

June 2006

## Intelligent Sensor for Autonomous Cleaning – the ISAC project: Results from sensor-robot integration

Authors: Mogens Blanke, Roberto Galeazzi, Ole F. Hansen and Nils A. Andersen  
Automation at Ørsted • DTU, Technical University of Denmark.

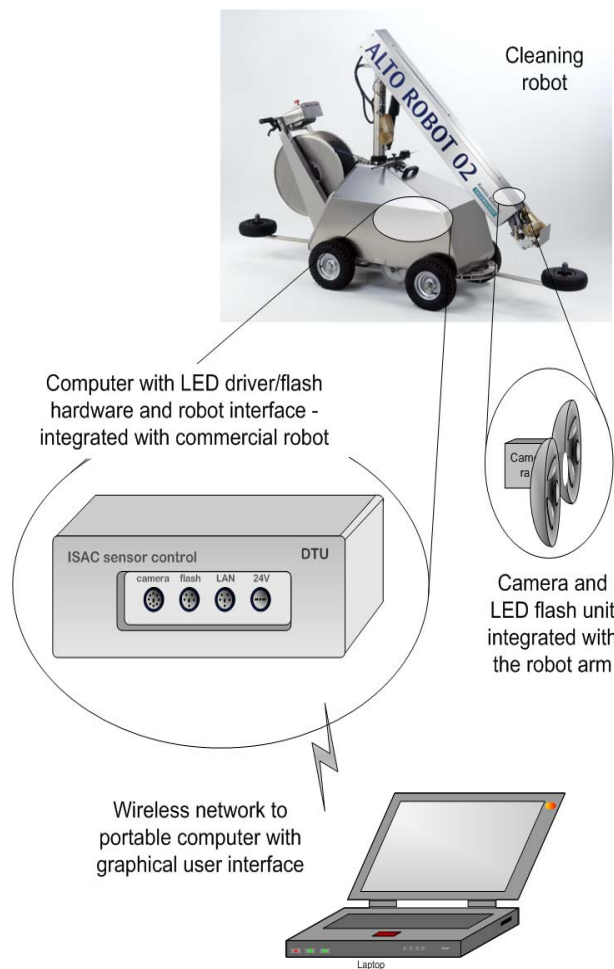


Present cleaning robots use an open loop cleaning strategy as they are unable to measure the cleanness. Thus they are only able to clean about 80% while they are stated to use far more of expensive high-pressure water than with manual cleaning. The ISAC project aims at developing an intelligent sensor for robot-based cleaning.

*ISAC computer and sensor mounted on the Ramsta-ALTO robot. Photo by Carsten Broder Hansen, IPU.*

