Quality assessment of butter cookies applying multispectral imaging

A method for characterization of butter cookie quality by assessing the surface browning and water content using multispectral images is presented. Based on evaluations of the browning of butter cookies, cookies were manually divided into groups. From this categorization, reference values were calculated for a statistical prediction model correlating multispectral images with a browning score. The browning score is calculated as a function of oven temperature and baking time. It is presented as a quadratic response surface. The investigated process window was the intervals 4–16 min and 160–200°C in a forced convection electrically heated oven. In addition to the browning score, a model for predicting the average water content based on the same images is presented. This shows how multispectral images of butter cookies may be used for the assessment of different quality parameters. Statistical analysis showed that the most significant wavelengths for browning predictions were in the interval 400–700 nm and the wavelengths significant for water prediction were primarily located in the near-infrared spectrum. The water prediction model was found to correctly estimate the average water content with an absolute error of 0.22%. From the images it was also possible to follow the browning and drying propagation from the cookie edge toward the center.
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.
Classification of Astaxanthin Colouration of Salmonid Fish using Spectral Imaging and Tricolour Measurement

The goal of this study was to investigate if it is possible to differentiate between rainbow trout (Oncorhynchus mykiss) having been fed with natural or synthetic astaxanthin. Three different techniques were used for visual inspection of the surface colour of the fish meat: multi-spectral image capturing, tricolour CIELAB measurement, and manual SalmoFan inspection. Furthermore, it was tested whether the best predictions come from measurements of the steak or the fillet of the fish. Methods used for classification were linear discriminant analysis (LDA), quadratic discriminant analysis (QDA), and sparse linear discriminant analysis (SLDA).

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, DTU Data Analysis, National Food Institute, Division of Industrial Food Research
Authors: Ljungqvist, M. G. (Intern), Dissing, B. S. (Intern), Nielsen, M. E. (Intern), Ersbøll, B. K. (Intern), Clemmensen, L. K. H. (Intern), Frosch, S. (Intern)
Number of pages: 27
Publication date: 2012

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English

Multispectral Imaging of Wok-Fried Vegetables

Quality control in the food industry is often performed by measuring various chemical compounds in the food involved. The authors propose an imaging concept for acquiring high-quality multispectral images to evaluate optical reflection changes in carrots and celeriac over a period of 14 days. For comparison, sensory analysis was performed on the same samples. Prior to multispectral image recording, the vegetables were prefried and frozen at -30 °C for 4 months. During the 14 days of image recording, the vegetables were kept at +5 °C. In this period, surface changes and thereby reflectance properties were very subtle. However, they noted statistically significant differences for some wavelengths and combinations of wavelengths. The corresponding sensory tests showed weak differences over the 14 days (significant at a 10% level of...
significance), which makes it the more important that the authors were able to detect minor changes using multispectral imaging. From our findings, it seems probable that oxidation caused the changes over time.

**General information**

State: Published  
Organisations: Department of Informatics and Mathematical Modeling, DTU Data Analysis, National Food Institute, Division of Industrial Food Research  
Authors: Clemmensen, L. K. H. (Intern), Dissing, B. S. (Intern), Hyldig, G. (Intern), Løje, H. (Intern)  
Publication date: 2012  
Main Research Area: Technical/natural sciences

**Publication information**  
Journal: Journal of Imaging Science and Technology  
Volume: 56  
Issue number: 2  
Article number: 020404  
ISSN (Print): 1062-3701  
Ratings:  
BFI (2018): BFI-level 1  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 1  
Scopus rating (2017): SNIP 0.686 SJR 0.237 CiteScore 0.59  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): SJR 0.214 SNIP 0.453 CiteScore 0.38  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 0.199 SNIP 0.394 CiteScore 0.34  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.214 SNIP 0.58 CiteScore 0.38  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 0.289 SNIP 0.854 CiteScore 0.48  
ISI indexed (2013): ISI indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 0.49 SNIP 1.352 CiteScore 0.8  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 0.481 SNIP 1.666 CiteScore 0.85  
ISI indexed (2011): ISI indexed yes  
BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 0.354 SNIP 0.982  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 0.377 SNIP 0.924  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 0.598 SNIP 1.248  
Scopus rating (2007): SJR 0.802 SNIP 1.384  
Scopus rating (2006): SJR 0.542 SNIP 1.235  
Scopus rating (2005): SJR 0.418 SNIP 1.037  
Scopus rating (2004): SJR 0.492 SNIP 1.285  
Scopus rating (2003): SJR 0.377 SNIP 1.329  
Scopus rating (2002): SJR 0.557 SNIP 0.912  
Scopus rating (2001): SJR 0.566 SNIP 1.388  
Scopus rating (2000): SJR 0.479 SNIP 1.155  
Scopus rating (1999): SJR 0.471 SNIP 0.82  
Original language: English  
DOIs:
Design of characteristics of optical filter set for prediction and visualization of fat content in raw beef cuts

