

2D to 3D Pose modeling: A scalable framework for individualized detection of tail-biting interactions in group-housed pigs

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The problem

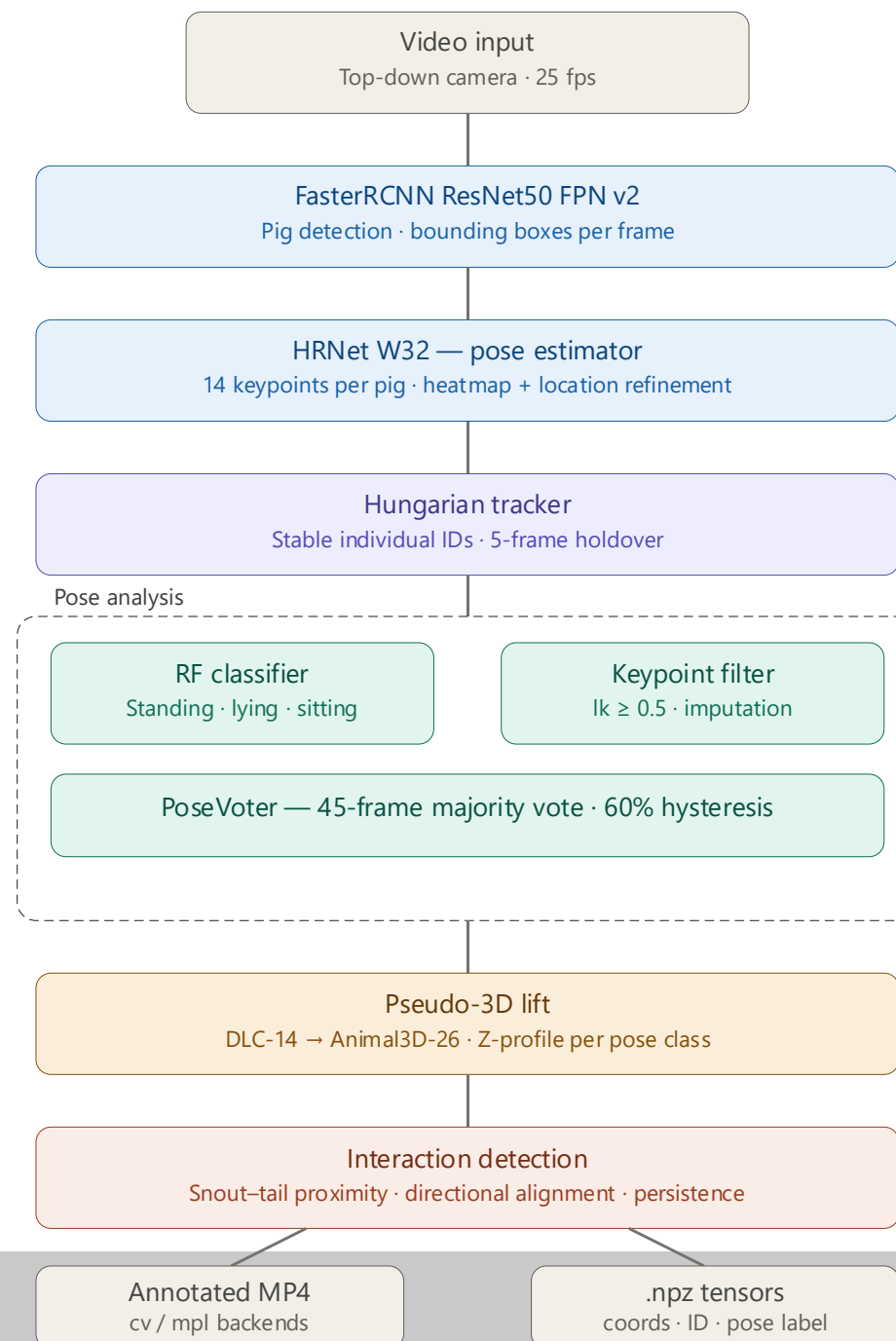
WHY TAIL-BITING DETECTION MATTERS?

- Welfare-critical behaviour in commercial pig production
- Early detection prevents escalation and injuries
- Manual observation at scale is infeasible
- Existing CV systems fail under high animal density

