Instance segmentation of pigs for automatic assessment of animal welfare related parameters during controlled atmosphere stunning

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AI 4 Animal Science, Ghent, 29.06.2026

Background and objective

- Background: Adequate stunning prior to slaughter is obligatory
- Approach: Welfare parameter extraction for issue detection during stunning via motion analysis
- → Robust segmentation is essential step for feature extraction
- Challenging visual environment in the footage due to background movement and shadows on the animals

Data

- Footage of controlled atmosphere stunning events
- N = 650 events with two animals per gondola
- Colour scheme: Greyscale footage; Frame rate: 50 fps

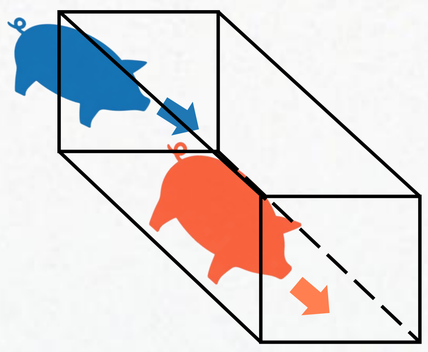
Annotation

- Software: LabelStudio (HumanSignal, v1.21.0) + Segment Anything Model (Meta)
- Training strategy: Human-in-the-Loop learning
- Annotation batch size: 100 frames (100 → 500)

Model and training details

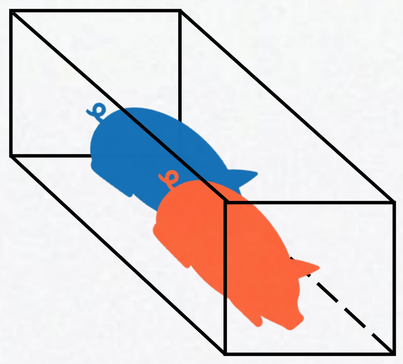
- Model: YOLO8n-seg (ultralytics, v. 8.4.14)
- Training: 300 epochs max; Input size: 640 × 640 px
- Batch size: Automatically selected based on available GPU memory
- Hardware: NVIDIA GPU (CUDA)

Controlled atmosphere stunning phases with relation to segmentation



1. Driving
Animal activity: intermediate
Dynamic background: yes
Illumination: high
Relevance: low

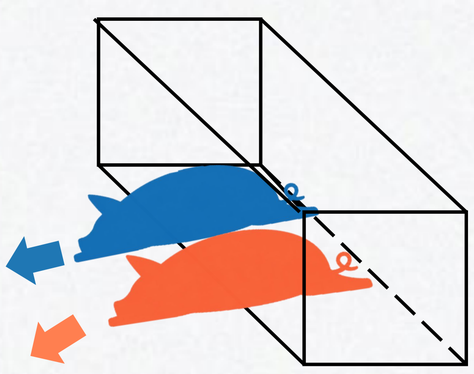
Sample frames



2. Descending
Animal activity: high
Dynamic background: yes
Illumination: medium
Relevance: high

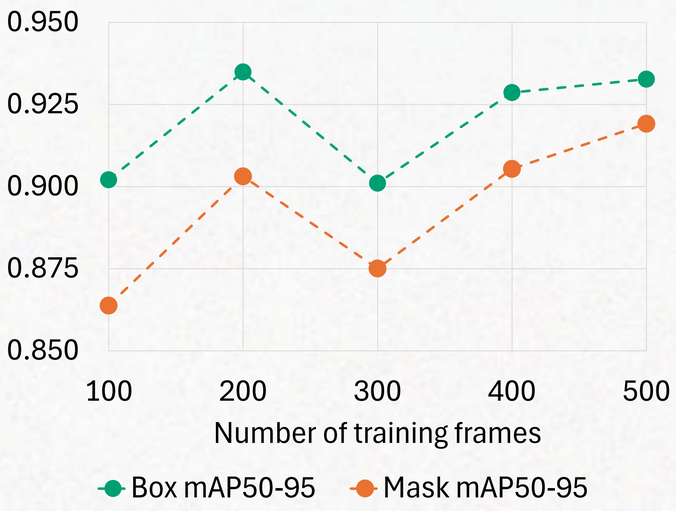
3. Stationary period
Animal activity: high to low
Dynamic background: no
Illumination: low
Relevance: high

