/05/2009 → 24/08/2012
Number of participants: 7
Phd Student:
Laursen, Lasse Farnung (Intern)
Supervisor:
Bærentzen, Jakob Andreas (Intern)
Christensen, Lars Bager (Intern)
Main Supervisor:
Ersbøll, Bjarne Kjær (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Madsen, Claus Brøndsgaard (Ekstern)
Sramek, Milos (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 DTU-stip, 2/3 FUR/andet
Project: PhD

Billede som objektivt mål for fødevarekvalitet
Department of Informatics and Mathematical Modeling
Period: 01/12/2008 → 19/04/2013
Number of participants: 7
Phd Student:
Møller, Flemming (Intern)
Supervisor:
Carstensen, Jens Michael (Intern)
Olesen, Susanne K. (Ekstern)
Main Supervisor:
Larsen, Rasmus (Intern)
Examiner:
Conradsen, Knut (Intern)
Hansen, Per W. (Ekstern)
Parker, Alan (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Ansat eksternt
Project: PhD

Shape Analysis of the Dynamics of the Human Ear Canal
Department of Informatics and Mathematical Modeling
Period: 01/07/2005 → 30/01/2009
Number of participants: 7
Phd Student:
Darkner, Sune (Intern)
Supervisor:
Olsen, Ole Fogh (Ekstern)
Paulsen, Rasmus Reinhold (Intern)
Main Supervisor:
Larsen, Rasmus (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Ahlberg, Jörgen (Ekstern)
Lorenz, Cristian (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU
Project: PhD

Global Illumination - Anvendelse af dynamiske løsningsrum i spil og animation
Department of Informatics and Mathematical Modeling
Period: 01/11/2004 → 29/05/2008
Number of participants: 6
Phd Student:
Frisvad, Jeppe Revall (Intern)
Supervisor:
Falster, Peter (Intern)
Main Supervisor:
Christensen, Niels Jørgen (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Henriksen, Knud (Ekstern)
Myszkowski, Karol (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Dynamical Shape analysis
Department of Informatics and Mathematical Modeling
Period: 01/03/2004 → 30/04/2008
Number of participants: 6
Phd Student:
Ólafsdóttir, Hildur (Intern)
Supervisor:
Larsen, Rasmus (Intern)
Main Supervisor:
Ersbøll, Bjarne Kjær (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Rueckert, Daniel (Ekstern)
Vannier, Michael W. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Visualisering, opmåling & editering af 3D-medicinske data
Department of Informatics and Mathematical Modeling
Number of participants: 7
Phd Student:
Jakobsen, Bjarke (Ekstern)
Supervisor:
Madsen, Jan (Intern)
Pedersen, Steen (Intern)
Main Supervisor:
Christensen, Niels Jørgen (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Henriksen, Knud (Ekstern)
Sramek, Milos (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Programbevilling
Project: PhD

System design for vision based dermatological measurement
Department of Informatics and Mathematical Modeling
Period: 01/03/2002 → 12/07/2005
Number of participants: 6
Phd Student: Gomez, David Delgado (Intern)
Supervisor: Ersbøll, Bjarne Kjær (Intern)
Main Supervisor: Carstensen, Jens Michael (Intern)
Examiner: Larsen, Rasmus Werner (Intern)
Johansen, Peter (Ekstern)
Thodberg, Hans Henrik (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Programbevilling
Project: PhD

System design for vision-based dermatological measurements
Department of Informatics and Mathematical Modeling
Period: 07/08/2001 → 31/01/2002
Number of participants: 4
Phd Student: Karras, Panagiotis (Intern)
Supervisor: Ersbøll, Bjarne Kjær (Intern)
Larsen, Jan (Intern)
Main Supervisor: Carstensen, Jens Michael (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsstipendium
Project: PhD

