

ROBUST SCRATCHING BEHAVIOR DETECTION IN MICE FROM GENERIC FEATURES AND A LIGHTWEIGHT NEURAL NETWORK IN 100 FPS VIDEOS

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INTRODUCTION

- The network is integrated into EthoVisionXT.
- The features as described in Van Dam *et al.* (2013)^[1] were used for classification. This enables robust behavior recognition across datasets without the need to retrain.
- The performance has been cross-validated across setups.

DATA

- Videos of nine setups from two different laboratories.
- Each video is about 30 minutes long.
- Black mice on sawdust covering.
- Recorded with a Basler USB-3 IR camera (acA1920-155um) at 100 frames per second with a resolution of 1920 x 1080 pixels.

METHODS

- The network uses the features described in Van Dam *et al.* (2013)^[1]. These are derived from tracked body-point locations and optical flow. From this, a normalized 2D motion profile map of the animal movement over time is created. The final set of 169 features is the result of sliding window statistics and 1D log-Gabor responses in the temporal direction.
- Classification by an MLP having one hidden layer with 75 units.
- Trained with Focal Loss, L2-regularization and dropout.
- Hyperparameter optimization with the Optuna framework^[2] with 500 trials.

FIGURES & TABLE

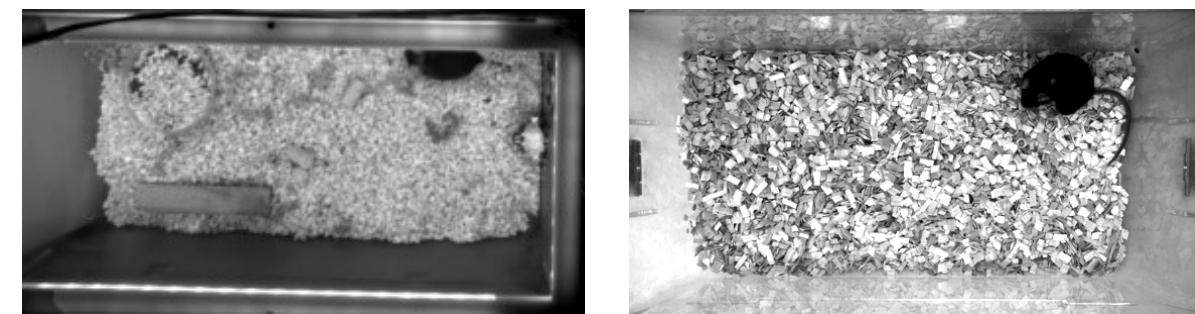


Figure 1: Stills from setup 3 (left) and setup 5 (right).

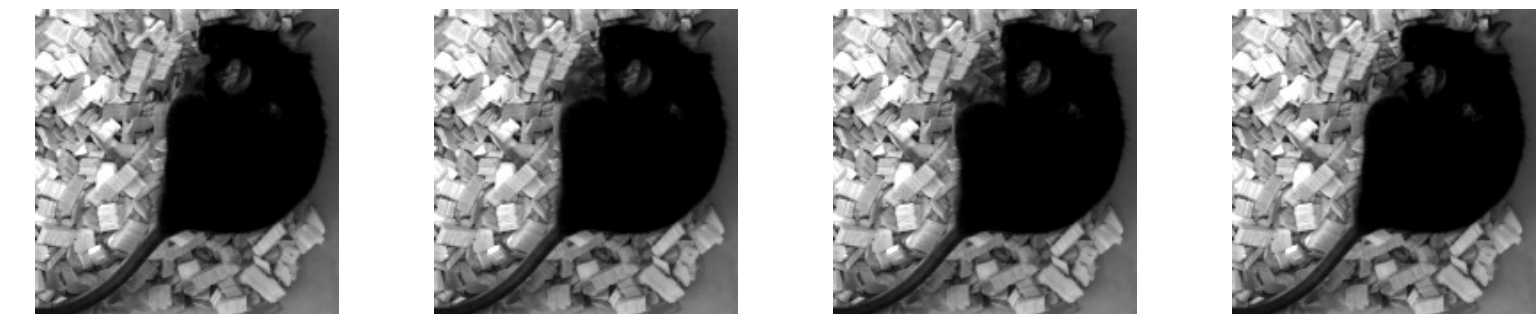


Figure 2: Four frames from a single scratching paw movement in setup 5.

