Comparison of Methods For Analyzing Mouse Locomotion With Free Software

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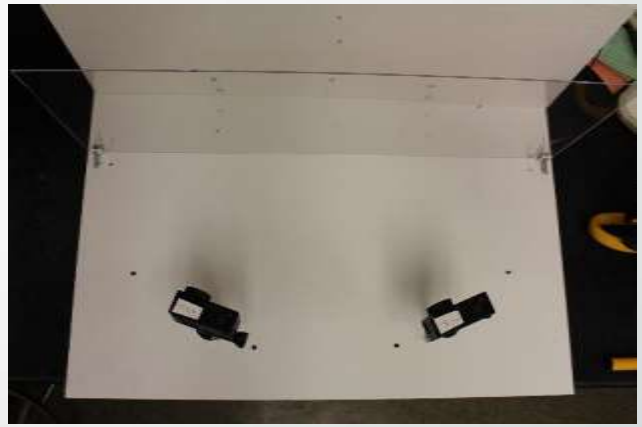
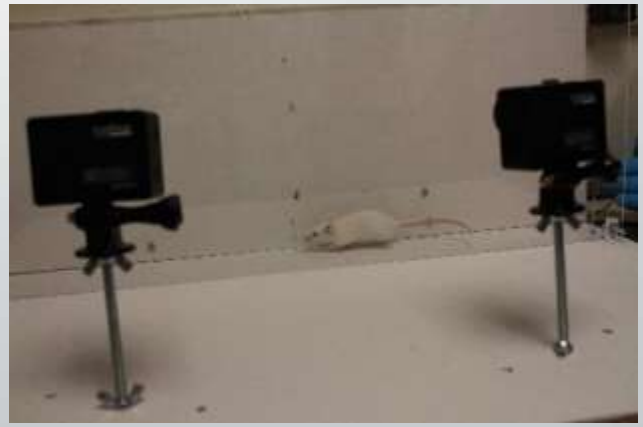
Objectives

- Evaluate GoPro cameras as a video recording device for small animal locomotion.
- Compare relative error between manual digitizing and deep learning.
- Determine repeatability of locomotor characteristics across trials.
- Determine the effects of one week of wheel exercise on stride characteristics.