Quantification of specific compounds in a food-matrix is a very important factor for an overall quantification of the quality. Near infrared (NIR) hyperspectral imaging is a powerful technique to quantify specific constituents as well as its spatial distribution of the food matrix. Hyperspectral imaging is however very expensive. We propose a way to design a simple measurement system consisting of a NIR sensitive monochrome camera together with a small set of optical filters to estimate and visualize a specific food compound without requiring a full hyperspectral device. Based on a set of hyperspectral measurements of beef and physical and chemical analysis of the fat within the beef, we propose a method to design a set of ideal Band Pass Filters (BPF), as small as possible while still maintaining predictability of fat content. The results show that 2 filters is a suitable amount of filters for prediction.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Toyohashi University of Technology, Mie Prefecture Livestock Research Institute
Authors: Kobayashi, K. (Ekstern), Nishino, K. (Ekstern), Dissing, B. S. (Intern), Mori, M. (Ekstern), Toyota, T. (Ekstern), Nakauchi, S. (Ekstern)
Number of pages: 98
Pages: 23-28
Publication date: 2011

Host publication information
Title of host publication: Scandinavian Workshop on Imaging Food Quality 2011 : Ystad, May 27, 2011 - Proceedings
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)

Number: 15
Main Research Area: Technical/natural sciences
Workshop: Scandinavian Workshop on Imaging Food Quality 2011, Ystad, Sweden, 27/05/2011 - 27/05/2011
Optical filter, Beef, NIR hyperspectral imaging, Content

Determination of astaxanthin concentration in Rainbow trout (Oncorhynchus mykiss) by multispectral image analysis.

Astaxanthin is the single most expensive constituent in salmonide fish feed. Therefore control and optimization of the astaxanthin concentration from feed to fish is of paramount importance for a cost effective salmonide production. Traditionally, methods for astaxanthin determination include extraction of astaxanthin from the minced sample into a suitable solvent such as acetone or hexane before further analysis. The existing methods have several drawbacks including being destructive and labour consuming. Current state-of-the-art vision systems for quality and process control in the fish processing industries are typically based on traditional trichromatic (Red Green Blue) imaging. The relative presence of some wavelengths and absence of others is a specific characteristic of many material properties. Consequently, the adaption of multispectral imaging technology can reveal relevant information and measurement of more biological quality parameters such as fat, astaxanthin and cartilage content, simultaneously. A multispectral image may also be referred to as a surface chemistry map where a set of neighbouring spectra are recorded, revealing information about the surface chemistry to a larger degree than in a trichromatic image. In this study multispectral imaging has been evaluated for characterization of the concentration of astaxanthin in rainbow trout fillets. Rainbow trout’s (Oncorhynchus mykiss), were filleted and imaged using a rapid multispectral imaging device. The multispectral imaging device captures reflection properties in 19 distinct wavelength bands. Subsequently, the astaxanthin concentration was determined by a traditional chemical method. The astaxanthin concentration of the analysed samples ranged from 0.20 to 4.34 ppm. In total 7 samples were detected as outliers and removed from the data set before further analysis. A partial least squares regression (PLSR) model was build to predict the astaxanthin concentration from novel images. The obtained model was evaluated with a test set. The root mean square error of prediction obtained from the test set was 0.27 ppm and a goodness of fit of 0.86. The PLSR model made it possible to predict the astaxanthin concentration in each pixel of the image – surface chemistry map - and thereby show the astaxanthin distribution in the fillet. The projected images clearly show a difference in astaxanthin distribution, showing that the upper part of the fillet contains the highest concentration of
astaxanthin. This study has shown that multispectral imaging is a promising method for rapid and non-destructive analysis of astaxanthin concentration of rainbow trout, and thereby a qualified candidate for replacement of traditional laborious and destructive analysis of the astaxanthin concentration.