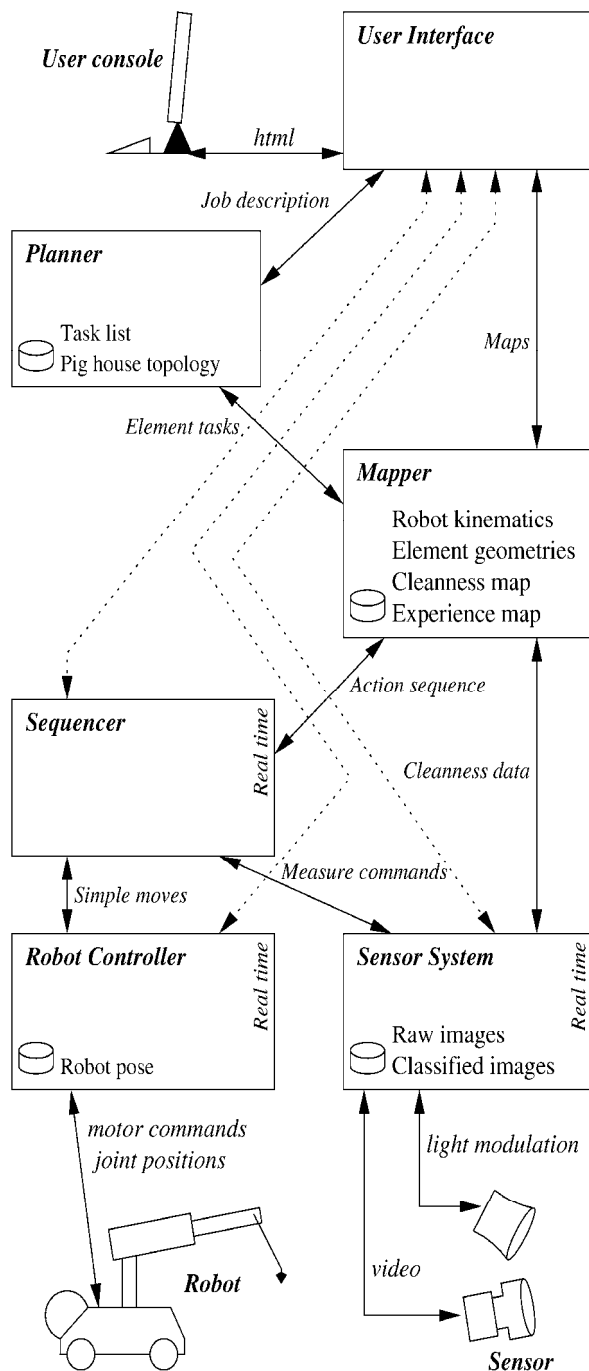
A patented cleanness sensor has been developed in ISAC. It consists of a computer vision camera, together with an illumination system and integrated computer control. High-power light emitting diodes are used to generate a sequence of specific wave-lengths, illuminating the surface in turn. The multi-spectral image is classified into clean, dirty and unknown using multi-dimensional statistics.

Recent progress in the project has been to get the sensor system integrated with the robot to enable automated mapping of the floor in a pig pen. The first tests with autonomous mapping in a production pig house were conducted in late 2005. Subsequent analyses of pictures and software refinements have made improvements in software reliability and in the classification algorithms.



Recent progress in the project has been to get the sensor system integrated with the robot to enable automated mapping of the floor in a pig pen. The first tests with autonomous mapping in a production pig house were conducted in late 2005. Subsequent analyses of pictures and software refinements have made improvements in software reliability and in the classification algorithms.

*Hardware configuration for ISAC sensor and robot control computer mounted on the ALTO 2 robot (the robot was developed by Ramsta Robotics AB).*



## Software architecture for robot control and ISAC sensor.

A modular, component-based software architecture has been designed to implement the robot cleaning system, as illustrated in the figure to the left. Rectangular boxes in the figure represent software components, which are distributed amongst the computer devices in the system.

A socket interface is used to facilitate distribution of modules between suitable hardware platforms. Hard real-time requirements are isolated in the robot and sensor system modules.

Standard browser technology is used for the user interface and a wireless LAN connection is established to the portable computer, placed at convenient distance from the pen.

## References:

I. Braithwaite, M. Blanke, G-Q. Zhang and J. M. Carstensen: Design of a Vision-based Sensor for Autonomous Pighouse Cleaning. EURASIP Journal of Applied Signal Processing. 2005(13) pp 2005-2018.

Zhang, G. Q., J. S. Strøm, M. Blanke and I. D. Braithwaite: Spectral signatures of surface materials in pig buildings. Biosystems Engineering, 2006. (accepted)

M. Blanke and I. D. Braithwaite: Methods and apparatus for classification of surfaces. Patent application EP 04031021.1, US 60/640,057 2005

The ISAC project is supported by the Danish Council for Research and the Ministry for Food and Health under the Sustainable Technology in Agriculture Programme. The project is managed by professor Mogens Blanke, DTU.

Participants in the project are: Technical University of Denmark (departments: Ørsted•DTU, IMM, MEK); Danish Institute for Agricultural Sciences, Research Center Bygholm; The National Committee for Pig Production, Nilfisk-ALTO A/S and Gerni A/S.

## Topics of coming newsletters

Navigation systems and IT in Denmark

Single plant spraying

Portraits of Ph.D. students in the area of agricultural engineering and technology