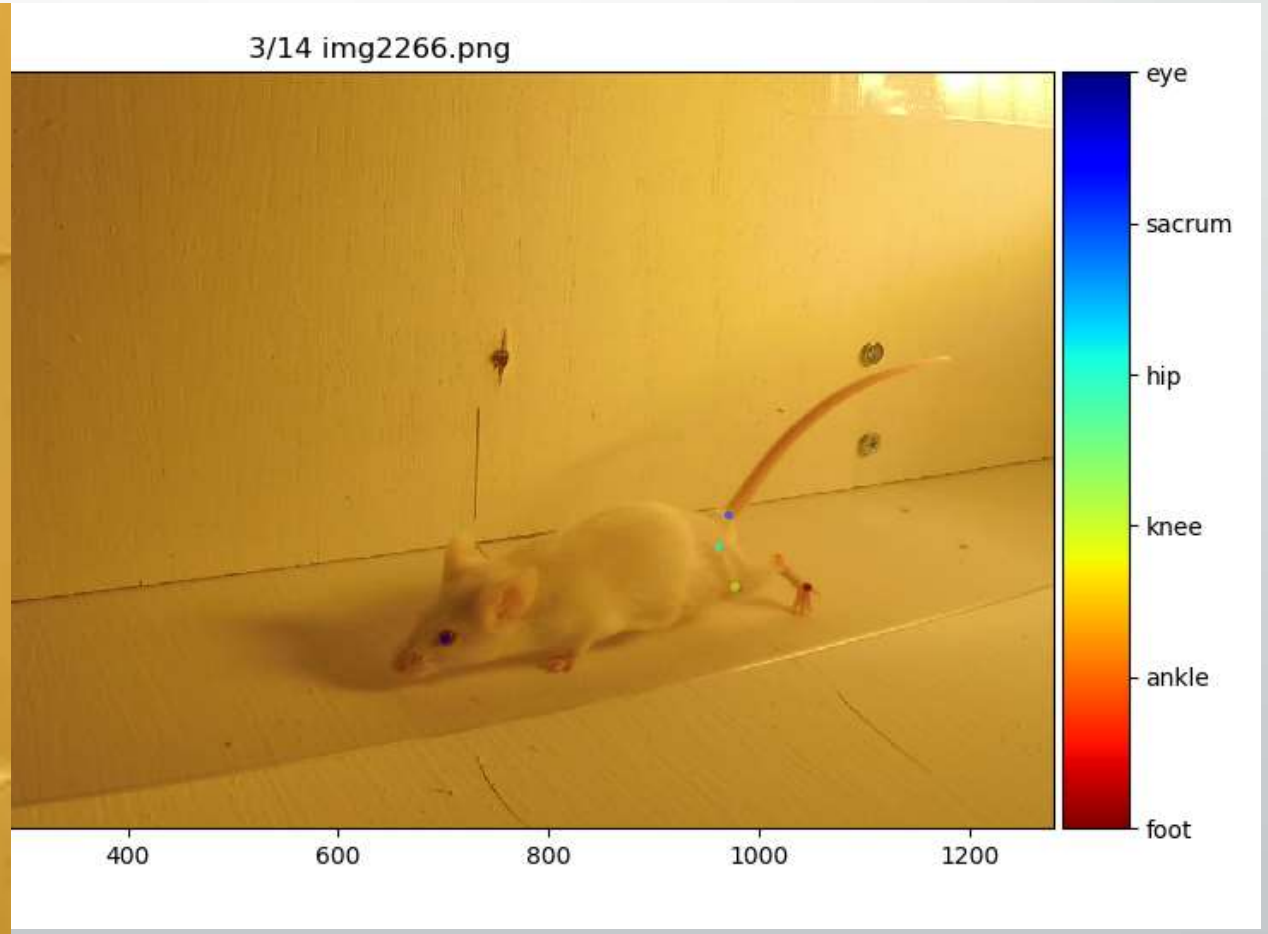




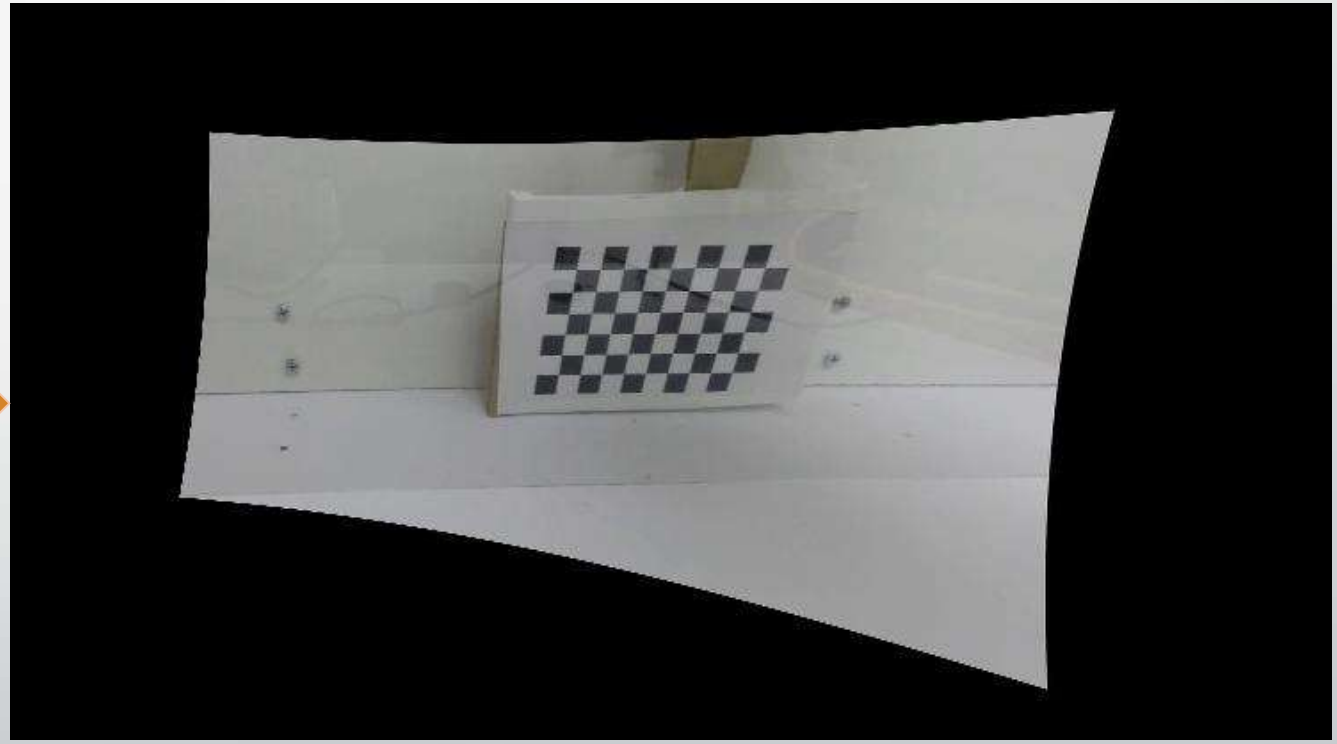
Experimental Design

- Nine mice were filmed prior to and after one week of voluntary wheel locomotion.
- We filmed 174 trials using two GoPro cameras operating at 120 FPS.
  - ~200,000 frames of video
- Step 1: Comparison of manual digitizing to Deep Learning using DeepLabCut
  - Digitize only a few hundred frames as training data

