STØTTET AF Svineafgiftsfonden

Deliverable D3.2

For the SusAn project:

Improving pig system performance through a whole system approach

PigSys

SEGES

UNI KASSEL VERSITÄT

SLU

Report on early warning models

Introduction

Despite the high health status and productivity of modern pig producing herds, some housing conditions still have impact on health and welfare and result in reduced productivity as well (Aarnink 2006). The number of animals within a herd has increased over the years, which leaves less time per pig for the caretaker during the daily check. It is therefore more difficult for the caretaker to recognize behavioral changes (e.g. lying position and postures) which is known to precede pen fouling at the very early signs of an outbreak. Pen fouling is a response to suboptimal pen climate where the pigs start to rest in the defecation area of the pen and defecate in the resting area.

If pigs were monitored around the clock, early signs of undesired events might be recognized. Hereby interventions could be implemented timely enough to either prevent the events from occurring or limit the consequences. Constant monitoring by personnel is, however, not a realistic option so technical solutions have been considered in various applications for livestock production throughout the last two decades (Berckmans 2014). By installing for instance machine vision systems (video cameras), water meters or temperature sensors in pig herds, the animals would be monitored automatically around the clock, and real time data streams could be modeled into early warning systems.

An early warning system can detect early stages of events like normal and abnormal behaviors preceding pen fouling. When an event is detected, the warning system will communicate an alarm to the caretaker. The alarms provide the caretaker with valuable information on the status of the animals and will act as decision support in the daily management (Dominiak and Kristensen 2017). In addition, early and real-time detection of behaviors of animals reduces the cost of animal production, limiting losses from diseases and mortality, and improves the job satisfaction of stock people (Nasirahmadi et al., 2017).

Pen Fouling monitoring in PigSys

Partners in the PigSys project have developed monitoring techniques based on video data from finisher pig producing herds in France, Denmark, Germany and Sweden (Fig 1) using machine learning techniques with the possibility to detect normal and abnormal lying behaviors in pig pens. Image data were used to train deep learning models and the models were then tested on both images and video data from the herds.

The warning system would work, based on distances between the pigs and a categorization of either their lying position (sternal/belly or lateral/side) or whether they were standing. Based on a series of image processing steps (Fig 2) the system gave a number for the group distance. If pigs were lying close to each other (huddled together) and maybe also in sternal position, it was too

