Reducing Annotation Effort with Multi-Layered Labels and a Pig Segmentation Model: A Case Study on Pig Behaviour and Identification

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Introduction

Labelling images is essential for training models in animal behaviour identification, detection, and segmentation tasks. However, this process becomes highly labour-intensive when working with large animal groups or trying to capture infrequent behaviours. Additionally, models are often not interchangeable across experiments. Since labelling effort remains constant for each image, the workload increases linearly with the number of images and models required. To address these challenges, an approach is presented to reduce annotation effort in pig tracking, segmentation, behavior, and identification.

M&M

- **Generalisable pig segmentation model** based on 207 images.
- **Selective dot labelling** of pigs showing target behaviours on 381 images.
- **Stop labelling** when model predictions are accurate for segmentation, behaviour, colour and stripe pattern (Figure 1).
- **Multiple labels** to the same object for easier validation and quality control (Figure 2).

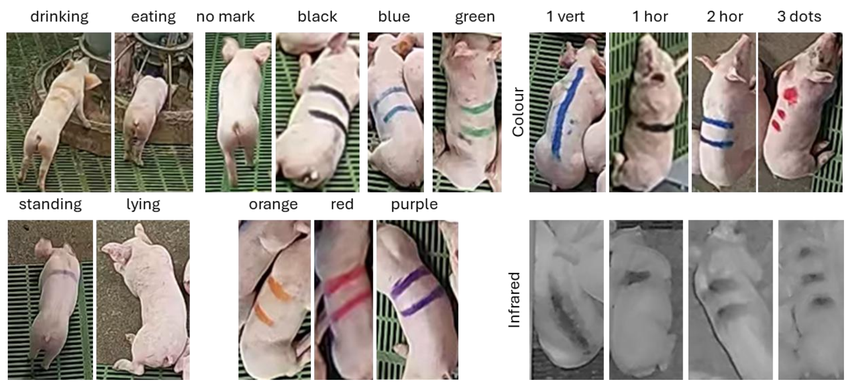

Figure 1: examples of the behaviour classification: drinking, eating, standing and lying; colour: no mark, black, blue, green, orange, red and purple and stripe pattern: 1 vertical line, 1 horizontal line, 2 horizontal lines and 3 dots during day recordings (Colour) and night recordings (Infrared)

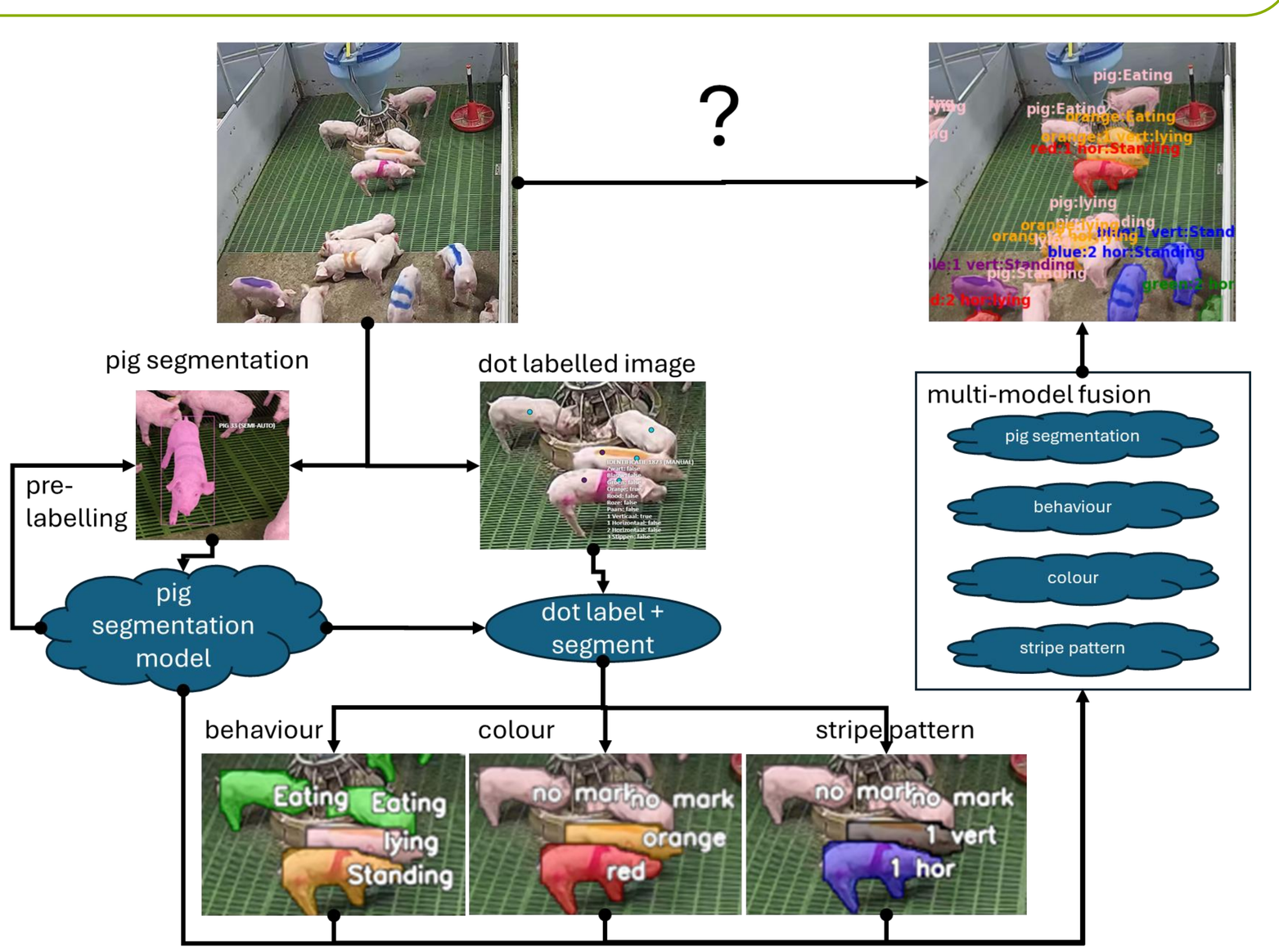

Figure 2: Data flow from image to output of multi-model fusion. Images were labelled with segments and dots and combining these labels resulted in Behaviour, Colour and Stripe pattern datasets used to train different segmentation models. The 4 models were combined in a multi-model fusion to result in segmentation, tracking, behaviour classification and identification of the pigs in images.