CORE TECHNICAL CHALLENGES ARE

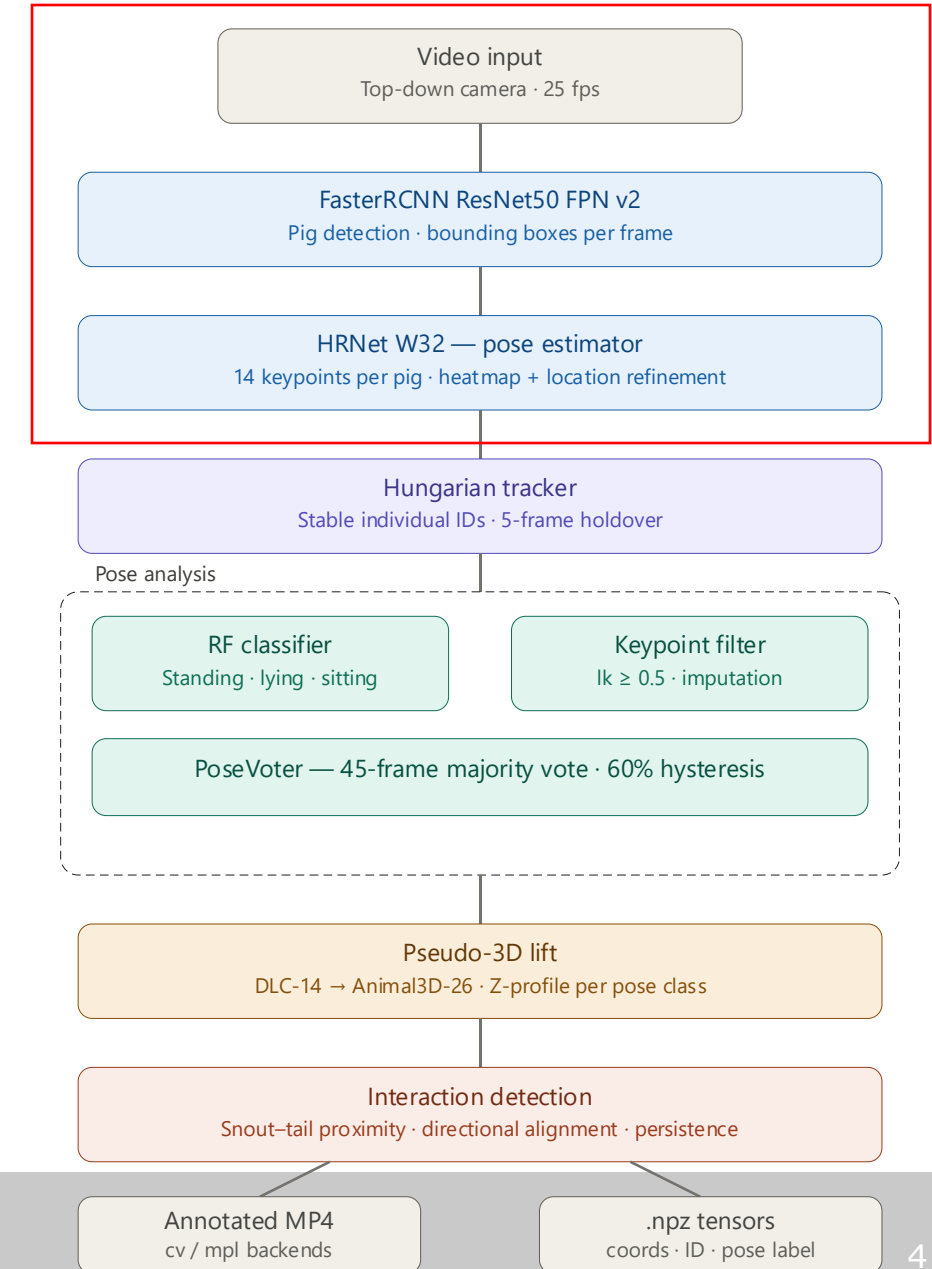
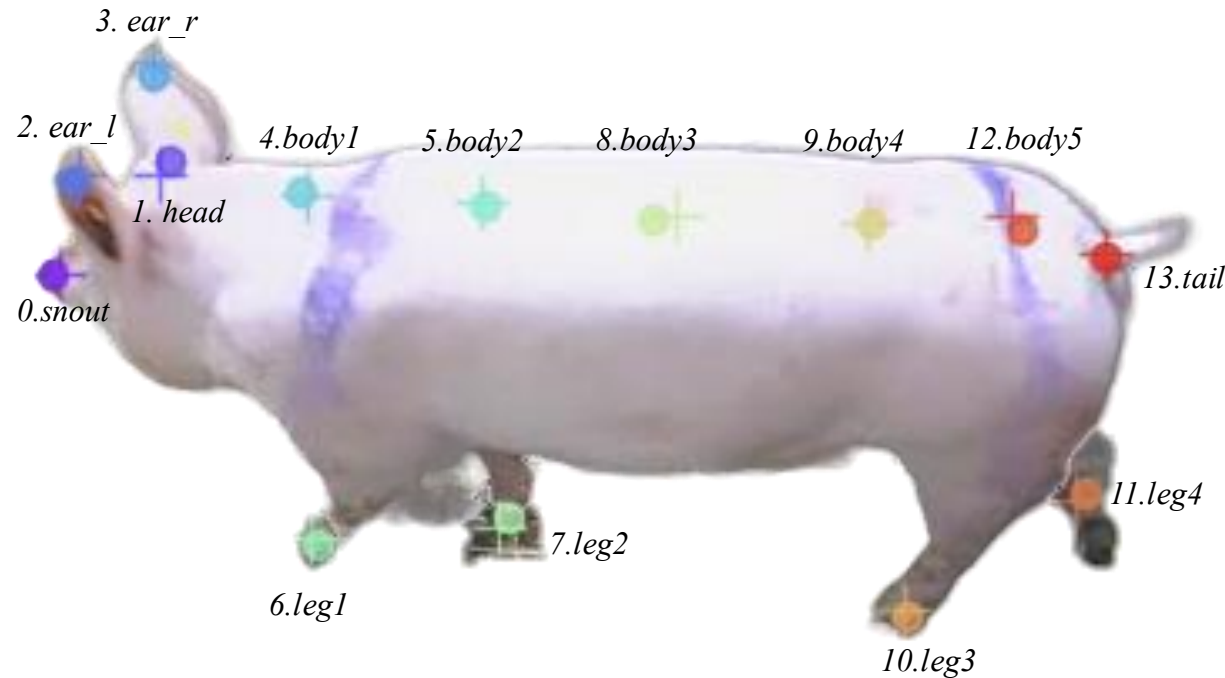
- Occlusions and body overlap
- Perspective ambiguity in top-down view
- Unstable individual ID across frames
- Incidental proximity $\neq$ directed contact