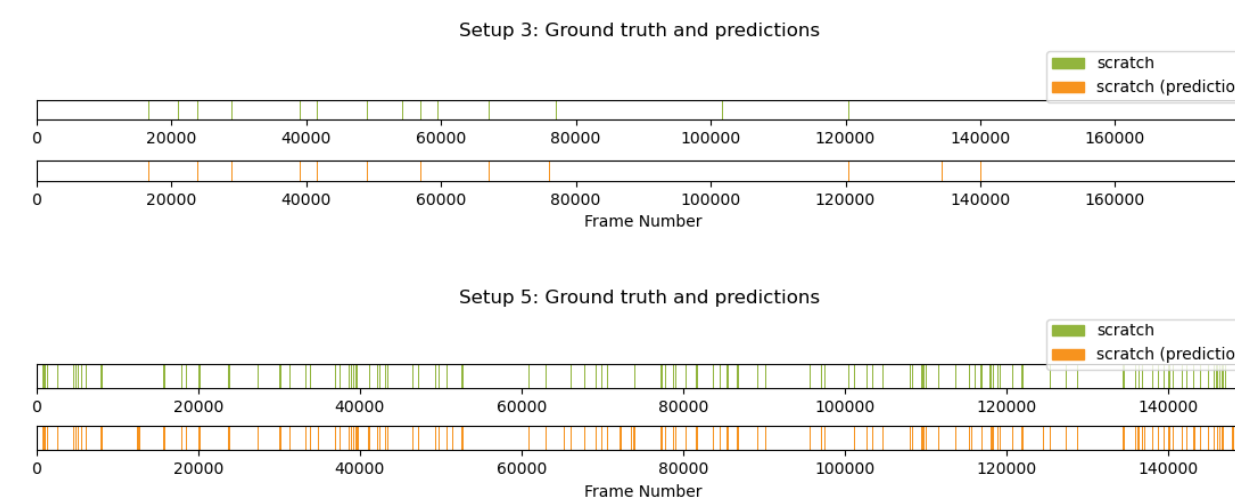


Figure 3: Model predictions compared to ground truth for setup 3 and setup 5.

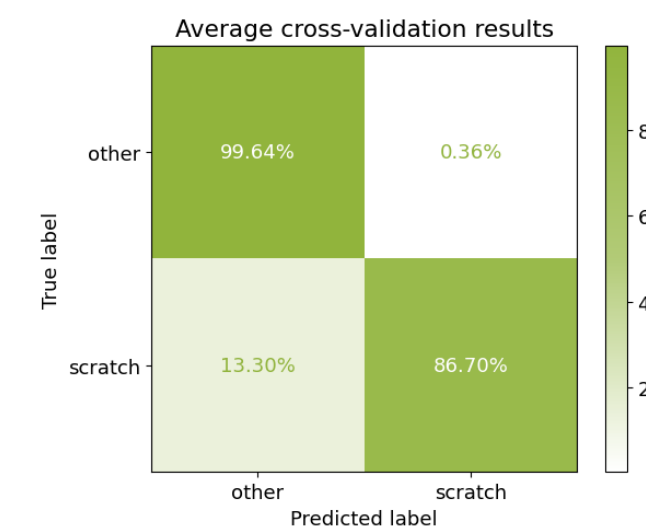


Figure 4: Confusion matrix with the results of repeated cross-validation.

Table 1: Results of repeated cross-validation. The number before the \pm sign indicates the mean and the one after the standard deviation. Setups 4 and 8 did not contain any scratching behavior.

Video	F1 score	Precision	Recall
Setup 1	0.72 \pm 0.00	0.80 \pm 0.02	0.67 \pm 0.01
Setup 2	0.76 \pm 0.01	0.78 \pm 0.02	0.75 \pm 0.01
Setup 3	0.81 \pm 0.01	0.83 \pm 0.01	0.80 \pm 0.01
Setup 4	-	-	-
Setup 5	0.91 \pm 0.00	0.90 \pm 0.01	0.92 \pm 0.01
Setup 6	0.90 \pm 0.00	0.91 \pm 0.01	0.89 \pm 0.01
Setup 7	0.67 \pm 0.02	0.72 \pm 0.04	0.62 \pm 0.02
Setup 8	-	-	-
Setup 9	0.77 \pm 0.00	0.79 \pm 0.02	0.76 \pm 0.01
Total	0.87 \pm 0.00	0.88 \pm 0.01	0.87 \pm 0.01

RESULTS

- High overall F1 score, precision and recall (Table 1). Low overall variance.
- The network performs well despite a significant data imbalance.
- Some setups are harder for the network than others.

REFERENCES

1. Van Dam, E.A., Van der Harst, E., Ter Braak, C.J.F., Tegelenbosch, R.A.J., Spruijt, B.M., and Noldus, L.P.J.J., (2013). An automated system for the recognition of various specific rat behaviours. *Journal of Neuroscience Methods* **218(2)**, 214–224.
2. Akiba, T., Sano, S., Yanase, T., Ohta, T., & Koyama, M. (2019, July). *Optuna: A next-generation hyperparameter optimization framework*. In Proceedings of the 25th ACM SIGKDD international conference on knowledge discovery & data mining (pp. 2623–2631).



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