**General information**
State: Published
Organisations: Division of Industrial Food Research, National Food Institute, Department of Informatics and Mathematical Modeling, DTU Data Analysis
Authors: Frosch, S. (Intern), Dissing, B. S. (Intern), Ersbøll, B. K. (Intern), Nielsen, M. E. (Intern)
Publication date: 2011
Event: Abstract from 12th Scandinavian Symposium on Chemometrics, Billund, Denmark.
Main Research Area: Technical/natural sciences
Source-ID: 287128

**Multispectral Imaging for Determination of Astaxanthin Concentration in Salmonids**
Multispectral imaging has been evaluated for characterization of the concentration of a specific carotenoid pigment; astaxanthin. 59 fillets of rainbow trout, Oncorhynchus mykiss, were filleted and imaged using a rapid multispectral imaging device for quantitative analysis. The multispectral imaging device captures reflection properties in 19 distinct wavelength bands, prior to determination of the true concentration of astaxanthin. The samples ranged from 0.20 to 4.34 μg per g fish. A PLSR model was calibrated to predict astaxanthin concentration from novel images, and showed good results with a RMSEP of 0.27. For comparison a similar model were built for normal color images, which yielded a RMSEP of 0.45. The acquisition speed of the multispectral imaging system and the accuracy of the PLSR model obtained suggest this method as a promising technique for rapid in-line estimation of astaxanthin concentration in rainbow trout fillets.

**General information**
State: Published
Organisations: DTU Data Analysis, Department of Informatics and Mathematical Modeling, National Food Institute
Authors: Dissing, B. S. (Intern), Nielsen, M. E. (Intern), Ersbøll, B. K. (Intern), Frosch, S. (Intern)
Pages: e19032
Publication date: 2011
Main Research Area: Technical/natural sciences

**Publication information**
Journal: P L o S One
Volume: 6
Issue number: 5
ISSN (Print): 1932-6203
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.01 SJR 1.164 SNIP 1.111
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.11 SJR 1.236 SNIP 1.101
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.427 SNIP 1.136 CiteScore 3.32
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.559 SNIP 1.148 CiteScore 3.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.772 SNIP 1.153 CiteScore 3.94
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.982 SNIP 1.156 CiteScore 4.15
Multispectral imaging of wok fried vegetables
This paper shows how multispectral images can be used to assess color change over time in wok fried vegetables. We present results where feature selection was performed with sparse methods from the multispectral images to detect the color changes of wok fried carrots and celeriac stored at +5°C over 14 days. A pairwise t-test was used to detect if the differences over days were significant. For both the original as well as a follow experiment significant differences were seen in particular for celeriac, but also to some extend for carrots.

General information
State: Published
Organisations: Mathematical Statistics, National Food Institute, Department of Informatics and Mathematical Modeling, DTU Data Analysis
Authors: Løje, H. (Intern), Dissing, B. S. (Intern), Clemmensen, L. K. H. (Intern), Ersbøll, B. K. (Intern), Adler-Nissen, J. (Intern)
Pages: 59-62
Publication date: 2011

Host publication information
Title of host publication: Scandinavian Workshop on Imaging Food Quality 2011 : Ystad, May 27, 2011 - Proceedings
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Number: 15
Main Research Area: Technical/natural sciences
Workshop: Scandinavian Workshop on Imaging Food Quality 2011, Ystad, Sweden, 27/05/2011 - 27/05/2011
Wok fried vegetables, Celeriac, Multispectral images, Carrots, Color change
Electronic versions:
Pages from tr11_15-6.pdf
Links:
http://www2.imm.dtu.dk/projects/SWIFQ/
Source: orbit
Source-ID: 279483
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011
New vision technology for multidimensional quality monitoring of food processes