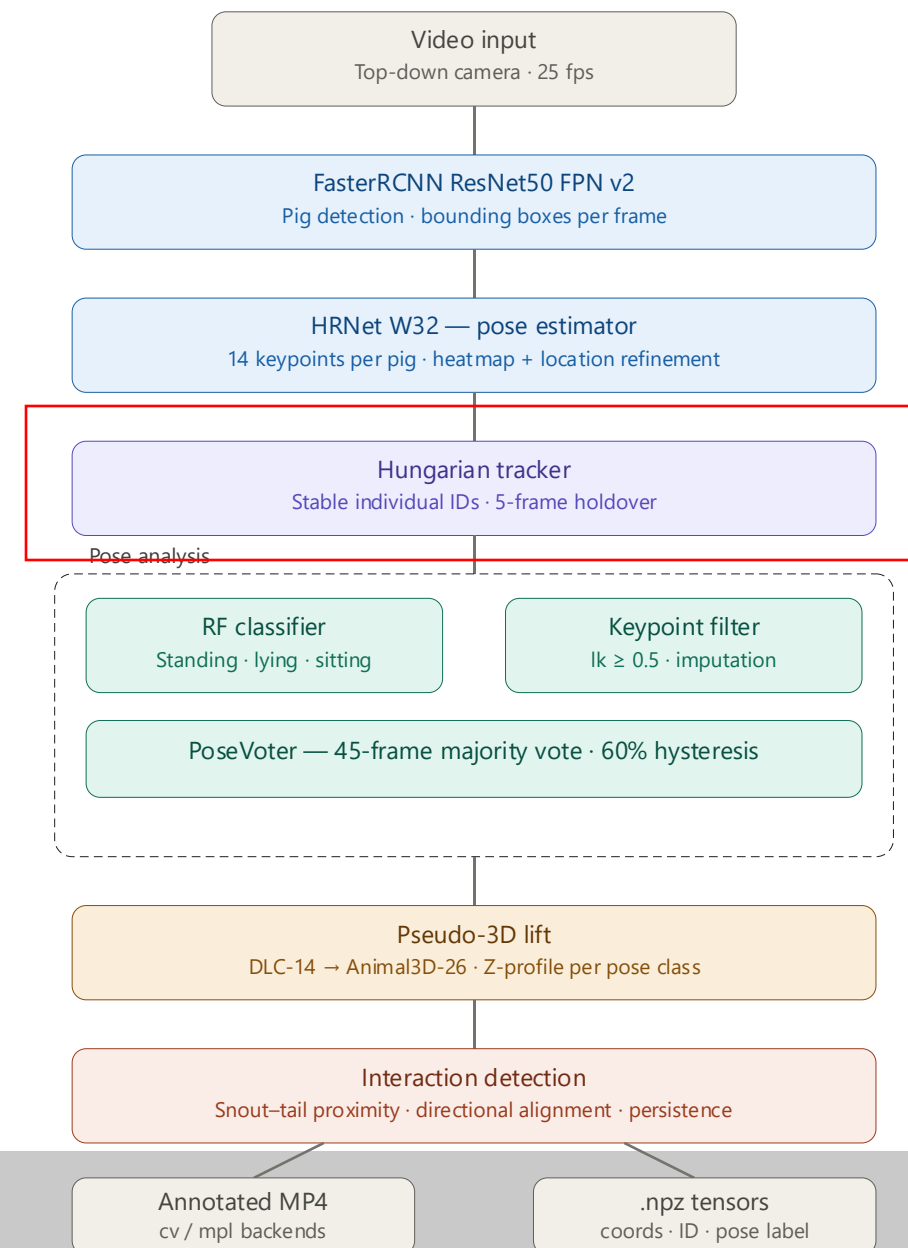
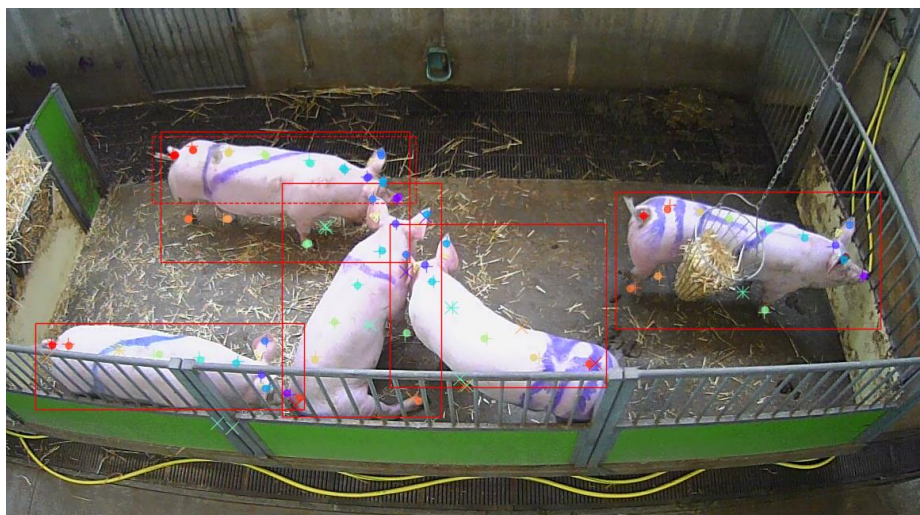