Training Data

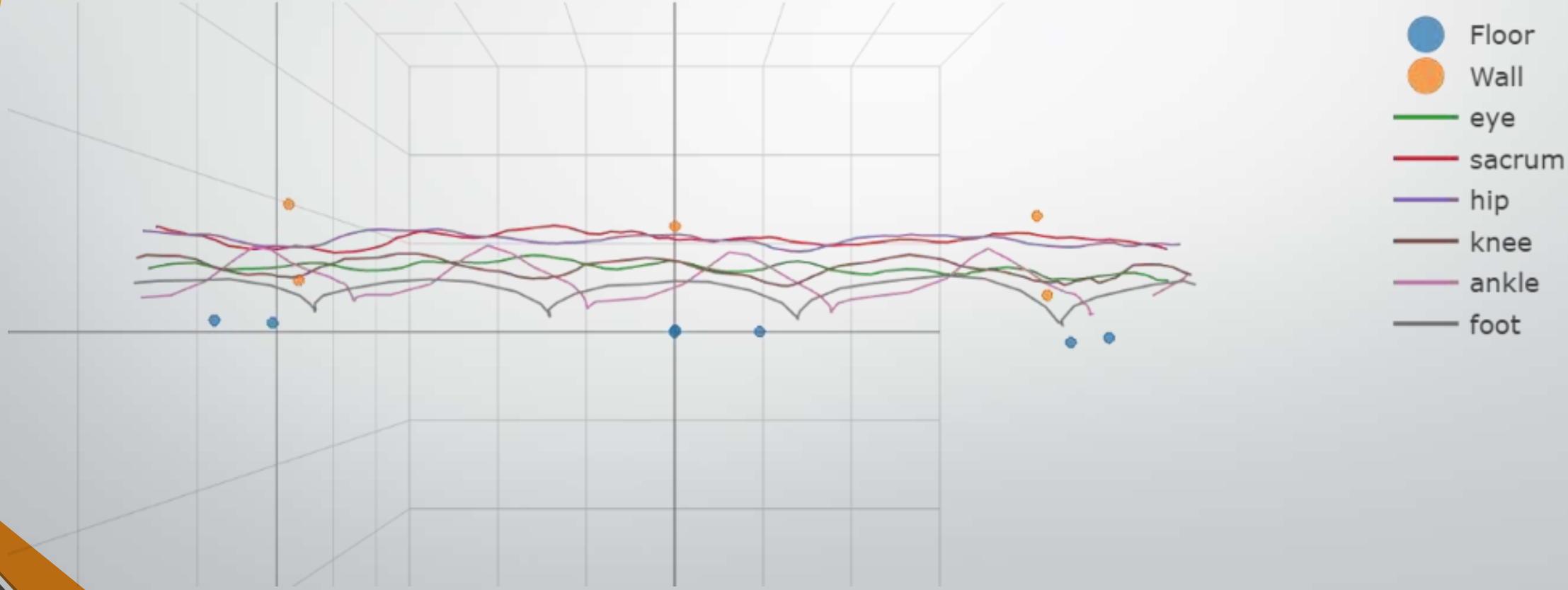


GoPro Image Dewarping

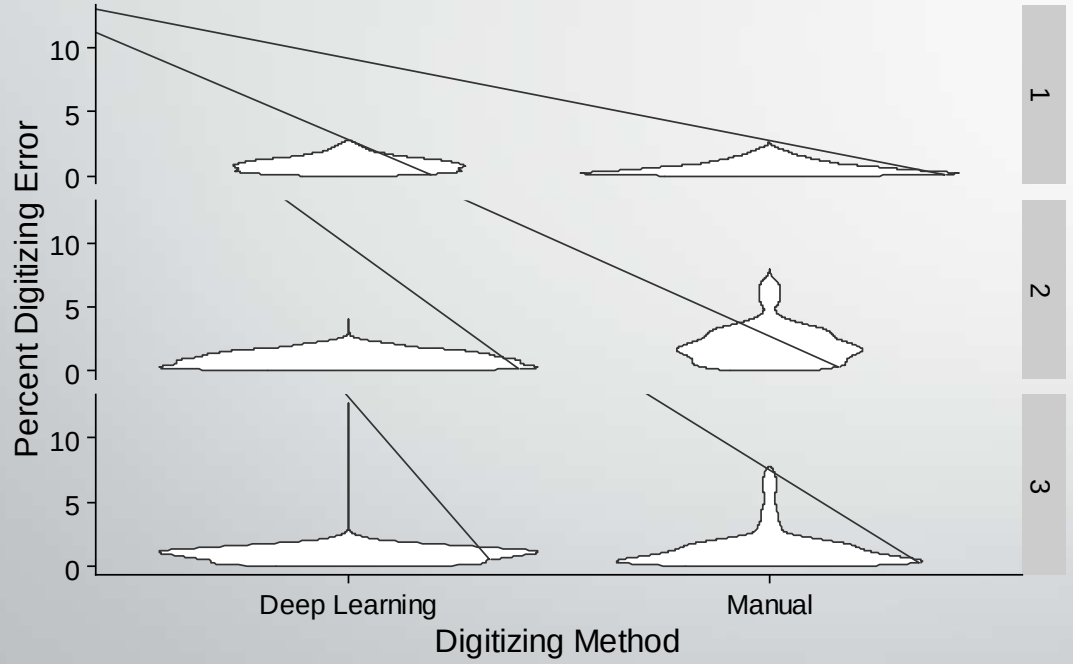


Landmark Tracking

3D Reconstruction



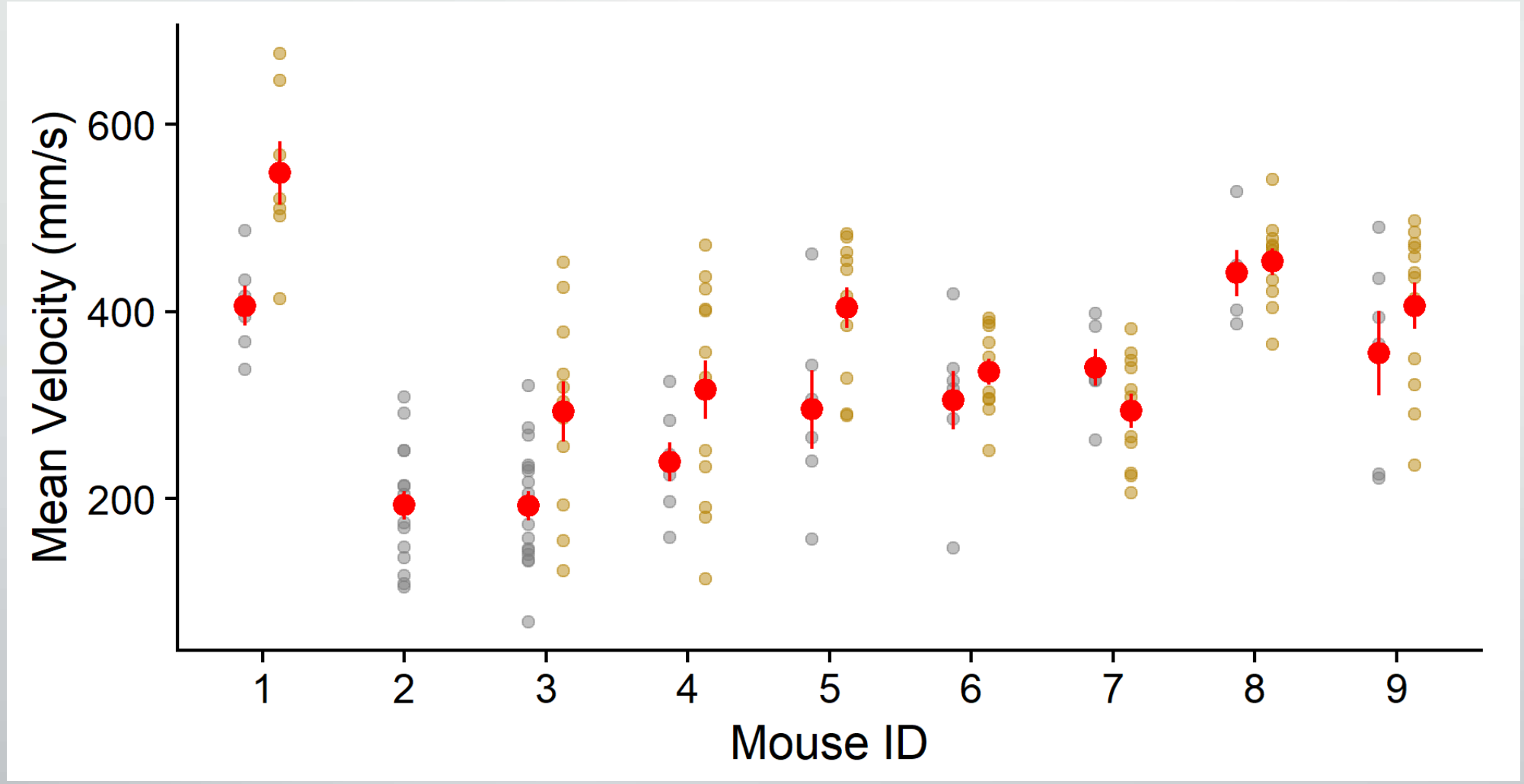
Digitizing Error



- Percent digitizing error was estimated for a known length for 3 separate trials
- Compared deep learning (left) to manual digitizing (right)
- Error was not statistically different (P = 0.35) between methods
- Deep Learning had lower mean absolute error (0.9% vs. 1.4%)
  - Much lower time cost

