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Validation of a smart camera system for slaughterhouse surveillance

T. Bas Rodenburg, Annemarie Baars, Mona Giersberg
Animals in Science & Society, Faculty of Veterinary Medicine
Utrecht University



Conventional slaughterhouse surveillance

- Inspectors are limited in number and in available time
- Inspectors commonly have to oversee a large slaughterhouse facility
- Inspectors have multiple responsibilities: animal welfare and food safety
- Conventional camera systems (CCTV): same time constraints

Smart slaughterhouse surveillance

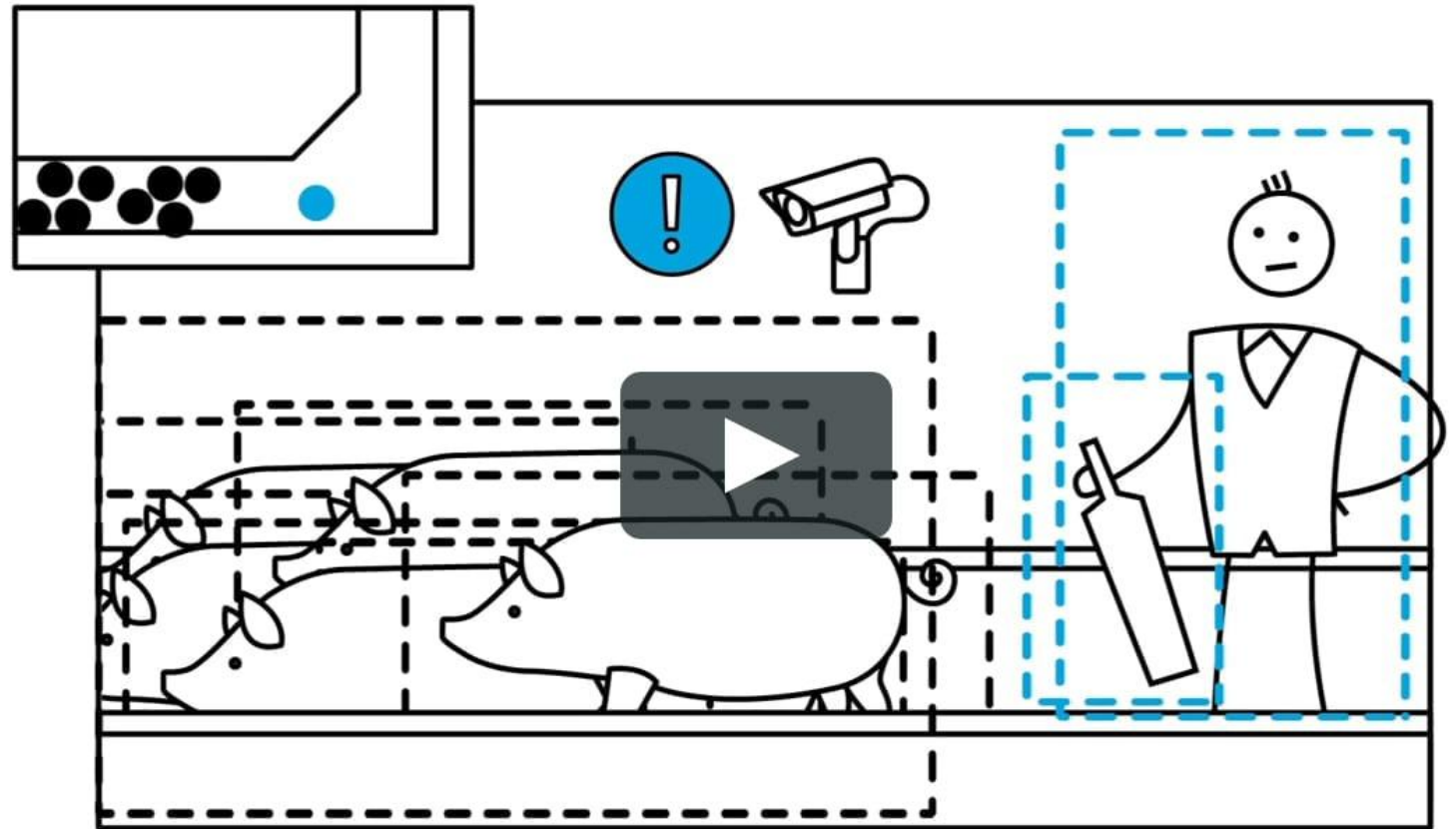
- Cameras (and potentially other sensors) oversee the different stages within the slaughterhouse
- The smart camera system is continuously monitoring the process
- In case of 'deviations from normal', footage is recorded and stored in the system for evaluation
- Operator evaluates footage and takes action in case of true positive