Starting setup for detector & pose

14 KEYPOINT MODEL

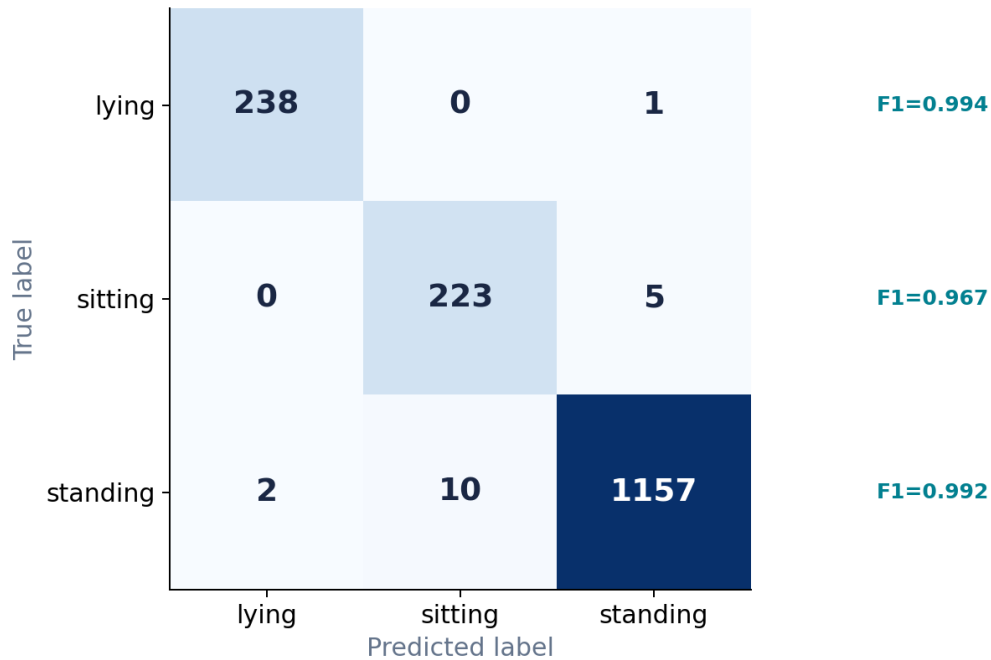


Tracking: from SORT to stable IDs



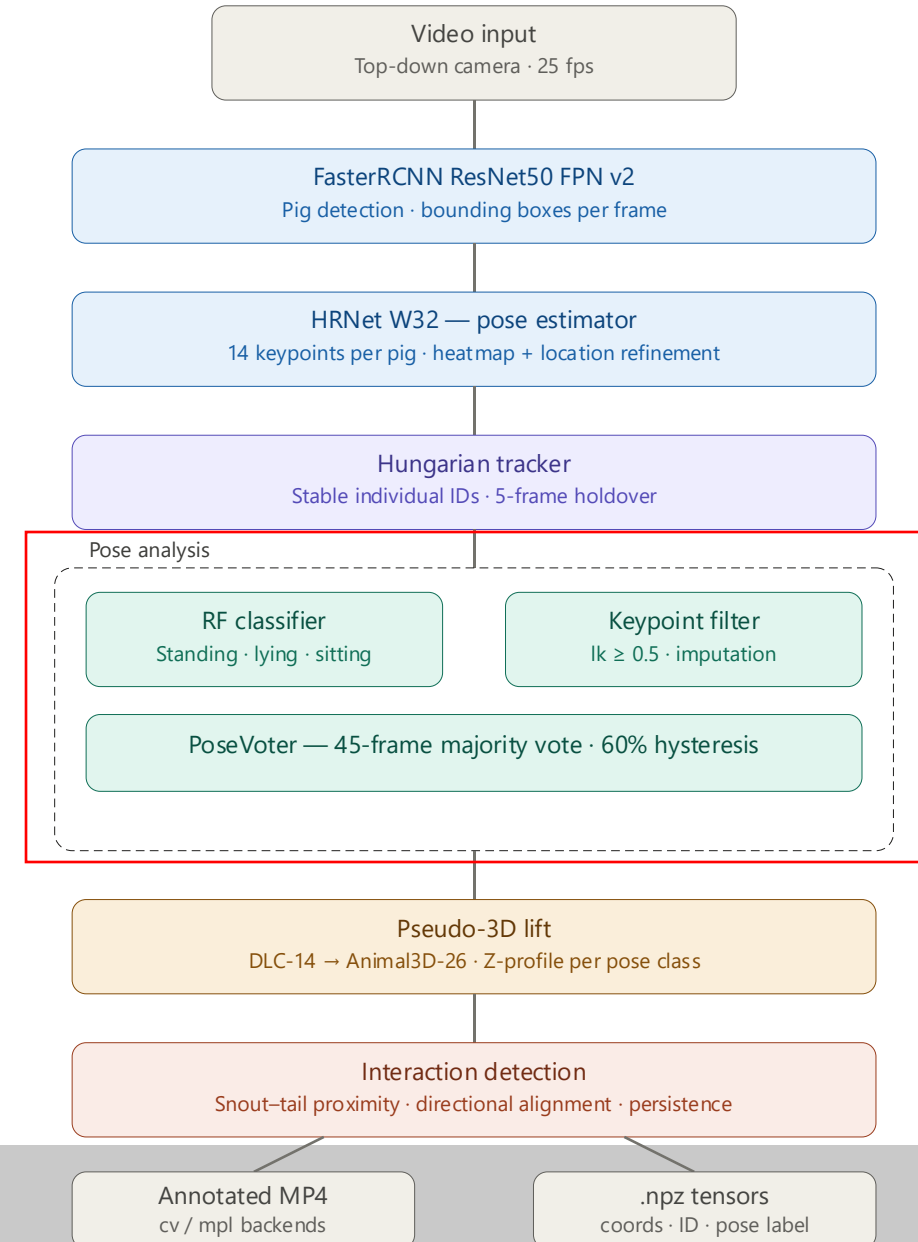
Pose classifier

Confusion matrix | CV F1 = 0.932

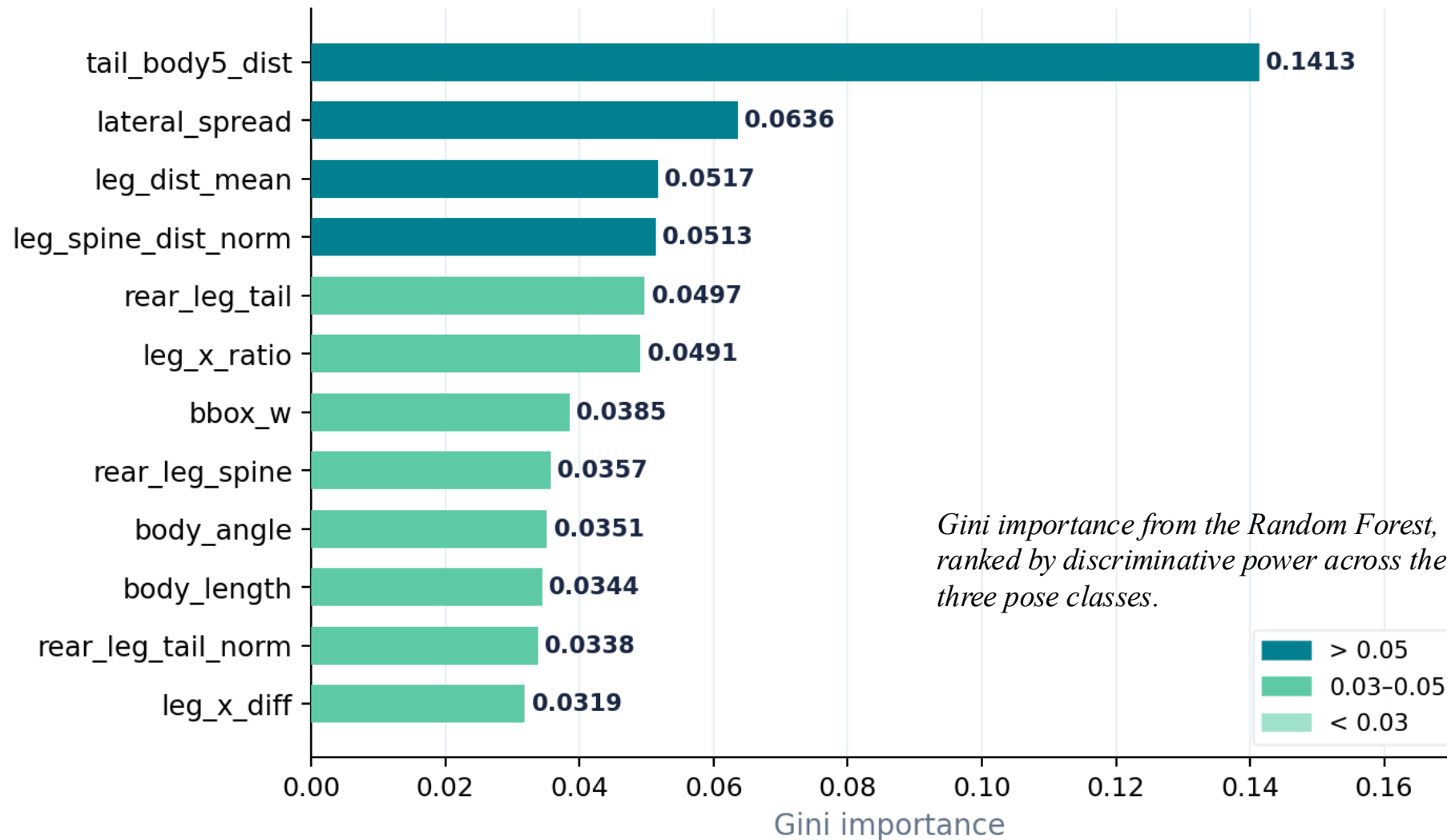


Classification report — Random Forest pose classifier | CV F1 = 0.932

Class	Precision	Recall	F1	Support
lying	0.992	0.996	0.994	239
sitting	0.957	0.978	0.967	228
standing	0.995	0.990	0.992	1,169