Formanalyse af ørekanaler
Department of Informatics and Mathematical Modeling
Period: 01/06/2001 → ...
Number of participants: 8
Phd Student: Paulsen, Rasmus Reinhold (Intern)
Supervisor: Conradsen, Knut (Intern)
Delingette, Hervé (Ekstern)
Laugesen, Søren (Intern)
Main Supervisor: Larsen, Rasmus (Intern)
Examiner: Carstensen, Jens Michael (Intern)
Cootes, Timothy F. (Ekstern)
Thodberg, Hans Henrik (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Erhvervsforskerordningen
Project: PhD
Image analysis in predictive biotechnology
Department of Informatics and Mathematical Modeling
Period: 01/06/2000 → 26/02/2004
Number of participants: 6
Phd Student:
Hansen, Michael Adsetts Edberg (Intern)
Supervisor:
Frisvad, Jens Christian (Intern)
Main Supervisor:
Carstensen, Jens Michael (Intern)
Examiner:
Nielsen, Jens (Intern)
Esbensen, Kim H. (Ekstern)
Petrov, Maria (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Multivariate Statistics in Predictive Biotechnology
The aims of the studies are based on the main hypothesis that the combination of multivariate statistics and image
analysis of features can be used as a tool in (visual and chemical) database identification processes within isolates from
the fungal genera Penicillium and Aspergillus. Databases of functional characteristics are expected to be complementary
to the known DNA-sequence based databases. The identification is based on visual as well as secondary metabolite
profiles. Secondary metabolites are end products of the bio-chemical processes that take place within cells of all living
organisms, and they are therefore indirectly descriptive of the cells metabolic processes. If different cells use different
processes, there will also be a difference in the variety of metabolites produced. Furthermore the chemical variation in the
metabolites can be directly related to ecology and habitat.

Department of Informatics and Mathematical Modeling

Intelligent, Interactive Templates and their Application to 3D Medical Modelling
Department of Informatics and Mathematical Modeling
Number of participants: 7
Phd Student:
Darvann, Tron Andre (Intern)
Supervisor:
Conradsen, Knut (Intern)
Main Supervisor:
Ersbøll, Bjarne Kjær (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Cootes, Timothy Francis (Ekstern)
Mars, Michael (Ekstern)

Financing sources
Purity-analysis of SEED
Application of herbiciders is currently reduced substantially in the conventional seed-production. In organic farms a production of grass and clover are being developed, to meet the needs for ecologically produced seed in the year 2000. These changed methods of cultivation will, no doubt, increase the amount of unwanted seeds in the raw material and therefore increase the need for surveillance and new development of the cleaning process. To meet the increasing demands of the cleaning process the development of a prototype for a vision-based purity-analysis machine have started. The machine aims at a usage in the field of process control of the cleaning process plus the purity control. The project will, in the development face, focus on one of the most difficult and therefore also one of the most vision-relevant problems, that is to differ between seeds of meadow grass and 1 year old meadow grass.

Department of Informatics and Mathematical Modeling
Period: 01/09/1999 → 31/08/2001
Number of participants: 3
Project ID: 3147
Project participant:
Frederiksen, Martin Stig (Intern)
Hartelius, Karsten (Intern)
Project Manager, organisational:
Carstensen, Jens Michael (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 300,600.00 Danish Kroner

3D Shape Analysis. Project no.: 1299
Project no.: 1299. The aim of the present project is to describe three dimensional (3D) objects in order to model and simulate the shape variation. This allows for: 1. Knowledge driven design/optimal design. 2. Prediction of the full object based on partial knowledge about the object (occlusion). 3. Prediction of a future object based on previous observations (growth prediction). The methods in the study are based on morphometric tools also called shape analysis. The basis for the analysis is landmark data. Landmark are homologues point presumed to correspond over the object of a data set. When having only a few landmarks the registration may be performed manually, but for thousands of points it becomes tedious and practically impossible. In many cases punctual landmarks are hard to establish in images, and the process requires considerable prior anatomical knowledge. We search for automated methods for landmark detection in this study. Such methods have already been developed in the Ph.D study by Per Andresen, but must be extended to provide a tool for industrial and medical 3D shape analysis. Having the landmarks defined for the complete data set, we are able to use well known methods from statistics such as Principal Component Analysis (PCA), different tests on the data (like test for distribution, effective dimension of the data etc.), model testing and validation etc.