Repeatability of Stride Parameters

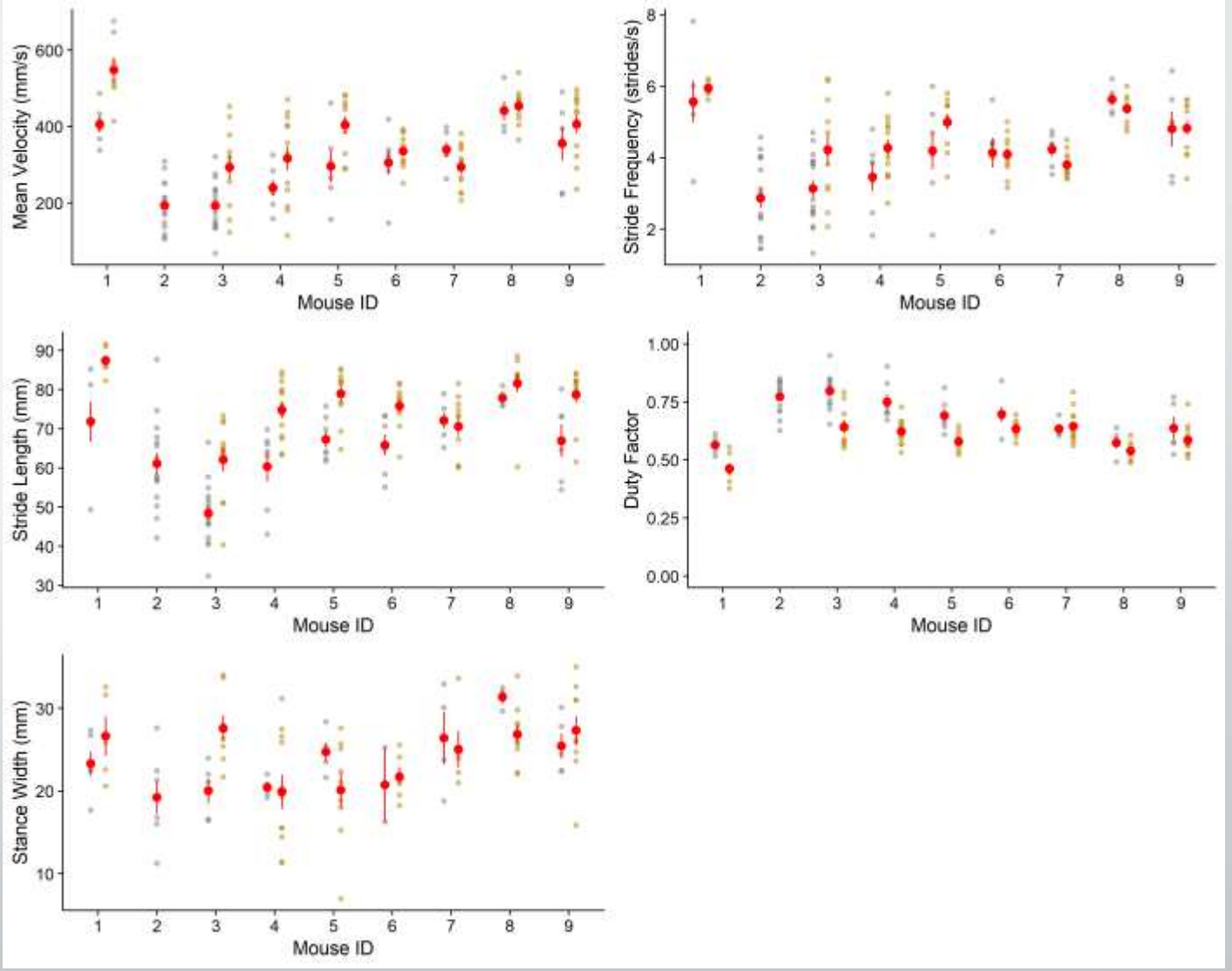
Trait	ICC Before	ICC After
Mean Velocity (mm/s)	0.632	0.576
Stride Frequency (strides/s)	0.481	0.499
Stride Length (mm)	0.500	0.553
Duty Factor	0.592	0.548
Stance Width (mm)	0.433	0.281



Mean Difference: 62.5 mm/s (95% interval = 37.7-91.6)

Stride Characteristics

Trait	Mean Difference (After – Before)	95% Interval
Mean Velocity (mm/s)	63.67	37.48-90.8
Stride Frequency (strides/s)	0.43	0.11-0.73
Stride Length (mm)	10.15	7.89-13.25
Duty Factor	-0.09	(-0.11)-(-0.06)
Stance Width (mm)	0.97	(-1.46)-2.79



Conclusions

- Consumer grade hardware and free software is a viable solution to the challenges of studying locomotor kinematics in mice.
- Inexpensive hardware coupled with deep learning yields both increases in video throughput and marker accuracy.
- We found significant locomotor differences after only one week of wheel acclimation
- Wheel activity is potentially a non-invasive approach to altering gait kinematics in mice.

Acknowledgments

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