AI4Animals

Deloitte.

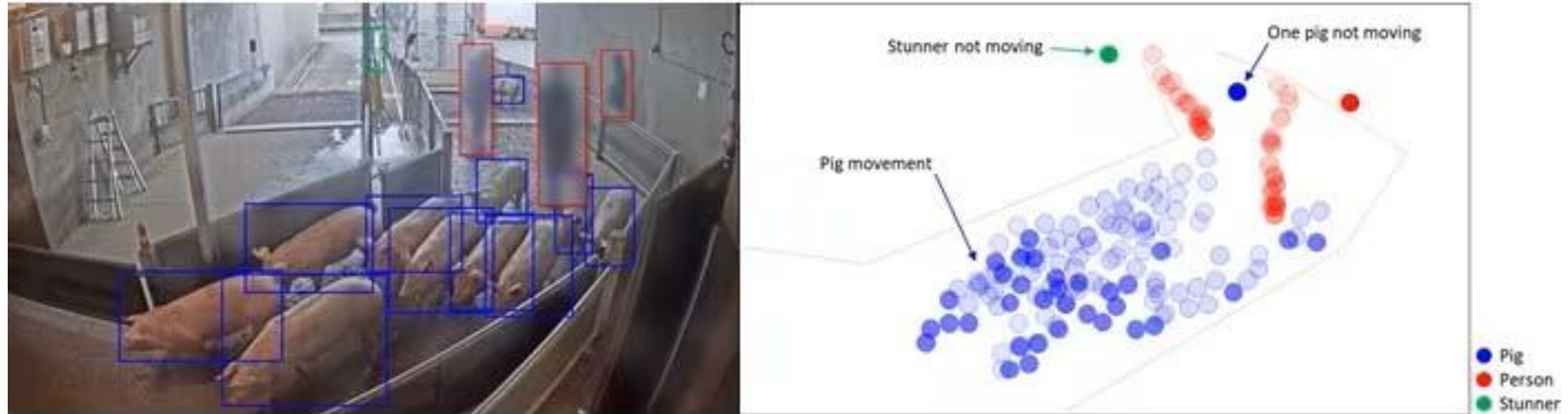


*Eyes on
Animals*



<https://www.youtube.com/watch?v=UcS46AKytXg>

Continuously monitoring deviating patterns



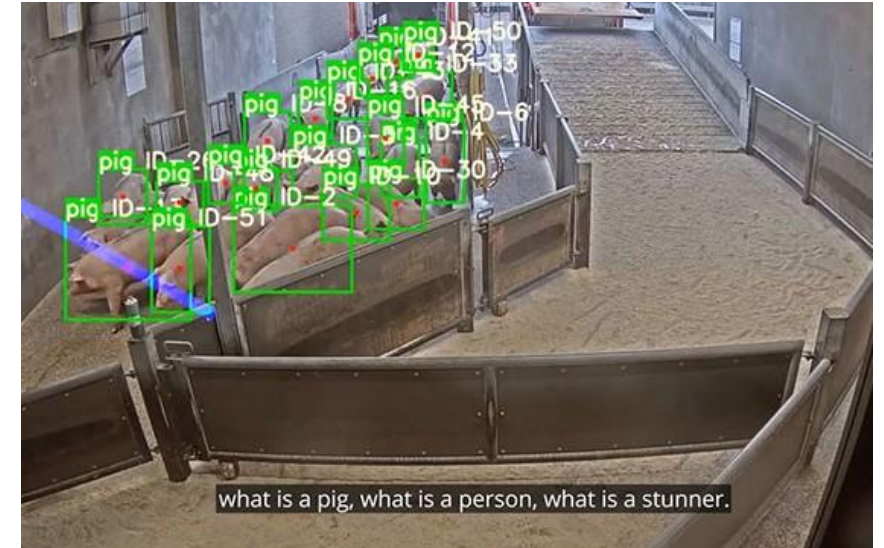
The AI4A algorithm detects animals, people, and objects and how they interact. Their movements can be visualized, as can be seen on the right where lighter dots indicate detections further back in time. Movements are analyzed to determine potential issues, such as a pig staying behind.

External validation needed

- Is the smart AI system really measuring what it is supposed to be measuring?
- Does it miss certain detections? **False negatives**
- Does it collect many irrelevant detections? **False positives**
- Need to compare with 'golden standard': detailed human observations

Validation study

- Two relevant indicators selected:
 - Use of the low voltage electrical prod at the entrance to the electrical stunner (relatively common)
 - Signs of life before entering the scalding tank (very rare)



Use of the electrical prod

- 20 videos of 10 minutes each of the stunning area
- Analysed by a human for 'holding / not holding the prod'
- Protocol similar to the training protocol of the algorithm and same detection area (close to stunner)
- 461 events detected
- Accuracy, Sensitivity, Specificity, Precision calculated

Use of the electrical prod

	Gold standard (trained human observer)		
Algorithm	Positive	Negative	Row total
Positive	39,7%	8,4%	48,1%
Negative	8,7%	43,2%	51,9%
Column total	48,4%	51,6%	100,0%

Use of the electrical prod

	Accuracy	Sensitivity	Specificity	Precision
Use of the prod	0.83	0.82	0.84	0.82

- 8.4% False positives: will be removed by operator + train algorithm
- 8.7% False negatives: missed (but continuous monitoring – system will still miss far fewer events than human observer)

Signs of life before scalding tank

- Very rare: induced by stimulating the carcass briefly 3 times with the mobile stunner