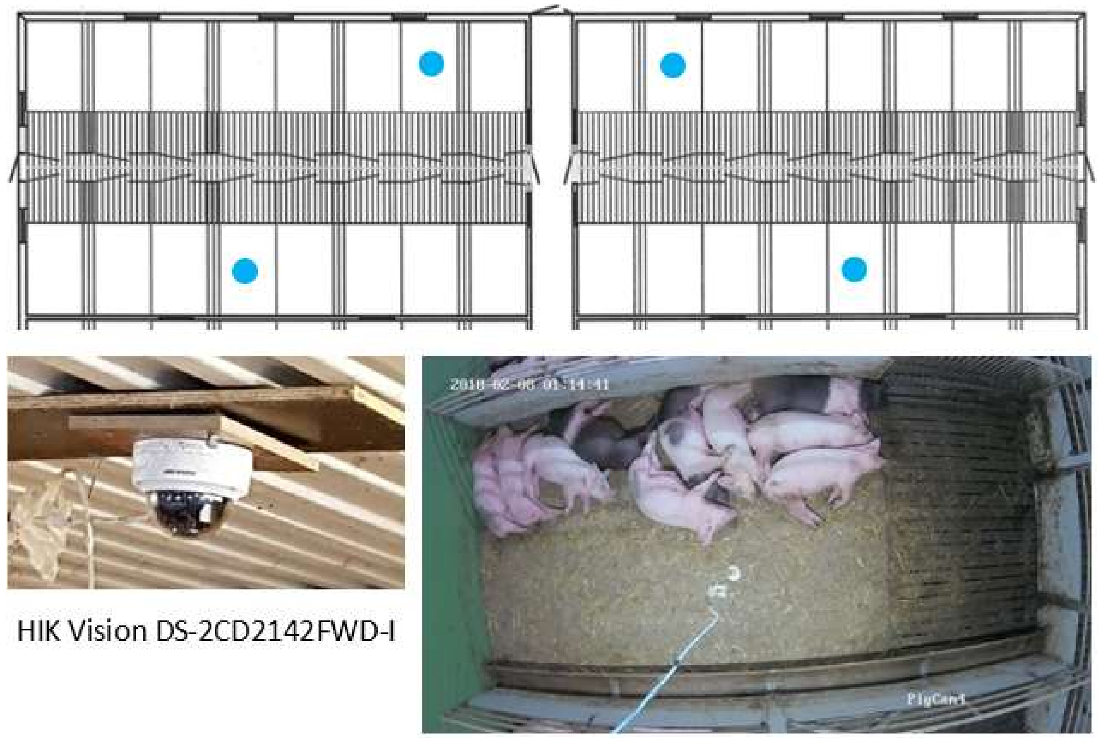

Fig 1. Top: Two sections in a Swedish finisher herd with cameras placed over pens marked with blue dots. Bottom left: Camera of type HIK Vision used in the setup. Bottom right: Example of image of pig pen used for the early warning model for pen fouling detection
(Picture by Anne-Charlotte Olsson and Knut-Håkan Jeppsson, SLU)

cold in the pen (See appendix A). On the other hand, if they were lying in a distance from each other and in lateral position, it was likely to be too warm in the pen.
The model gives a number for each image which belongs to the distance between lying animals. It is also possible to give the percentage of lying on side and belly which could be used for an individual animal lying posture indicator. In such a setup the model would be able to give an early warning if the percentage of pigs lying in the dunging area increased above a defined threshold. This was, however, not tested in the current project.

The final models were able to identify pigs' lying posture, activity, lying position as well as lying distance under different environmental conditions as described by Nasirahmadi et al. (2019). The model for lying position and standing/lying pig was successfully used in a commercial pig house for growing/finishing pigs in Sweden (WP5). All models were transferred to a Raspberry Pi with the possibility of real time monitoring and early warning notice.

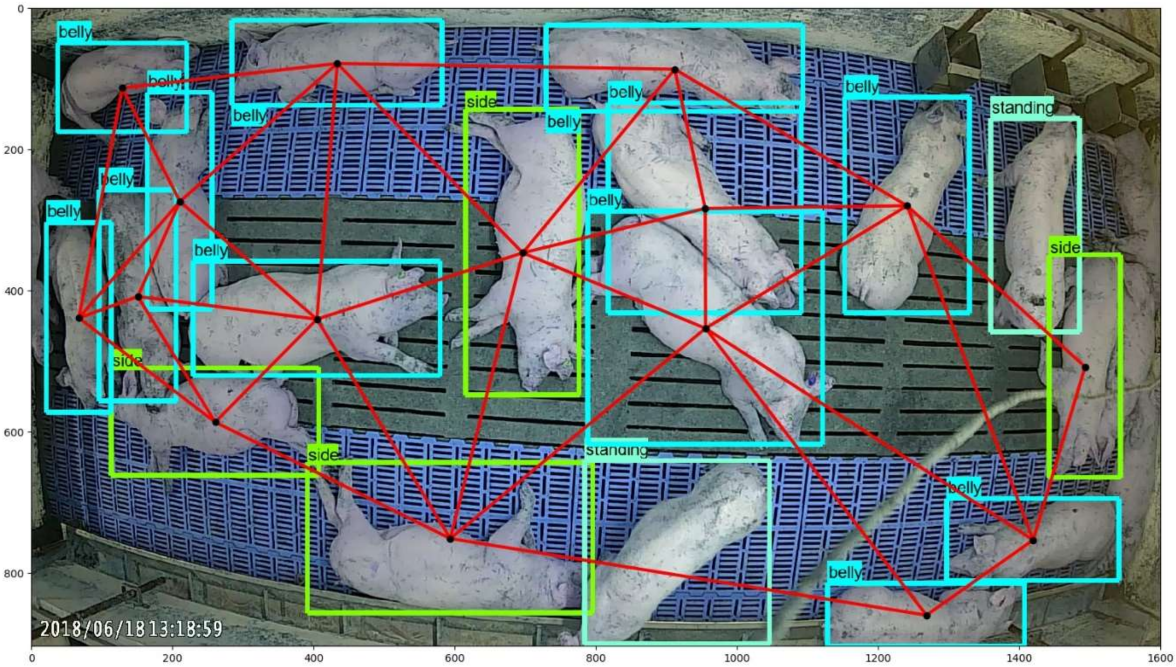

Fig 2. Example of the image processing step used in the development of an early warning system for changes in lying behavior preceding pen fouling. Red lines show the shortest distance between individual pigs. Positions of the pigs are marked as lying in sternal (belly) position, lateral (side) position, or as standing (Picture by Abozar Nasirahmadi, UniKassel).

