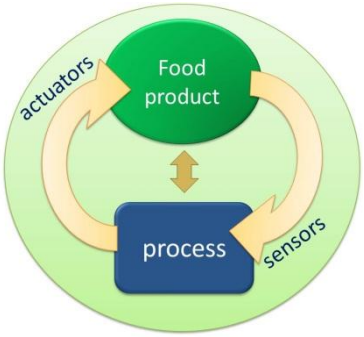
Validation project Hyperspectral Cameras

Detection of foreign objects, latent defects and visualization of the composition

General Project Information

In a new approved IWT-VIS-project, called 'Sensors For Food', **Flanders' FOOD** and research partners from **IMEC**, **KULeuven, VUB** en **IBBT/Ghent University** join forces for four years to evaluate, optimize and validate innovative sensors for applications in the food industry. All this is 80% funded by the Flemish IWT. **Hyperspectral cameras** are among the diverse sensor systems tackled. They have great potential for cost-effective monitoring of **food quality**, **safety** and **processing** with improved accuracy and speed. In the following paragraphs more information is given on the broader Sensors For Food project and the specific validation project on hyperspectral cameras. As participant in this validation project, you can also benefit from the services offered by the Sensors For Food Platform.

Sensors For Food platform



Design, optimisation and control

As a result of the recently finished Intelligence For Food project, the Sensors For Food platform brings food manufacturers and technology providers together in a forum for food industry sensor systems. The aim is to improve, increase the awareness and explore the application of existing, new and upcoming sensor systems for the food industry. Activities include: a screening of needs and opportunities for the food industry, a technology watch on emerging sensor innovations, generation and support of innovative ideas, networking and partner matching between food companies and technology suppliers. Via a centralized contact point, advice is provided concerning sensor systems that are already available for the food industry. For example, assistance is offered for issues regarding sensor calibration and selection. Furthermore, a number of thematic seminars, workshops and training courses will be organized.

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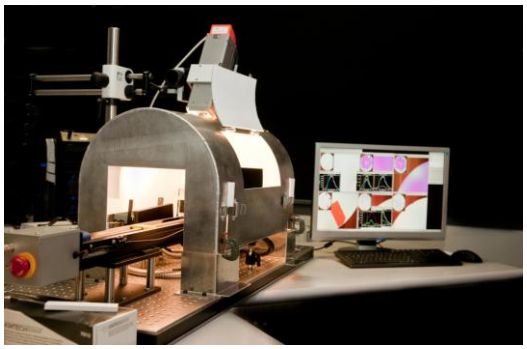
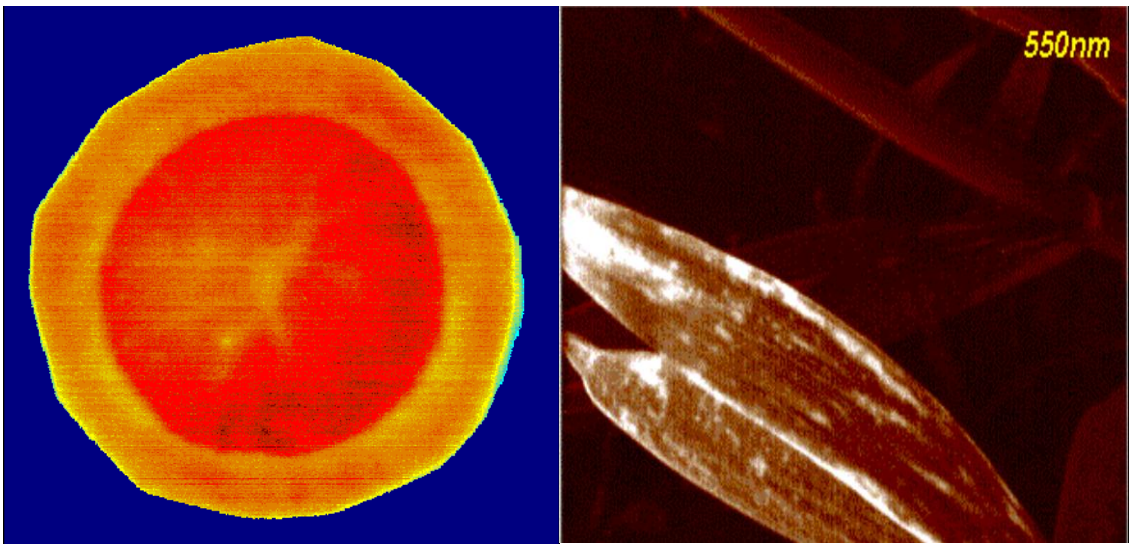
Sensors For Food Validation project Hyperspectral Cameras