- Stunner placed on the middle of the carcass
- Response: front and hind legs move upwards and downwards
- Comparison live observation of movement with detections by the system

Signs of life before scalding tank

- Two sessions: 13 December 2023 and 31 January 2024
- 13 December 2023: 10 carcasses, 3 times brief stimulation, 90 s in between: **100% detection by the system**
- 31 January 2024:
 - 20 carcasses, 3 times brief stimulation, 90 s in between: **100% detection by the system**
 - 10 carcasses, 1 time brief stimulation, 90 s in between: **90% detection by the system**

Discussion

- Use of the electrical prod: accuracy, sensitivity, specificity and precision **all above 0.80** (expected range: between 0.7 and 0.9)
 - Few studies available to compare with: only 20% slaughterhouse sensor systems externally validated (Voogt et al., 2023)
 - Chance model, based on data – accuracy of 0.52 expected
- Signs of life: all simulations were detected, when same protocol was used as for training the algorithm (and 90% with less stimulation)
 - Rare events: regular simulations needed to check that system is still functioning

Conclusions

- For the two indicators validated, the AI4Animals system provides a valid solution for smart monitoring, with all indicators over 0.82
- Additional benefits are observed from the mandatory evaluation of the footage by the slaughterhouse personnel
 - False positives: shared with developer to further improve algorithm
 - True positives: slaughterhouse to take action
- For use of the prod, this has already led to changes in protocols and more detailed observations of the stunning area

Thank you!

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- Thanks to Deloitte for providing the data from the AI4Animals system and for valuable information on the training of the algorithms
- Thanks to the participating slaughterhouse for allowing us to conduct this validation study