Spectroscopy and spectral imaging in combination with multivariate data analysis and machine learning techniques have proven to be an outstanding tool for rapid analysis of different products. This may be utilized in various industries, but especially rapid assessment of food products in food research and industry is of importance in this thesis. The non-invasive spectroscopic imaging techniques are able to measure individual food components simultaneously in situ in the food matrix while pattern recognition techniques effectively are able to extract the quantitative information from the vast data amounts collected. Underlying qualitative features (latent structures) are extracted from multivariate spectral data in order to quantify desired quality parameters properly. Specifically multispectral imaging which has been explored to a lesser extent than ordinary spectroscopy, having the possibility to exploit the inherent heterogeneity that exists in foodstuffs have been investigated here. An extra feature obtained by combining spectroscopy, imaging and chemometrics is exploratory analysis. This is central in food research, since novel hypotheses about the food systems under observation may be generated using this inductive analytical approach. For the food industry it is an additional advantage that the fast, non-invasive, remote sensing nature of the spectroscopic imaging methods allows on-line measurements. In this way spectroscopic imaging in combination with advanced data analysis meets the high throughput needs for quality control, process control and monitoring. In this Ph.D. project the possibilities provided by spectroscopic imaging and chemometrics have been utilized to improve the analysis and understanding of different food products. The work is presented in seven papers and two additional technical reports which make up the core of the thesis. Furthermore an introduction together with a linking of the contributions is presented in this thesis. The papers puts an emphasis on the use of multispectral imaging in the baking industry where especially the non-enzymatic browning appearance and features related to this are highlighted. These are features such as colour, water content and internal structure of bread. A paper presenting enzymatic browning in pre stir fried and thawed vegetables is also presented showing that imaging techniques such as the one investigated in this thesis is able to detect even subtle colour changes. The possibility for quantifying early as well as late spoilage in raw pork meat is investigated where use of the heterogenetic structure is utilized to obtain good results on predicting sensory evaluations as well on laboratory analysis. Colour in other settings such as in the sherry industry is equally important, and a paper describing detection of carotenoid pigment in trouts using spectral images shows promising results. Finally, two technical papers present possible ways of mapping multispectral images to a visible colour space, as well as how an alternative multispectral imaging system, making use of lters, may be used to design new more broad ranged filters. Fewer filters will increase the speed of such systems. Methods for solving such problems is to the knowledge of the authors rarely covered in the literature.

General information
State: Published
Organisations: DTU Data Analysis, Department of Informatics and Mathematical Modeling, National Food Institute
Authors: Dissing, B. S. (Intern), Ersbøll, B. K. (Intern), Adler-Nissen, J. (Intern)
Number of pages: 194
Publication date: 2011

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English
Series: IMM-PHD-2011
Number: 256
Main Research Area: Technical/natural sciences
Electronic versions:
  phd256_bdi.pdf
  Source: orbit
  Source-ID: 276639
Publication: Research › Ph.D. thesis – Annual report year: 2011

Spectral Imaging as a Tool in Food Research and Quality Monitoring of Food Production

General information
State: Published
Organisations: Division of Industrial Food Research, National Food Institute
Authors: Frosh, S. (Intern), Dissing, B. S. (Intern), Adler-Nissen, J. (Intern), Nielsen, M. E. (Intern)
Number of pages: 532
Pages: 373-384
Publication date: 2011

Host publication information
Title of host publication: Wide Spectra of Quality Control
Publisher: InTech
β-glucans accelerate the closing of open wounds in carp, Cyprinus carpio

**General information**

**State:** Published

**Organisations:** Division of Industrial Food Research, National Food Institute, DTU Data Analysis, Department of Informatics and Mathematical Modeling

**Authors:** Schmidt, J. (Intern), Przybylska, D. A. (Intern), Ljungqvist, M. G. (Intern), Dissing, B. S. (Intern), Ersbøll, B. K. (Intern), Nielsen, M. E. (Intern)

**Publication date:** 2011

**Event:** Poster session presented at Tissue Repair & Regeneration, New London, NH, .

**Main Research Area:** Technical/natural sciences

**Source:** orbit

**Source-ID:** 287045

**Publication:** Research › Poster – Annual report year: 2011

Using image analysis to monitor biological changes in consume fish

The quality of fish products is largely defined by the visual appearance of the products. Visual appearance includes measurable parameters such as color and texture. Fat content and distribution as well as deposition of carotenoid pigments such as astaxanthin in muscular and fat tissue are biological parameters with a huge impact on the color and texture of the fish muscle. Consumer-driven quality demands call for rapid methods for quantification of quality parameters such as fat and astaxanthin in the industry. The spectral electromagnetic reflection properties of astaxanthin are well known and have in previous studies been shown to change as a function of astaxanthin concentration. This may be utilized to quantify the amount of astaxanthin contained in salmonid fishes by assessing a spectral measurement of the fillet. Existing ways of assessing the amount of astaxanthin and fat in salmonid fishes is based on highly laborious chemical analysis. Trichromatic digital imaging and point-wise colorimetric or spectral measurement are also ways of estimating either the redness or the actual astaxanthin concentration of the fillet. These methods all have drawbacks of either cumbersome testing or lack of spectral or spatial information. The use of multispectral imaging to assess the variation in fat and astaxanthin concentration both between fish and within fish is investigated. Since reference values cannot be obtained corresponding to pixel-wise measurements, sub areas of the fillet are predicted and averaged in order to establish correlation to reference measurements. In the present experiment salmon fillets were sampled at different locations. Each sample consists of a biopsy which was cut in three layers in order to understand the depth distribution of astaxanthin as well as the spatial distribution. For each layer in each sample, chemical fat and astaxanthin determination was carried out as a reference value and a multispectral image was acquired to establish a correlation. A prediction model has been calibrated to predict the astaxanthin concentration on a pixel-wise level resulting in an astaxanthin-map of the fillet reflecting the intra fillet variation in astaxanthin concentration. The model is validated according to spatially varying samples across the fillet.