Traditionally, quality inspections in the food industry are performed by the naked eye of experienced employees. An automation trend has lead to the introduction of cameras operating in the visual to near infrared (NIR) domain, enabling automated quality inspections. Vis/NIR-spectroscopy is also frequently applied for a quick determination of the composition of some food products or to differentiate products based on their spectral fingerprint. To combine the best of these two worlds, spectral camera based image processing systems are being developed that enable to combine traditional image processing with spectroscopy. For every pixel of the image, the light is split into many narrow wavelength bands, resulting in a particular spectral fingerprint of an object: a unique spectral curve giving very detailed information about that object. This spectral signature does not only allow the detection of foreign objects, product defects and surface hygiene,, but also makes it possible to determine the chemical composition for every pixel. It is for instance possible to map the distribution of moisture and fat in food products like salmon fillets and pork minced meat (application of Qvision - Norway). Applied as line scanners, this technology is particularly suited for monitoring coveyor belts and sorting lines. It can also be applied for color analyses (classifications, variations, distributions) and pattern recognition. In fact, the power of the system relates to the fact that it can combine these diverse quality and safety screenings in one application.

The Flemish food industry could also benefit from this technology. Therefore, the aim of this validation project is to make this technology accessible for the Flemish industry. Within this validation project the research partners provide their extensive expertise in this domain and their advanced hyperspectral camera prototype systems to the participating companies, allowing them to discover and validate the possibilities of hyperspectral cameras for their company.



Detection of the cooking front in a potato (left) and mycotoxin-producing fungi on cereals (right) by hyperspectral imaging.

What do we offer?

This validation project has the aim to test, optimize and validate online quality measurements on food products with the aid of hyperspectral imaging. This approach will be compared to present reference techniques used in the food industry. The validation project combines technical evaluations (sensitivity, detection limit, robustness, measuring rate,…) with considerations on the balance between cost and detection performance. Knowledge transfer concerning fast quality assessment with spectral cameras in the food industry is an important aspect within the project. Support for applications in the VNIR domain (400-1000 nm) will be provided by IMEC, while MeBioS (K.U.Leuven) will support the NIR based applications (1000 – 2500 nm).

Participating companies can rely on the project to identify the potential of this technology for their problems, opportunities and challenges via demonstration of the technical feasibility on a set of relevant model systems and via support upon implementation. To this end, the validation project includes following steps:

1. **Application scouting**: Identification of possible applications within your company. During a visit to your company all steps in the production process are investigated to find out where the hyperspectral cameras can create added value. The identified possible applications will further be investigated through a series of simple and fast experiments in the lab to determine the potential of the technology for solving the problem. By preference, products with clearly distinguishable differences will be used in these feasibility studies.
2. **Proof of concept:** After the feasibility of the identified applications at the different companies has been revealed, the applications will be clustered in a number of model systems (2 for VNIR and 2 for NIR). For these, a more extensive series of experiments will be designed with the aim to define the necessary hardware, software and calibration procedures. This phase of the project results in determination of (i) the performance level that can be attained, (ii) the required calibration procedures and (iii) the necessary specifications of the hardware components. For proper assessment hereof, the challenges posed by the industrial environment will be taken into account.
3. **Transfer:** The appropriate specifications and information on the prototype of interest will be transferred to the participating companies, who are free to consult their system integrator of choice (a third party) for converting the prototype to a final product. Hence, we are not commercially implementing the technology into your company ourselves, but you can count on our experts to assist you during the entire implementation process. In the case that particular applications need further research, a bilateral follow-up project can be started.