Conclusion and perspectives

The models for early warning, based on animal behavior, have an interesting future. More research and technical development are needed to design the early warning system adapted for climate, animal health and environment control. With one camera in each pen the early warning systems could be used for regulating the thermal environment in individual pens (e.g. regulating air velocity) and/or offer the pigs opportunity to increase heat loss during high ambient temperatures (e.g. showers). Improving the heat balance of the pigs during high ambient temperatures will decrease the pen fouling and ammonia emission. Furthermore, the models could be used for early warning of animal health disorders etc. The time a pig is lying, the position and the posture could, especially during feeding time, be an early warning for animal health disorders.

Berckmans, D. (2014). "Precision livestock farming technologies for welfare management in intensive livestock systems. (Special Issue: Animal welfare: focusing on the future.)." Revue Scientifique et Technique - Office International des Epizooties **33**(1): 189-196.

Dominiak, K. N. and A. R. Kristensen (2017). "Prioritizing alarms from sensor-based detection models in livestock production - a review on model performance and alarm reducing methods." Computers and Electronics in Agriculture 133: 46-67.

Nasirahmadi, A., Edwards, S.A. and Sturm, B. (2017). "Implementation of machine vision for detecting behaviour of cattle and pigs." Livestock Science, 202, 25-38.

Nasirahmadi, A., Sturm, B., Edwards, S., Jeppsson, K.H., Olsson, A.C., Müller, S. and Hensel, O., (2019). "Deep Learning and Machine Vision Approaches for Posture Detection of Individual Pigs." Sensors, 19(17), 3738.

Aarnink, A. J. A., Schrama, J.W., Heetkamp, M.J.W., Stefanowska, J., Huynh, T.T.T. (2006). "Temperature and body weight affect fouling of pig pens." Journal of Animal Science: 8.

APPENDIX A

H24 - Lying behaviour

Sound lying behaviour in a pen with partially solid floor - sternal

Temperature

1. Look at how the pigs lie (huddled together, scattered, lying sternally/laterally).
2. Check stocking density.
3. Is there an even stocking density in the section?
4. Check temperatures.
5. Check for solar radiation from windows?
6. Check ventilation capacity.
7. Are the dimensions of the ventilation system correct? Have your advisor help you check this.
8. Intake of cold air / draught in the pens, slurry ventilation?
9. Closed / partially open pen sides?
10. Check compensation for outdoor temperature.

Temperature is too low / draught - lateral position

Mess on the solid floor

Become familiar with the pigs' signals

- If it is too cold or there is a draught, the pigs will huddle together and lie sternal.
- If it is too warm, the pigs often lie scattered and in lateral position.
- If it is too warm, the pigs will lie where it is coldest - on the slats or in places with a high air speed, for instance by pen partitions.
- If it is too warm, the pigs often"turn the pen around" and start defecating in the lying area.

	Additional comments - Check pigs' lying behaviour
4.	Check the temperature: • What is the desired temperature (see controller) • Record the temperature by the sensor • Record the temperature in representative pens (e.g. 4 pens). Use an infra-red thermometer to record the temperature by the pen partition approx. 50 cm above the floor and approx. 30 cm from the back wall • Check the inlet temperature of the floor heat Examples of temperature strategies are shown in H21.
5.	The temperature in the pens increases significantly under the impact of solar radiation from windows facing south-west. Cover these windows in flamingo or use lime coating. In facilities with diffuse ventilation, the roof surface must not have skylights.
8.	Intake of cold air / draught in the pens and slurry ventilation can be determined by using smoke or an anemometer and recording the ammonia level. Draught is defined as air speeds above 0.2 m/s if the difference between the temperature of the inlet air and the temperature of the facility is higher than 4° C.
9.	The pens should have partially open pen partitions. Completely closed pen partitions will reduce the ventilation in the animals' activity zone.
10.	If wall inlets are used for ventilation, the outdoor temperature compensation must be active to close the damper when outdoor temperatures drop and to avoid draught in the pigs' activity zone. Example of settings: set point 18° C, band width 4° C and reduction 70 per cent. In most controls, this example means that when outdoor temperatures drop below 22 (18+4)° C, air intake will be reduced and full reduction (70 per cent) will be active at 18° C. Note that in most controllers, a 100 per cent reduction equals no reduction (check manual).