macro avg	0.981	0.988	0.984	1,636



Feature importance — top 12 predictors



3D lift from flat to spatial volume

Built on FMPose3D

Wang, Yu & Mathis · CVPR 2026

github.com/AdaptiveMotorControlLab/FMPose3D

— Pretrained weights

SuperAnimal quadruped HRNet checkpoint used for pose estimator warm-start - no training from scratch

— Skeleton definition

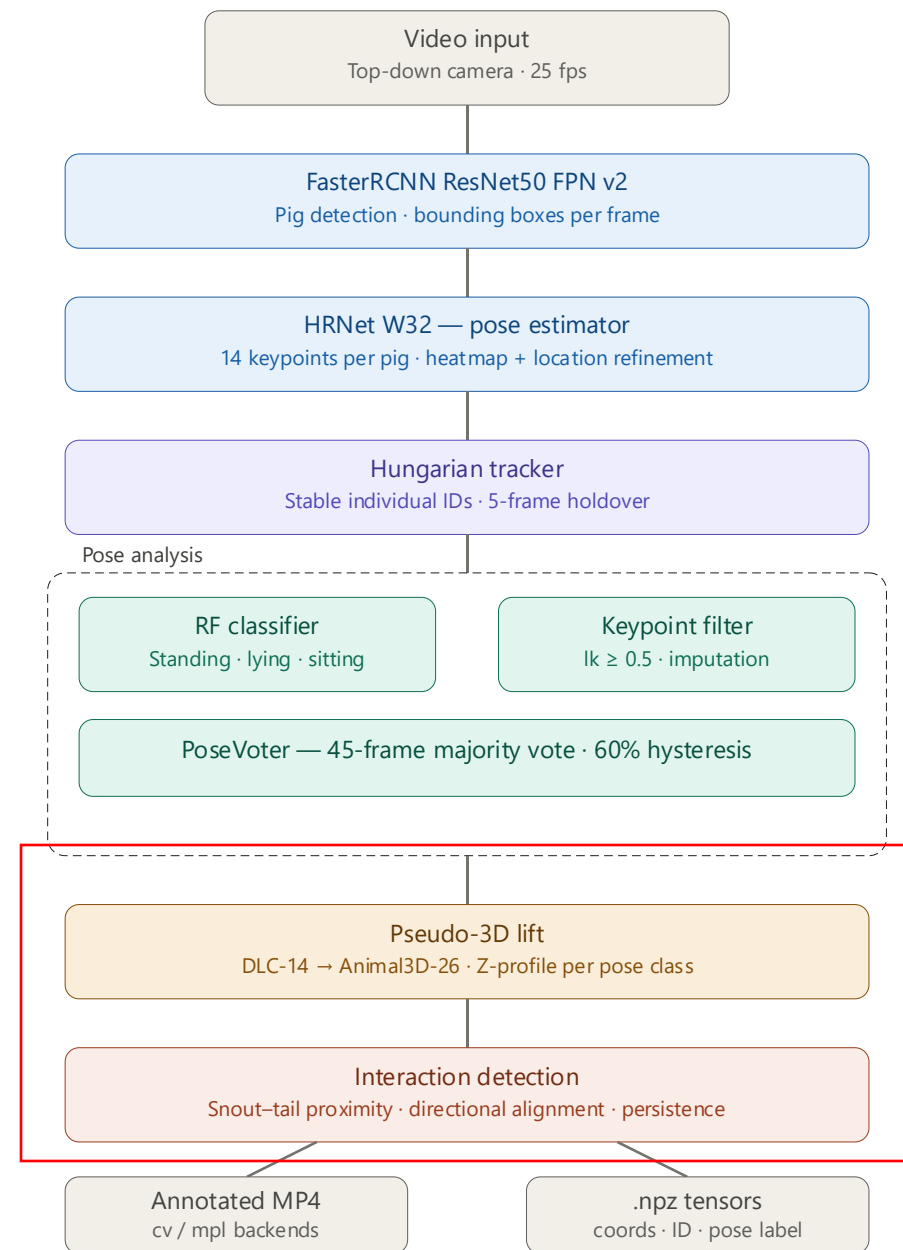
Animal3D-26 joint layout and keypoint mapping adapted from FMPose3D codebase