Suggested work plan for the validation project Hyperspectral Cameras

WP3	Validation project: Hyperspectral Cameras																	
	Task	Partner	Year 1				Year 2				Year 3				Year 4			
1	Application scouting VNIR spectral camera	Imec	Pr			Sl				Ra								
2.a	Extended test VNIR-application 1	Imec						Be										
2.b	Analysis hardware VNIR-application 1	Imec							Ha									
2.c	Validation VNIR-application 1 on company samples	Imec								Pc								
2.d	Transfer VNIR-application 1	Imec										Ui						
3.a	Exended test VNIR-application 2	Imec													Be			
3.b	Analysis hardware VNIR-application 2	Imec													Ha			
3.c	Validation VNIR-application 2 on company samples	Imec														Pc		
3.d	Transfer VNIR-application 2	Imec															Wo	UiEi
4	Application scouting NIR spectral camera	MeBioS	Pr			Sl				Sl								Ra
5.a	Set up calibration model NIR-application A	MeBioS						Ca										
5.b	Analysis hardware NIR-application A	MeBioS							Ha									
5.c	Validation NIR-application A company environment	MeBioS								Pc								
5.d	Transfer NIR-application A	MeBioS										Ui						
6.a	Set up calibration model NIR-application B	MeBioS													Ca			
6.b	Analysis hardware NIR-application B	MeBioS													Ha			
6.c	Validation NIR application B company environment	MeBioS														Pc		
6.d	Transfer NIR application B	MeBioS															Wo	UiEi
7	Specific user group meetings	Imec & MeBioS	Sg		Sg		Sg		Sg		Sg		Sg		Sg		Sg	sEv

Legend:
Pr = Presentation literature study and visit Imec & MeBioS (Deliverable);
Sl = Selection food applications 1 and 2 for VNIR and 1 and 2 for NIR (Strategic Milestone);
Ra = Report on potential VNIR & NIR spectral cameras in the food industry (Deliverable)
Be = Image processing algorithm specific for application X (Technical Milestone)
Ha = Selection Hardware for application X in function of desired sensitivity and feasible cost (Deliverable)
Pc = Proof of concept via company relevant labo-set up for application X (Technical Milestone)
Wo = Workshop hyperspectral cameras (Deliverable);
Ui = Detailed proposal of prototype for company application X – with transfer algorithms (Deliverable);
Ei = Final report + Valorisation document (Deliverable)
Ca = Calibration model for determination of composition application X (Technical Milestone)
Sg = Specific biannual User group meeting (Deliverable);
sEv = specific Final meeting (Deliverable)

Financial contribution of the participating companies

The estimated project contribution per year is dependent on the size of the company, as determined by the total number of employees of the company in the concerned year and is represented in the following table:

Number of employees*	Minimal project contribution (yearly, VAT excl.)	**Estimated project contribution** (yearly, VAT excl)**	Maximal project contribution (yearly, VAT excl.)
< 50	750 €	**1.300 €**	1.950 €
51-100	1.125 €	**1.950 €**	2.925 €
101-150	1.500 €	**2.600 €**	3.900 €
151-200	1.875 €	**3.250 €**	4.875 €
201-250	2.250 €	**3.900 €**	5.850 €
> 250	3.000 €	**5.200 €**	7.800 €

*Number of employees of the largest legal entity that will have access to the results of the project

**Based on the number of companies that had expressed their interest in the Validation project upon submission of the Sensors For Food project application at IWT.

The real yearly project contribution can be higher or lower than the estimated project contribution.
The real yearly project contribution depends on the number and size of the participating companies. The real yearly project contribution has been limited to minimal and maximal project contributions mentioned in the table above.

Participating companies engage themselves to stay a member of the project and Flanders' FOOD for the duration of the project (see www.flandersfood.com/lid-worden-van-flanders-food).

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