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## Content

*This NewsLetter is dedicated a project in the development of Intelligent sensor for Autonomous Cleaning in livestock buildings (ISAC) – a project under DaNet which is part of the research program “Sustainable technology in agriculture”.*

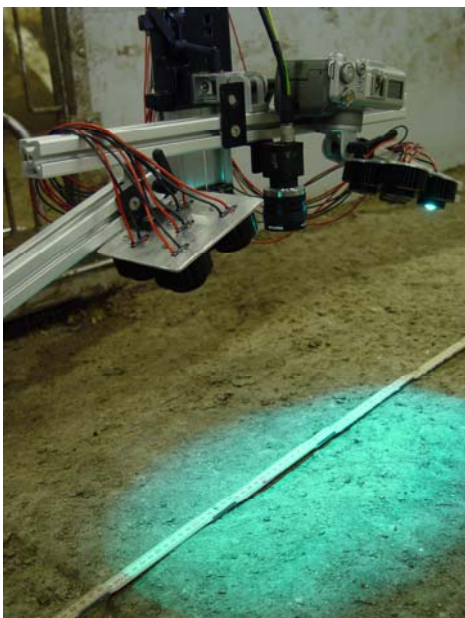
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One of the hardest jobs in modern agriculture is the cleaning of livestock buildings. A job that today mainly is done manually by high-pressure water cleaners – a hard and unhealthy job where dirt, water and micro organisms are whirled up and inhaled by the operator. Therefore a robot capable of doing the “dirty work” is under development.



## Intelligent Sensor for Autonomous Cleaning of livestock buildings

Today the use of autonomous robotic cleaning in livestock buildings, where only a few models are commercialized, often entails subsequently manual cleaning because the robot did not detect the cleanliness of the surfaces. The aim of the ISAC-project is to improve the human working environment and to optimize the use of cleaning resources in livestock buildings. The specific objective is to develop an intelligent sensor system capable of supplying data on the position and the extent of non-clean areas to a system for autonomous cleaning of livestock compartments.



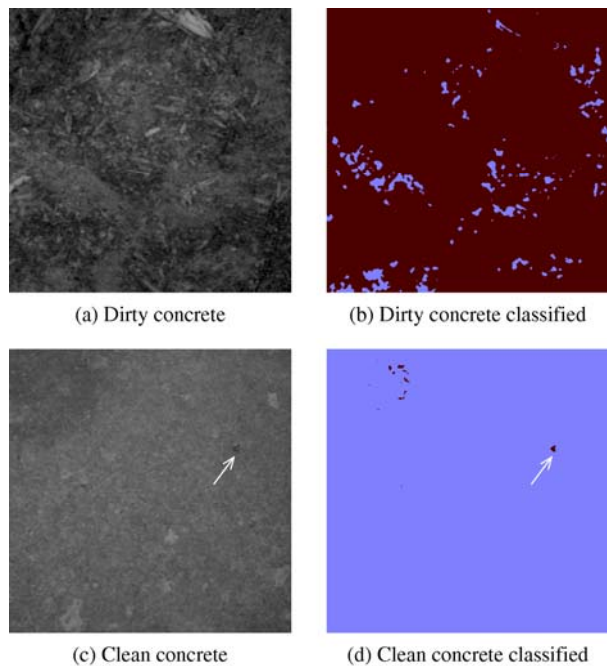
**Figure 1** Experimental prototype sensor used for validation in pigpen. The ruler is intended for calibration. The surface is dry manure on a solid concrete floor. A blue/green LED is flashing.

The project is lead by professor Mogens Blanke (DTU) and is conducted in collaboration between the Technical University of Denmark (DTU), the Danish Institute of Agricultural Sciences (DIAS), the Danish Bacon and Meat Council, and the company Nilfisk Advance (daughter companies Gerni A/S and ALTO A/S). The project duration is four years, from 2002-2006.

The first phase of the project formulated requirements showing that visible dirt down to a size of 2 mm should be detectable by the sensor.

A special ISAC-pen was designed to investigate basic sensor principles under laboratory conditions at Research Centre Bygholm, DIAS. Results of spectral measurement showed that multispectral techniques might be useful. These results were published in 2004 at international conferences and the possibility of using CCD camera with illumination or filtering in pre-defined spectral ranges was pointed out. Multispectral classification was pursued at DTU and

novel analysis techniques were developed and implemented in a sensor prototype. A patent is pending on the ISAC sensor technology and detailed results are in print as a journal paper. An ISAC sensor with a computer and dedicated electronics was built at DTU and a camera and illumination system constructed at DIAS. The prototype system is currently used in real pigpen measurements. The first real-life measurements were obtained in April and May 2005 with an effort from all project partners. The results are very promising. A result of classification is shown in figure 2.



**Figure 2** Classification results from ISAC cleanness sensor. Real image to the left classification to the right. In the classification images light colour means clean and dark colour dirt. The arrows show a speck classified as dirt due to age effects in the floor. Misclassification of such objects is avoided by learning.

The principle behind the new sensor is that observation of reflectance of clean and contaminated building materials is different in parts of the visible and the near infra-red wavelength ranges. Therefore it is possible to teach the sensors to “see” the dirt through the use of multi-spectral image analysis combined with appropriate illumination or camera filters. A special challenge is to be sure that the sensors identify the contamination on a surface disregarding the level of light and the type of surface material. At present the research is focused on materials most commonly used in newer livestock facilities, e.g. plastic, concrete, and steel. The ability to detect the extent of contamination of the surfaces will help an industrial cleaning robot to localize and make a specific effort, so that the surfaces are cleaned to the required level.

For more information on the project take a look at the project’s homepage: <http://www.isac.dk> or some of the following references:

- Braithwaite, I.; Blanke, M.; Zhang, G. & Carstensen, J. M. *Design of a Vision-based Sensor for Autonomous Pighouse Cleaning. Journal of Applied Signal Processing.* 2005. (In print).
- Braithwaite, I.; Blanke, M.; Zhang, G. *Classification of clean and dirty pighouse surfaces based on spectral reflectance. ISAC Project Report.* April 2004 ([Abstract in PDF file](#)) ([Full Report-Mail to Ørsted-DTU](#))
- Strøm, J.S.; Zhang, G. & Blanke, M. *Intelligent Sensor for Autonomous Cleaning in livestock buildings (ISAC) - A challenge in bio-environmental engineering.* Nov. 2003. *Proc. 2003 IFBBE Int. Forum on Bio-environment and Bio-energy engineering, Beijing, China.* 283-288. ([PDF file](#))
- Zhang, G. & Strøm, J.S., 2004. *Spectral signatures of surface materials in pig buildings. Proc. int. symp. of the CIGR 2nd Technical Section: New trends in farm buildings. Portugal. On CD-fb2004,* 316.

## Topics of coming newsletters

Next NewsLetter will be 1st of August.

Robotics in agriculture (AgroBotics)

Monitoring and management of ammonia emission