4. Ascending
Animal activity: low to not present
Dynamic background: yes
Illumination: medium
Relevance: high

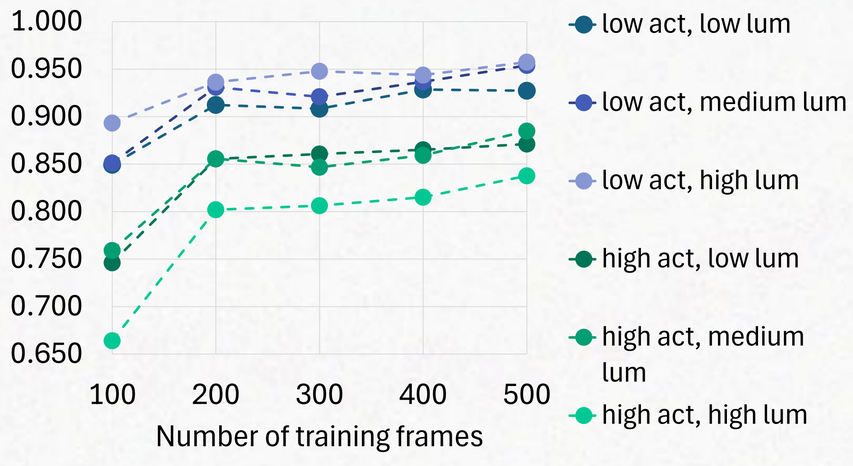


5. Ejection
Animal activity: passive movement
Dynamic background: yes
Illumination: high
Relevance: low

mAP50-95 values in dependence on number of training frames



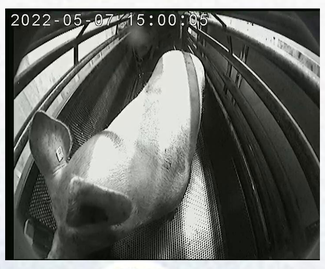
Mask mAP for test frames for different animal activity (act) and illumination (lum) based on 50 frames per category



Further development, usage and conclusion

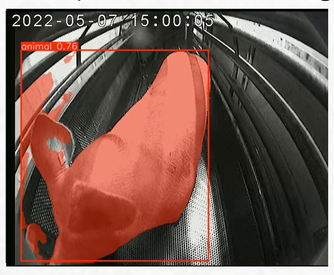
- Motion estimation is possible with few artefacts → segmentation robustness is sufficient
- Further metrics improvement by adding challenging frames to the train / val dataset
- Automated animal welfare parameter extraction, assessing each animal individually
- Validation of the extracted parameters with manual annotations

Original frame

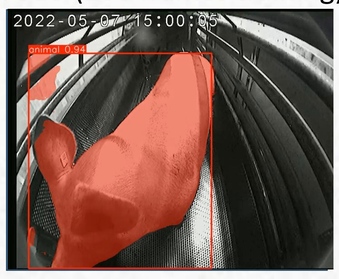


Manual annotation

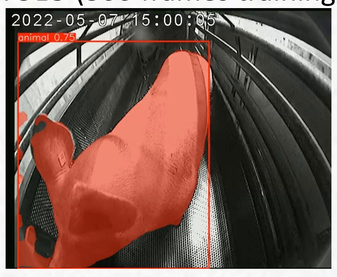
YOLO (100 frames training)



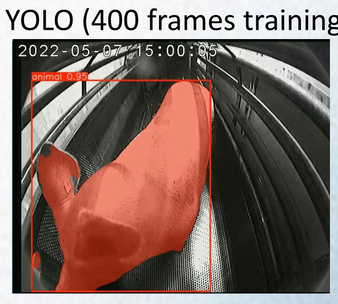
YOLO (200 frames training)



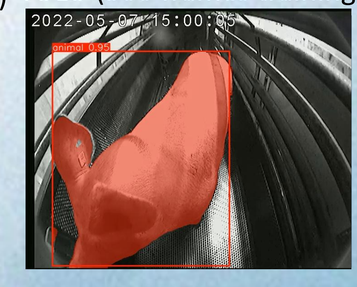
YOLO (300 frames training)



YOLO (400 frames training)



YOLO (500 frames training)



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This work was co-funded by the European Union's Horizon Europe Project 101136346 EUPAHW. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Co-funded by the European Union