— Z-lifter concept

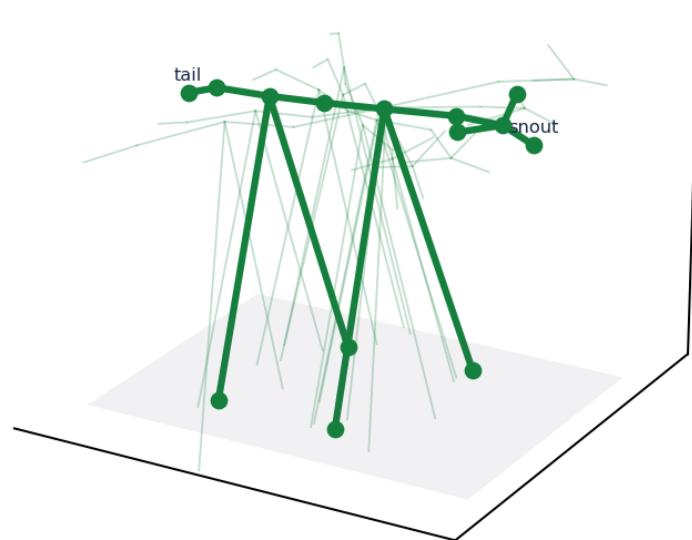
MLP 2D→3D inspired by FMPose3D flow-matching (100k synthetic poses · used as auxiliary validation)

— Integration path

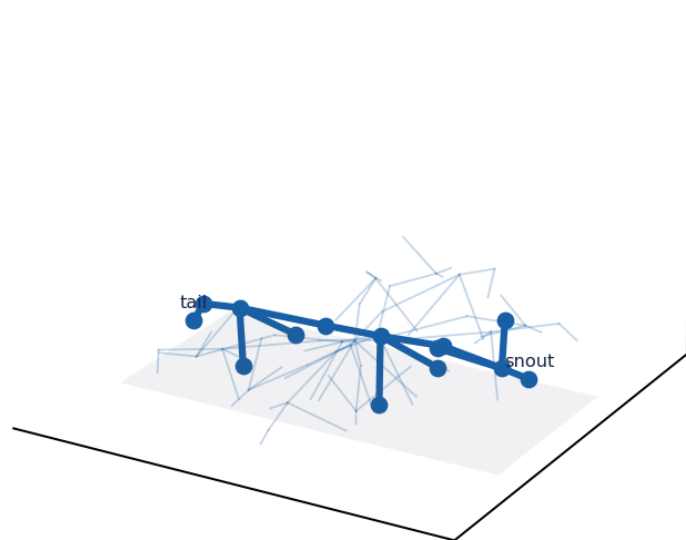
FMPose3D integrated into DLC in March 2026
→ natural upgrade to replace hand-crafted Z-profiles