Using Image Analysis On Standardised Full-Thickness Wounds In Scattered Mirror Carp (Cyprinus Carpio) As A Model For Wound Healing

**General information**

**State:** Published

**Organisations:** Division of Industrial Food Research, National Food Institute, Department of Informatics and Mathematical Modeling, DTU Data Analysis

**Authors:** Schmidt, J. (Intern), Dissing, B. S. (Intern), Ljungqvist, M. G. (Intern), Ersbøll, B. K. (Intern), Nielsen, M. E. (Intern)

**Publication date:** 2011

**Event:** Abstract from 15th International Conference on Diseases of Fish and Shellfish, Split, Croatia.

**Main Research Area:** Technical/natural sciences

**Source:** orbit

**Source-ID:** 287130

**Publication:** Research › Conference abstract for conference – Annual report year: 2011
Effect of astaxanthin concentration and origin on color setting in Danish trout aquaculture measured by multi-spectral vision analysis.

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.
Image analysis and multivariate statistics in production of aquaculture feed

General information
State: Published
Organisations: DTU Data Analysis, Department of Informatics and Mathematical Modeling, Division of Seafood Research, National Food Institute, FoodDTU
Authors: Ljungqvist, M. G. (Intern), Dissing, B. S. (Intern), Nielsen, M. E. (Intern), Ersbøll, B. K. (Intern), Frosch, S. (Intern)
Number of pages: 32
Publication date: 2009

Host publication information
Title of host publication: Book of Abstracts
Main Research Area: Technical/natural sciences
Conference: International Workshop on Multivariate Image Analysis, 01/01/2009
Links:
http://mseg.webs.upv.es/MIA_Workshop/
Monitoring water content using multispectral imaging and NIR in a minced

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, Division of Food Production Engineering, National Food Institute
Authors: Dissing, B. S. (Intern), Ersbøll, B. K. (Intern), Adler-Nissen, J. (Intern)
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
Publication: Research › Conference abstract in proceedings – Annual report year: 2009

Optimal Color Mapping of Multispectral Images

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Dissing, B. S. (Intern), Carstensen, J. M. (Intern)
Pages: 31-38
Publication date: 2009
Host publication information
Title of host publication: Proceedings from Gjøvik Color Imaging Symposium 2009
Main Research Area: Technical/natural sciences
Conference: Gjøvik Color Imaging Symposium, Gjøvik, Norway, 01/01/2009
Source: orbit
Publication: Research › Conference abstract for conference – Annual report year: 2009

Temporal reflectance changes in vegetables

Quality control in the food industry is often performed by measuring various chemical compounds of the food involved. We propose an imaging concept for acquiring high quality multispectral images to evaluate changes of carrots and celeriac over a period of 14 days. Properties originating in the surface chemistry of vegetables may be captured in an integrating sphere illumination which enables the creation of detailed surface chemistry maps with a good combination of spectral and spatial resolutions. Prior to multispectral image recording, the vegetables were prefried and frozen at -30°C for four months. During the 14 days of image recording, the vegetables were kept at +5°C in refrigeration. In this period, surface changes and thereby reflectance properties were very subtle. To describe this small variation we employed advanced statistical techniques to search a large featurespace of variables extracted from the chemistry maps. The resulting components showed a change in both the carrot and celeriac samples. We were able to deduct from the resulting components that oxidation caused the changes over time.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling, Division of Food Production Engineering, National Food Institute
Authors: Dissing, B. S. (Intern), Clemmensen, L. K. H. (Intern), Ersbøll, B. K. (Intern), Løje, H. (Intern), Adler-Nissen, J. (Intern)
Pages: 1917-1922
Publication date: 2009
Host publication information
Title of host publication: 2009 IEEE 12th International Conference on Computer Vision Workshops (ICCV Workshops)
Publisher: IEEE
ISBN (Print): 978-1-4244-4442-7
Main Research Area: Technical/natural sciences
Electronic versions:
Coupled Shape Modeling of the Medial Temporal Lobe

