Motion Biomarker

Continuously Monitor Motion In Real Time

INTRODUCTION

Observation and quantification of freely moving animals is a powerful tool for understanding the effects of genetic, environmental, and therapeutic manipulations on physiology and behavior (1,2). Numerous studies have demonstrated that animal strain, environment, handling, pharmacological agents, disease conditions, aging, stress, and altered neurological states can impact quantifiable aspects of animal activity (2-7). Measurement of overall activity, as well as specific subtypes of activity such as circadian rhythms and particular aspects of locomotion, can be used as an integrated readout for tracking disease progression.

VIUM MOTION BIOMARKER

Vium's automated sensors and computer-vision algorithms provide continuous observation using HD video captured at 24 frames per second (Figure 1). Our proprietary algorithms discriminate and quantify animal behaviors including spontaneous wheel-running, breathing rate, and circadian activity.

BIOMARKER VALIDATION

Our platform's ability to accurately measure motion across a range of at speeds up to 5 cm/s was validated using a speed-controlled visual target placed within Vium Smart Housing.

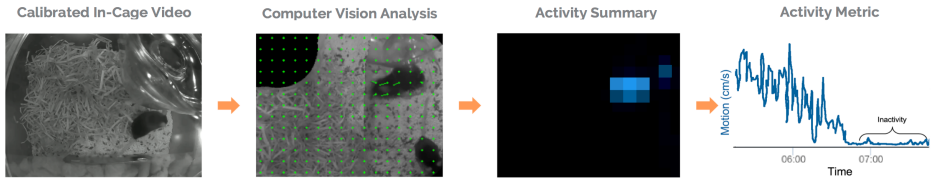


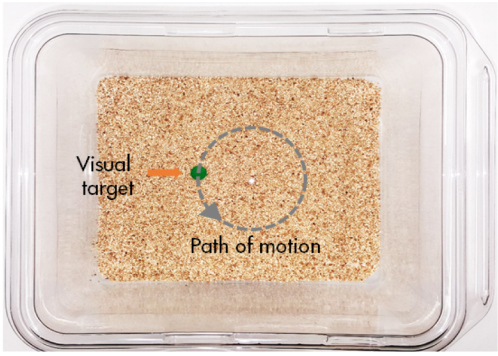
Figure 1: Activity is generated from HD video using computer vision algorithms.

Preclinical Researchers Use This Biomarker to:

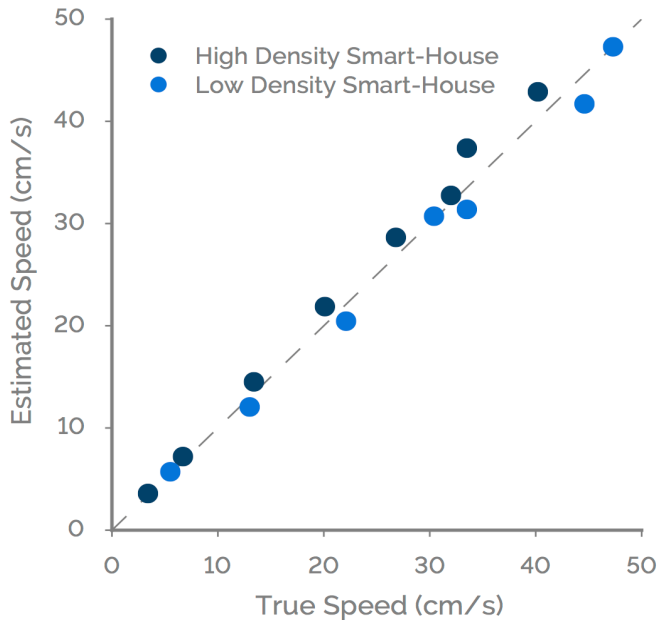
- **Continuously monitor animal activity in near-real time**
- **Conduct short-term studies to track acute effects of therapeutic interventions**
- **Conduct long-term studies to monitor delayed and/or chronic treatment effects**
- **Document the natural history of animal disease models**

METHODS AND RESULTS

A visual target, placed within a standard Vium Smart House, was set to move at physiologically relevant speeds ranging from 5 – 50 cm/s. Raw video was transformed into cage-floor coordinates, and rendered into velocity measurements via computer vision analysis (8). The speed estimated using computer vision video analysis was compared to actual speed of the visual target in both high density (mouse size) and low density (rat or mouse) Smart Houses (Fig. 2). Confidence interval is based on mean and standard deviation of the percentage error.



Example visual target used to validate speed of motion.



Statistics	High density	Low Density
R^2	0.998	0.997
RMS error	7.6%	5.4%
95% CI	2% to 12%	-11% to 5%

Figure 2: Estimated speed generated from the algorithm is highly correlated to the true speed of an object moving at a known speed.

DISCUSSION

Our validated Motion Biomarker is used to detect changes in overall animal activity, and also to derive biomarkers to assess disease progression in a variety of rodent models, such as Rheumatoid Arthritis, potentially replacing the need for more laborious and less reliable conventional measurements. Detection of these features of animal activity could be used as direct readouts of therapeutic efficacy in relevant models, as a source of insights into novel or unexpected drug effects, as an indicator of animal health or moribund status, and/or as an early indication of potential safety signals.

REFERENCES

1. Irwin S. Comprehensive observational assessment: Ia. A systematic, quantitative procedure for assessing the behavioral and physiologic state of the mouse. Psychopharmacologia. 1968 Sep 20;13(3):222-57.
2. Crawley JN. Behavioral phenotyping strategies for mutant mice. Neuron. 2008 Mar 27;57(6):809-18
3. Crabbe JC, Wahlsten D, Dudek BC. Genetics of mouse behavior: interactions with laboratory environment. Science. 1999 Jun 4;284(5420):1670-2.
4. Chesler EJ, Wilson SG, Lariviere WR, Rodriguez-Zas SL, Mogil JS. Influences of laboratory environment on behavior. Nat Neurosci. 2002 Nov;5(11):1101-2.
5. Chesler EJ, Wilson SG, Lariviere WR, Rodriguez-Zas SL, Mogil JS. Identification and ranking of genetic and laboratory environment factors influencing a behavioral trait, thermal nociception, via computational analysis of a large data archive. Neurosci Biobehav Rev. 2002 Dec;26(8):907-23.
6. Wahlsten D, Bachmanov A, Finn DA, Crabbe JC. Stability of inbred mouse strain differences in behavior and brain size between laboratories and across decades. Proc Natl Acad Sci U S A. 2006 Oct 31;103(44):16364-9.
7. Gallagher M, Rapp PR. The use of animal models to study the effects of aging on cognition. Annu Rev Psychol. 1997;48:339-70.