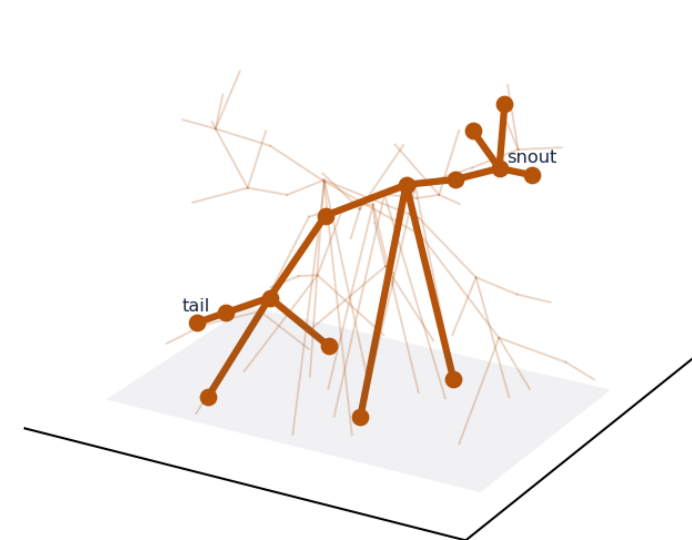
Standing



Lying



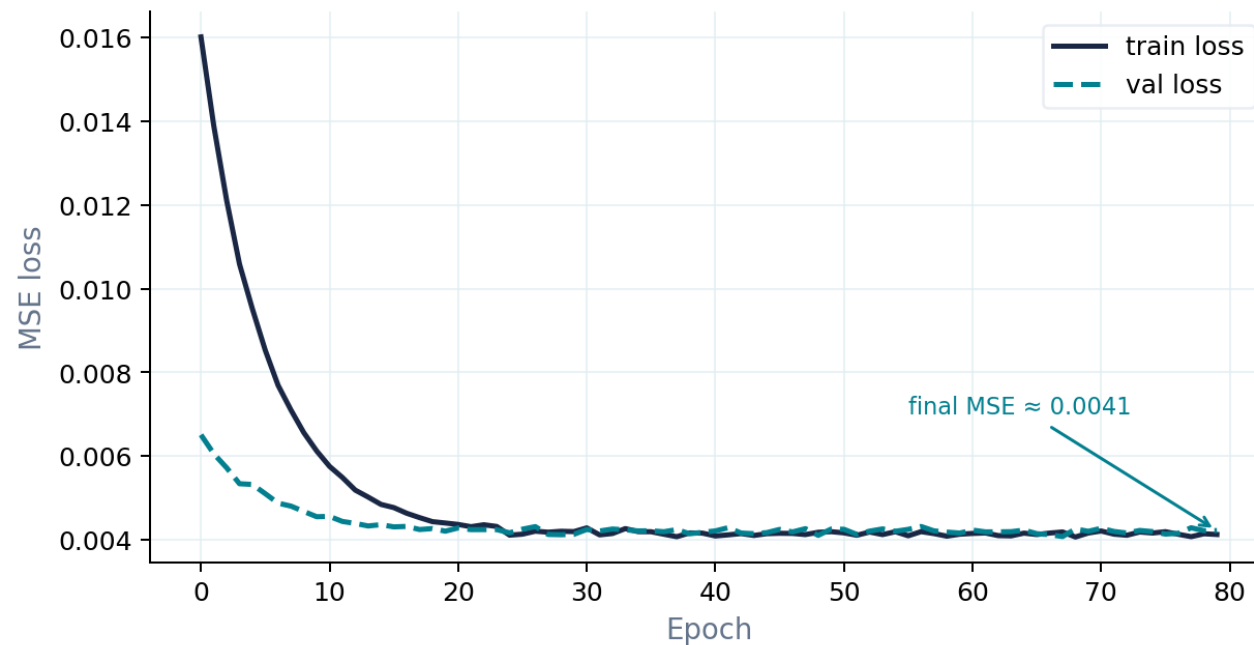
Sitting



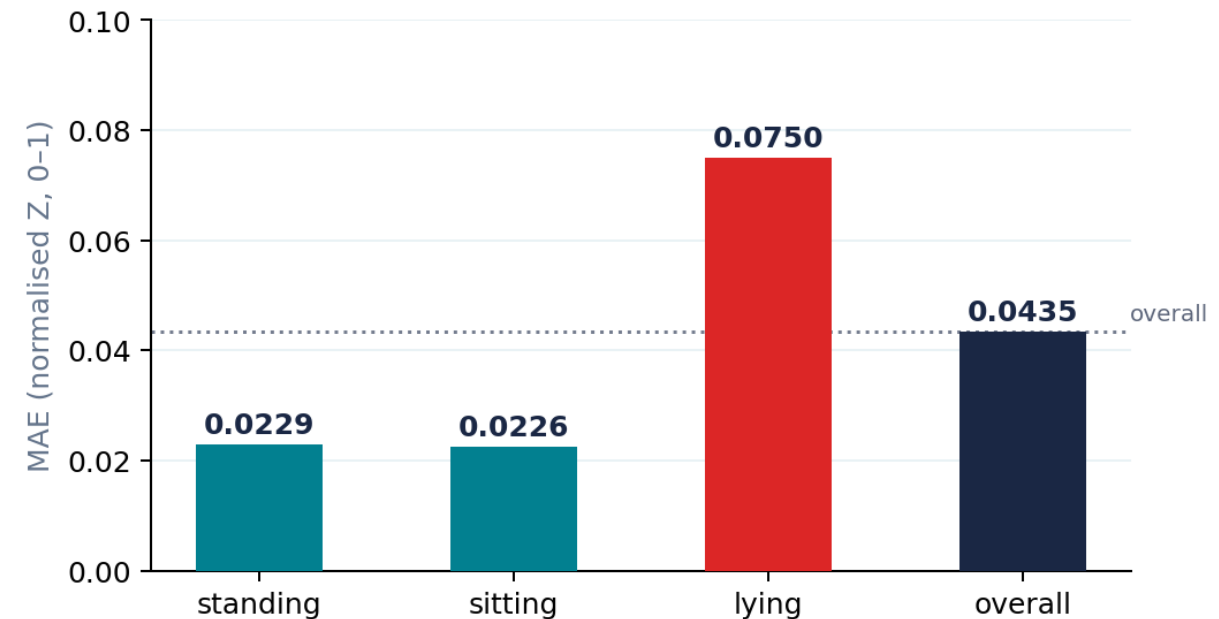
Reference 3D skeletons with augmented variants (5 samples each)

Synthetic data generation training

Z-lifter training curve | 80 epochs · Adam lr=1e-3

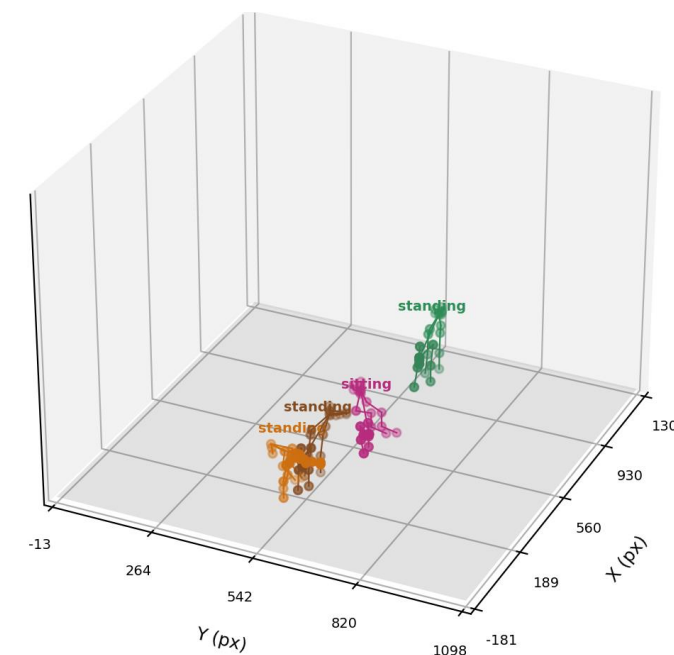
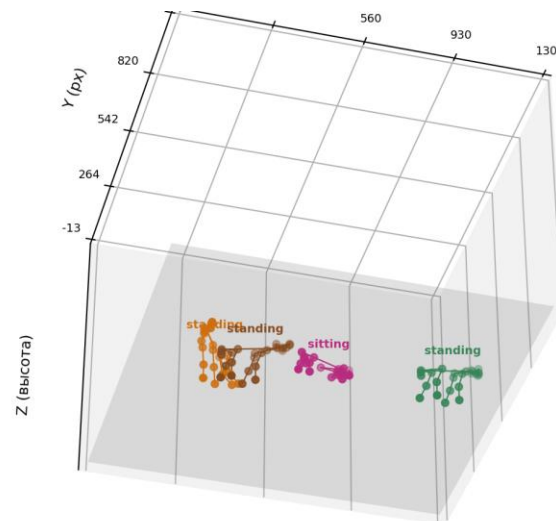
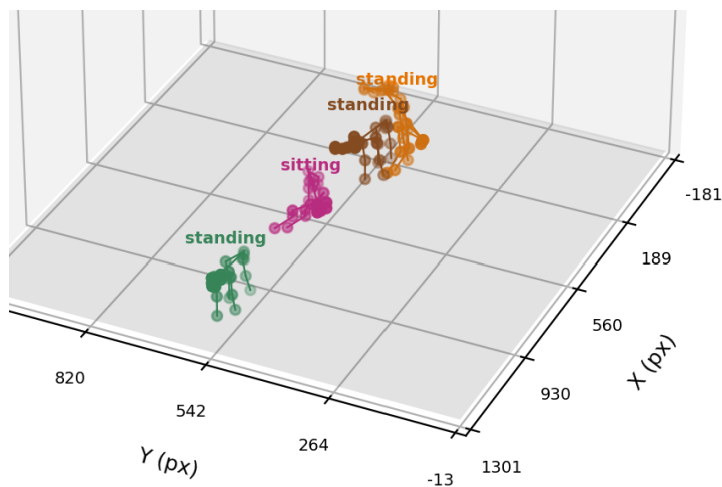
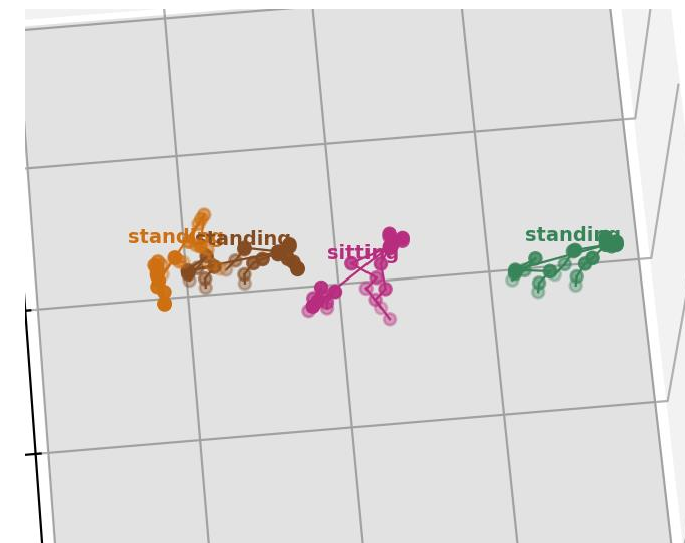
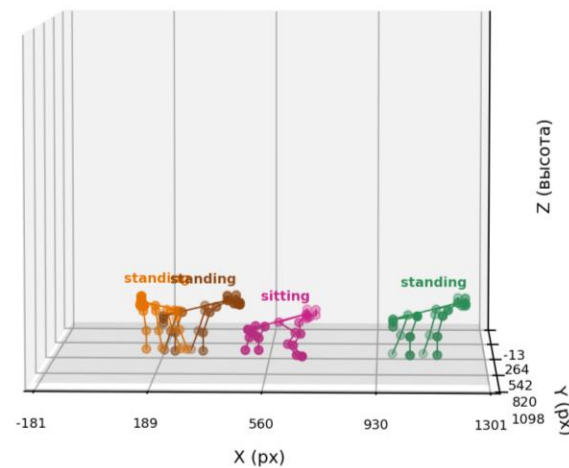