Here we investigate how regions in the Medial Temporal Lobe (MTL) in a dataset consisting of 13 different people changes using a Principal Component Analysis (PCA). The regions investigated are the Temporopolar, Parahippocampal, Entorhinal, Hippocampal, Perirhinal and Amygdalar regions. The MTL is located fairly deep in the brain where the contrast is quite low, and region-boundaries can be difficult to find, which is why a shape guiding term would be helpful for a segmentation algorithm. An expert used an interactive tool to draw binary (1 inside and 0 outside) Volumes Of Interests (VOI) for each of the 13 subjects. As the brain is symmetric, 12 VOIs has been drawn for each subject. A simultaneous multi-shape rigid registration scheme, similar to the one used in [Tsai et al., 2004] was used on the training shapes to remove linearities. As these are binary shapes, a set-diﬀerence cost function is minimized between all shapes. To represent shapes in the coupled shape model, signed distance maps (SDM) was used, [Tsai et al., 2004]. The eigen-problem was solved on the covariance matrix using svd, to find the eigenshapes and their magnitude. Seven modes of variation was extracted, representing 75% of the total variance which each represents different modes of variations. An interactive program was developed to investigate how the first seven modes changes the shapes. In figures 1 to 3 the most significant mode is seen varying with $\pm 2\sigma$ from the meanshape. Fig. 1. meanshape + 2$\sigma$ Fig. 2. meanshape Fig. 3. meanshape - 2$\sigma$ References [Tsai et al., 2004] Tsai, A., Wells, W., Tempany, C., Grimson, E. og Willsky, A. (2004). Mutual information in coupled multi-shape model for medical image segmentation. Elsevier Science.

General information
State: Published
Organisations: Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Dissing, B. S. (Intern), Larsen, R. (Intern), Skimminge, A. J. M. (Intern), Ramsøy, T. (Ekstern)
Publication date: 2007
Event: Abstract from 2nd Conference on Image Analysis and In-Vivo Pharmacology, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
imm5149.pdf
Source: orbit
Source-ID: 200540
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2007

Projects:

Follow the fish – Sustainable and optimal resource utilization in the Danish fish industry

National Food Institute
Division of Industrial Food Research
Danish Seafood Association
Skagerak Salmon A/S
Period: 01/07/2012 → 30/06/2016
Number of participants: 5
Acronym: BOPFISK
Project participant:
Frosch, Stina (Intern)
Nielsen, Michael Engelbrecht (Intern)
Adler-Nissen, Jens (Intern)
Dissing, Bjørn Skovlund (Intern)
Phd Student:
Johansson, Gine Ørholt (Intern)
Financing sources
Source: Public research programme (public)
Name of research programme: GUDP
Amount: 5,309,520.00 Danish Kroner
Year of approval: 2012

Relations
Activities:
Danish Seafood Association (DSA)
Danish Seafood Association (DSA)

New vision technology for multidimensional quality monitoring of food processes
Department of Informatics and Mathematical Modeling
Period: 01/05/2008 → 31/08/2011
Number of participants: 6
Phd Student:
Dissing, Bjørn Skovlund (Intern)
Supervisor:
Adler-Nissen, Jens (Intern)
Main Supervisor:
Ersbøll, Bjarne Kjær (Intern)
Examiner:
Jørgensen, Bo Munk (Intern)
Christensen, Lars Bager (Intern)
Parkkinen, Jussi (Ekstern)

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

New vision technology for multidimensional quality monitoring of food processes
The trained process operator plays a key role in today's food industry. His or her ability to judge processes such as continuous baking, roasting and frying processes by visual inspection is crucial. Automation has been slow due to inadequate technology. New forms of vision technology where the product is illuminated uniformly over a large area (50 cm²) and at specified wavelengths have the potential of matching much closer the visual judgement made by the trained process operator. The technology has proven its ability to difficult tasks in particle sorting and recent results indicate its large potential in food process control. The aim of the project is to investigate the potentials of this new vision technology and develop the technical/scientific basis for widespread use in process control of continuous baking, roasting and frying processes.

Division of Food Production Engineering
National Food Institute
Department of Systems Biology
Department of Informatics and Mathematical Modeling
Period: 15/03/2007 → 01/01/2012
Number of participants: 2
Project participant:
Adler-Nissen, Jens (Intern)
Project Manager, organisational:
Dissing, Bjørn Skovlund (Intern)