Department of Informatics and Mathematical Modeling
Period: 01/08/1999 → 31/07/2001
Number of participants: 2
Project participant:
Andresen, Per Rønsholt (Intern)
Project Manager, organisational:
Carstensen, Jens Michael (Intern)

Signal and Image Processing for Telemedicine (SITE).
Project No. 3135. The rapid development in sensor technology, signal processing methods and parallel computing technology has enabled the physical realization of complex mathematical models in a diversity of scientific and industrial areas. This beginning interdisciplinary convergence of methodologies in science and technology has already had an impact on several industries and is emerging in medical imaging and more generally in telemedicine. It seems very likely that bringing together specialists from the mentioned areas could further boost the development of medical information processing in Denmark. Such considerations also lead to incorporating the disciplines signal processing, scientific computing, and image analysis in the Department of Mathematical Modelling (IMM) together with applied mathematical physics, numerical analysis, operations research, and statistics. Furthermore, there has been established a close cooperation between scientists from DTU and several departments from different hospitals and university clinics.
Department of Informatics and Mathematical Modeling  
Period: 01/07/1999 → 30/06/2003  
Number of participants: 9  
Project participant:  
Madsen, Kaj (Intern)  
Hansen, Per Christian (Intern)  
Hansen, Lars Kai (Intern)  
Ersbøll, Bjarne Kjær (Intern)  
Carstensen, Jens Michael (Intern)  
Larsen, Jan (Intern)  
Sørensen, John Aasted (Intern)  
Sigurdsson, Sigurdur (Intern)  
Project Manager, organisational:  
Conradsen, Knut (Intern)  

Project-no.: 1223.Center for IT-Research (CIT)  
Department of Informatics and Mathematical Modeling  
Period: 01/08/1998 → 31/12/1999  
Number of participants: 5  
Project participant:  
Hartelius, Karsten (Intern)  
Frederiksen, Martin Stig (Intern)  
Dørge, Thorsten Carheim (Intern)  
Folm-Hansen, Jørgen (Intern)  
Project Manager, organisational:  
Carstensen, Jens Michael (Intern)  

1227 Industrial Center for Surface Analysis, Micro Analysis and Image Analysis  
Project nr. 1227. The objective is to provide methods for visually analysing surfaces acquired by microscopy. This includes development and implementation of methods to assist and do the actual measurements and characterisation.  
Department of Informatics and Mathematical Modeling  
Danish Technological Institute  
Danaklon A/S  
Obteco A/S  
Bang & Olufsen A/S  
Elsam A/S  
Ferroperm A/S  
Dandy A/S  
Period: 01/01/1997 → 05/02/2001  
Number of participants: 3  
Project participant:  
Jørgensen, Søren Falch (Intern)  
Schultz, Nette (Intern)  
Project Manager, organisational:  
Carstensen, Jens Michael (Intern)  

Financing sources  
Source: Unknown  
Name of research programme: Ukendt  
Amount: 616,541.00 Danish Kroner  

Avancerede trackingsensorer
Samarbede med DELTA LYS & OPTIK, FORCE og en række virksomheder

Department of Informatics and Mathematical Modeling

DELTA

FORCE Instituttet
Period: 01/01/1997 → …
Number of participants: 1
Project Manager, organisational:
Carstensen, Jens Michael (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 163,853.00 Danish Kroner

Project-no.: 1224. Center for Sensor Technologies (CST)
Project-no.: 1224.

Department of Informatics and Mathematical Modeling
Period: 01/01/1997 → 31/10/1999
Number of participants: 3
Project participant:
Frederiksen, Martin Stig (Intern)
Hansen, Johan Dore (Intern)
Project Manager, organisational:
Carstensen, Jens Michael (Intern)

The use of polarimetric SAR for the mapping and characterization of the natural environment

Department of Informatics and Mathematical Modeling
Period: 01/01/1997 → 19/07/2005
Number of participants: 7
Phd Student:
Sørensen, Stefán Meulengracht (Intern)
Supervisor:
Nielsen, Allan Aasbjerg (Intern)
Skriver, Henning (Intern)
Main Supervisor:
Conradsen, Knut (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Hasager, Charlotte Bay (Intern)
Quegan, Shaun (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Anden Forskningsrådsfinan.-SU
Project: PhD

Vision-baseret måling
Anvendelse af en kombination af et kamera og en computer som et avanceret måleinstrument har et enormt potentiale. Der er nu blevet hardwaremæssigt håndterbart at udføre sådanne målinger on-line på generelle platforme som f.eks. PC'ere. Udfordringen i at udnytte dette potentiale ligger på software-siden. Et standard farvekamera leverer ca. 30 MB/s, der måske skal omsættes til de 100B/s, der er relevante i den givne problemstilling. Resultatet skal endvidere være robust ikke kun over for målestøj, men også over for f.eks. ændringer i belysningen samt irrelevante objekter i billedfeltet. Det er projektets formål at udvikle et softwaresystem, der implementerer vision-baseret måling til f.eks. produkt- og procesovervågning i industrien og til sikkerheds-/trygheds-overvågning.
Department of Informatics and Mathematical Modeling