Z-lifter validation MAE by pose class



Interaction detection logic

Frame 4400 — 2D

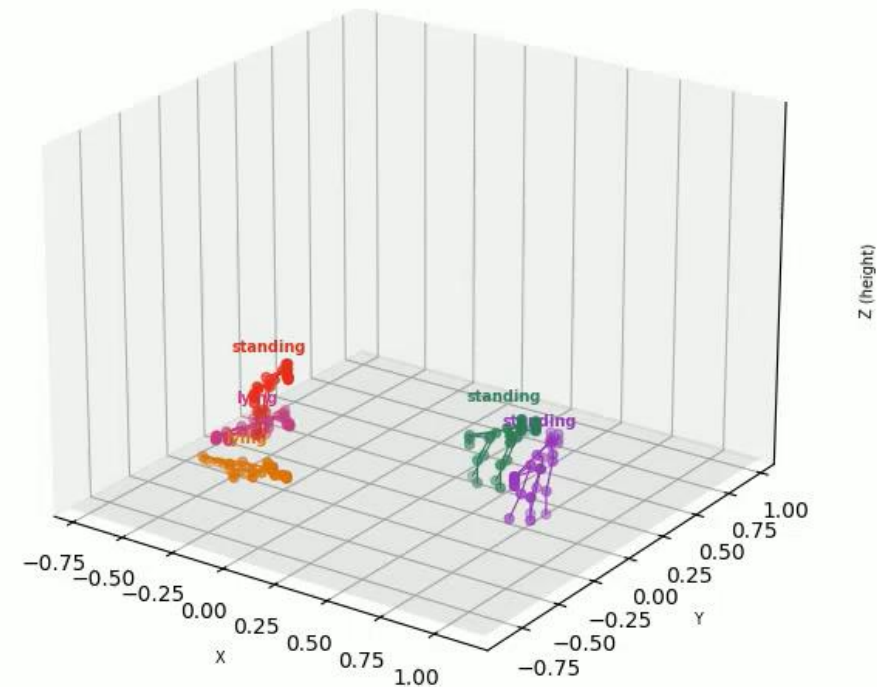


Qualitative results and render examples

Frame 14686 — 2D



Frame 14686 — Real 3D (FMPose3D)



Limitations and failure modes

Current limitations

— No ground truth for 3D

Z-profiles are hand-crafted approximations.
No stereo/depth sensor to validate joint heights.

— Interaction detector not validated

No annotated tail-biting episodes available.
Precision/recall cannot be formally evaluated.

— Single-pen generalisation

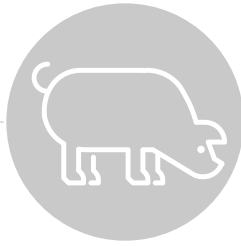
1,650 labels from one recording session.
Performance on other farms untested.

— Our OD classifier still need adjustment

Object detector performance remains
inconsistent; ID assignment errors persist across
frames despite Hungarian matching.

Summary

- We built a complete pipeline that turns raw overhead video into tracked pseudo-3D pig skeletons — running on a single camera with no extra hardware
- Our pose classifier learns to tell apart standing, lying and sitting pigs with 93% accuracy, just from the geometry of 14 body keypoints
- By linking Z coordinates to predicted pose, we recover enough depth to score snout-to-tail proximity in 3D — which is exactly what tail-biting detection needs
- The hardest remaining problem is identity: when pigs overlap, IDs still occasionally swap, and that is what we want to solve next



Thanks!

- Swiss Association for Animal Sciences (SAAS) fund for the promotion of young scientists
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- Department of Agronomy, Food, Natural resources, Animals and Environment
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