Results

Pig segmentation model

- Pre-labelling images in CVAT → reduced manual annotation effort for segmentation.
- Model precision of 83%, a recall of 95%, and an F1 score of 89%.

Further annotation effort reduction (Figure 3):

- Colour & Pattern (Day): labelled 20/35 pigs (40% reduction)
- Stripe Pattern (Night): labelled 4/35 pigs (90% reduction)

More effort available for infrequent behaviours and facilitated verification of ground truth labels with multi-model fusion output.

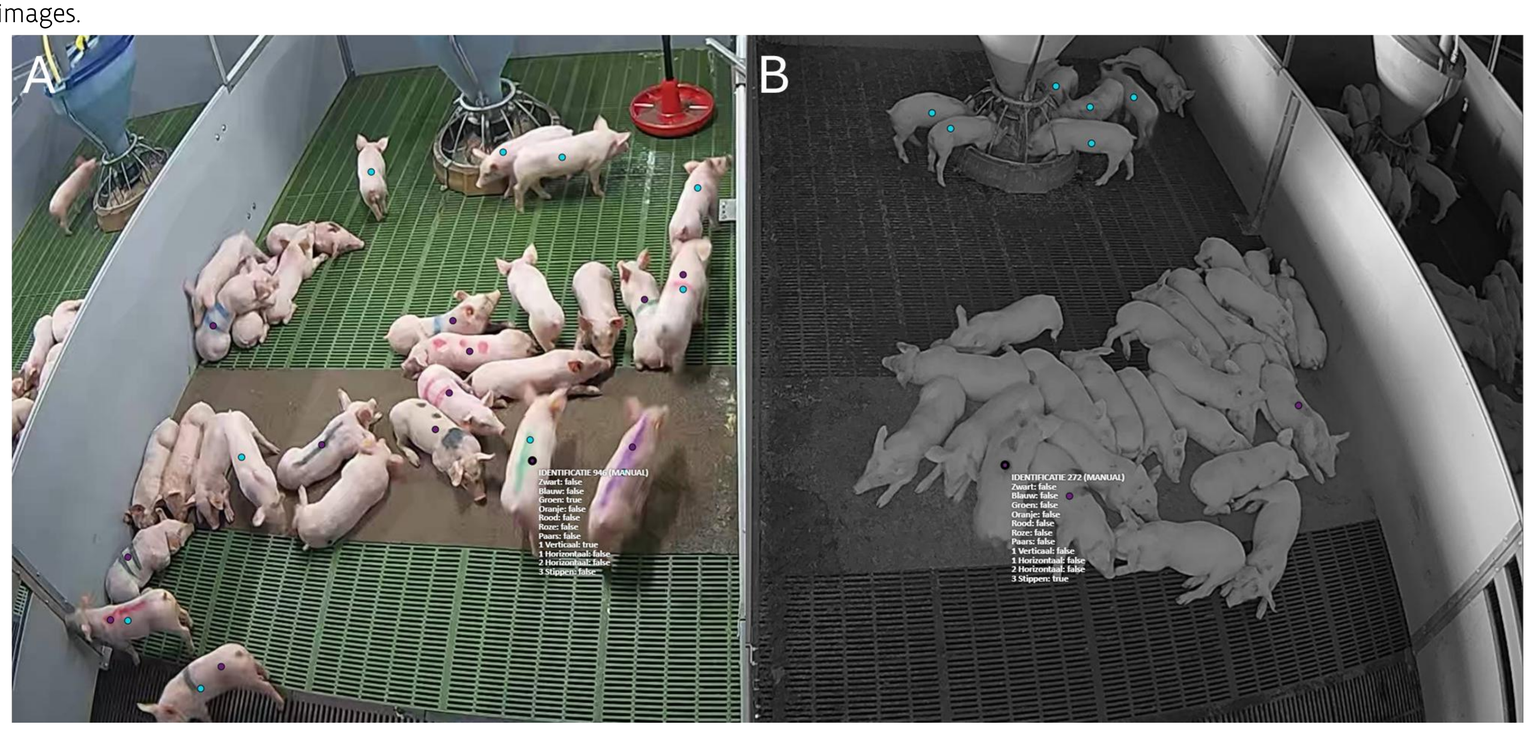

Figure 3: Example of labelling of behaviour (light blue dots) and identification (purple dots) during day (A) and night (B) recordings. Only pigs with colour, stripe pattern and/or target behaviour were labelled. Details in CVAT illustrate dot labelling with checkboxes: pig on image A where "green" and "1 vertical line" are set to true and pig image B where only "3 dots" are set to true.

Conclusion

This multi-step approach provides three advantages: (1) a general pig segmentation model reduces manual labelling efforts in new environments, (2) dot-based labelling focuses on pigs exhibiting target behaviours, minimizing redundant effort, and (3) multi-layered labelling prevents data duplication and facilitates adding additional labels later. This methodology streamlines labelling workflows while generating high-quality datasets for behaviour and identification detection in large animal groups.

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