Center for IT-forskning

7-Technologies
Period: 01/01/1997 → ...
Number of participants: 1
Project Manager, organisational:
Carstensen, Jens Michael (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 531,434.00 Danish Kroner

Benthiske samfunds stokastiske geometri
Administration
Period: 01/11/1996 → 25/01/2001
Number of participants: 5
Phd Student:
Sørensen, Per S. (Intern)
Supervisor:
Ersbøll, Bjarne Kjær (Intern)
Main Supervisor:
Conradsen, Knut (Intern)
Examiner:
Carstensen, Jens Michael (Intern)
Windfeld, Kristian (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Kandidatstipendium ansat på DT

Dynamisk Teksturanalyse
Administration
Period: 01/09/1996 → 30/03/2001
Number of participants: 3
Phd Student:
Fisker, Rune (Intern)
Supervisor:
Carstensen, Jens Michael (Intern)
Main Supervisor:
Conradsen, Knut (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-Su Stipendium, Eksperiment

Analyse af multimodale 3D & 4D billeder
Department of Informatics and Mathematical Modeling
Period: 01/08/1996 → 28/02/2000
Number of participants: 3
Phd Student:
Andresen, Per Rønsholt (Intern)
Main Supervisor:
Carstensen, Jens Michael (Intern)
Automated Visual Inspection of Textile
A system for in-line inspection of textile using a line-scan camera is designed. Algorithms based on stochastic modelling of weave pattern are developed and tested.

Department of Informatics and Mathematical Modeling

mitex
Period: 01/01/1996 → 31/08/1997
Number of participants: 2
Project participant:
Fisker, Rune (Intern)
Project Manager, organisational:
Carstensen, Jens Michael (Intern)

Colour and texture inspection equipment ESPRIT Project 21023 - CATIE
The objective is to provide cost effective colour and texture based automatic inspection and sorting solutions for industry. Three application areas are considered: Hot steel strip, wood slabs, and food. Novel solutions for low delay image analysis, a few tens of milliseconds from imaging to decision, will be developed and used in real-time on-line inspection demonstrators in each application. The inspection system platform will be the same and exploit an off-the-shelf component based parallel architecture designed to support hypothesis-and-verification oriented inspection strategies. The platform will cope with the high volumes of data associated with colour and texture inspection. The basic technology of high-performance personal computers will be used. Because of the vibrations of hot strip and the nature of motion of food particles to be sorted high speed prism based colour line-scan cameras will be developed to capture the RGB values of each pixel at the same time. Due to the required high line scan rates, stable illuminators with feature enhancing radiation patterns will be designed, and an on-line colour camera calibration technique will be developed to make the colour measurements independent of longer term changes in illumination.

Department of Informatics and Mathematical Modeling

Spectra-Physics VisionTech, Oy
ELEXSO Sortiertechnik GmbH
Junckers Industrier A/S
STN Atlas Elektronik GmbH
T.V.I. - Temet Vision Industry Oy
Fraunhofer Gesellschaft
University of Oulu
VTT - Technical Research Centre of Finland
Period: 01/01/1996 → 31/05/1999
Number of participants: 3
Project participant:
Hansen, Johan Dore (Intern)
Hartelius, Karsten (Intern)
Project Manager, organisational:
Carstensen, Jens Michael (Intern)
**Quantification of enzymatic effect**

Department of Informatics and Mathematical Modeling

Novo Nordisk A/S  
Period: 01/01/1996 → …  
Number of participants: 2  
Project participant:  
**Folm-Hansen, Jørgen (Intern)**  
Project Manager, organisational:  
**Carstensen, Jens Michael (Intern)**  
Project

**Bladskivebestemmelse for sukkerroer ved hjælp af billedanalyse**

Administration  
Period: 01/05/1995 → …  
Number of participants: 4  
Phd Student:  
**Frydendal, Ib (Intern)**  
Supervisor:  
**Carstensen, Jens Michael (Intern)**  
Main Supervisor:  
**Conradsen, Knut (Intern)**  
Examiner:  
**Nielsen, Allan Aasbjerg (Intern)**

**Financing sources**

Source: Internal funding (public)  
Name of research programme: Erhvervsforskerordningen  
Project: PhD