# A Novel Automatic Method to Track the Body and Paws of Running Mice in High Speed Video [1]

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Examining locomotion has improved our basic understanding of motor control and aided in treating motor impairment. Mice are a premier model of human disease and increasingly the model system of choice for basic neuroscience. High frame rates (higher than 150 Hz) are needed to quantify the kinematics of running mice, due to their high stride frequency (up to 10 Hz). Thus manual tracking, especially for multiple markers, becomes time-consuming and impossible for large sample sizes. Therefore, an automated method is necessary. Several methods have been used to automatically or semi-automatically track mice, including commercially available systems (Digigait [1, 2], Motorater, Noldus Catwalk [3, 4]). These systems can be typically prohibitively expensive, and may only provide information about paws during the stand phase. In research and industry approaches to tracking mice have frequently relied on shaving fur and then drawing markers on the skin for subsequent tracking raw video [5], or on the attachment of retroreflective markers, and the use of optical motion capture systems. These methods have the drawback of requiring anesthesia and multiple handlings applications of markers, and the problem of animal removing the attached markers. Here, we develop methods to track and label the body and paws directly from high speed color video, without shaving fur or attaching markers. We analyse data from the C57BL/6 mouse, because it is the most widely used strain in basic research and biomedicine.

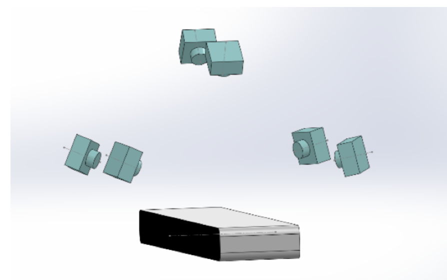

Figure 1. Cameras and belt setup.

In overview, our method first finds the centroid of the mouse body, and then uses the body location in combination with color and temporal information across frames to determine the front and hind paw locations. We utilize an automated, computer vision feedback driven treadmill system [6] to gather video frames from four color cameras placed at the sides of the treadmill (Figure 1). Video data were gathered at 250 frames per second with a resolution of 2048×700 pixels. The mouse body is detected through analysis of the average intensity of the mouse as compared with the treadmill and background after background subtraction. Candidate paws are then identified through color segmentation in HSV-transformed frames. Finally, we distinguish between candidate paw positions by comparison across time, examining frames before and after that under consideration, and select as true paw locations. The proposed method was validated in N 1000 frame (4 second) video sequences from a mouse. The detection accuracy was 98.3% for the front paw and 100% for the hind paw. This study shows the feasibility of the method; future work will be expanding the test sample for further videos from different mice.

(a) (b) (c) (d)

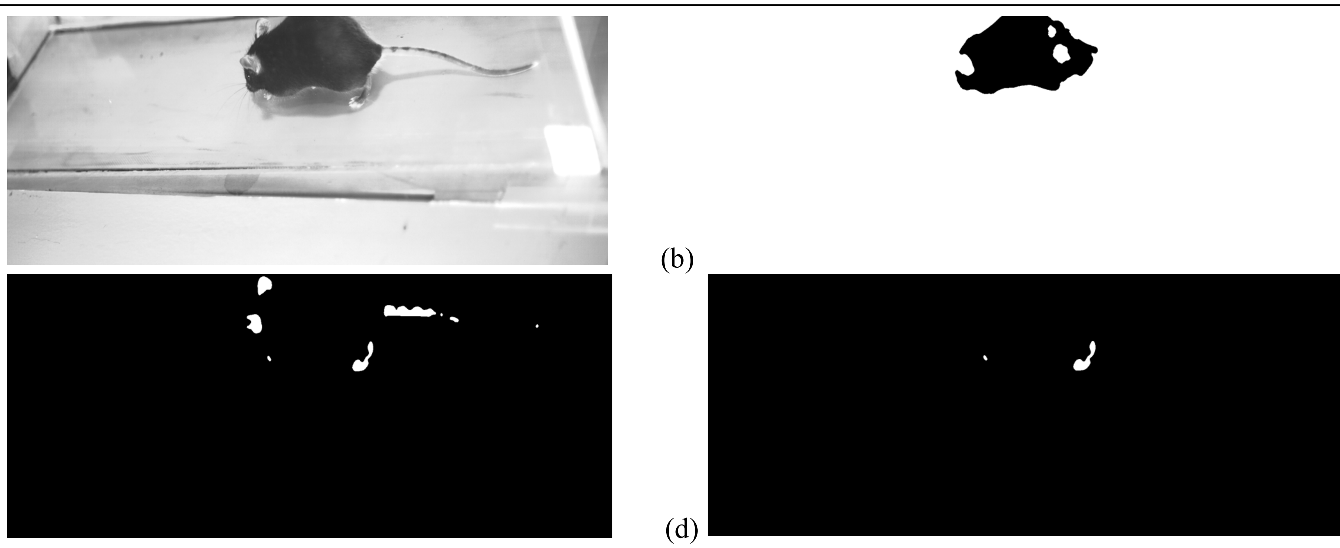

Figure 2. A sample gray scaled frame has been illustrated in (a) and respectively mouse body, suspected paw objects, and segmented paws are illustrated in (b), (c), and (d) .

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[1] C. W. Dorman, H. E. Krug, S. P. Frizelle, S. Funkenbusch, and M. L. Mahowald, "A comparison of DigiGait™ and TreadScan™ imaging systems: assessment of pain using gait analysis in murine monoarthritis," *Journal of Pain Research,* vol. 7, pp. 25-35, 2014.

[2] K. K. Gadalla, P. D. Ross, J. S. Riddell, M. E. Bailey, and S. R. Cobb, "Gait analysis in a Mecp2 knockout mouse model of Rett syndrome reveals early-onset and progressive motor deficits," *PLoS One,* vol. 9, p. e112889, 2014.

[3] P. Huehnchen, W. Boehmerle, and M. Endres, "Assessment of paclitaxel induced sensory polyneuropathy with "Catwalk" automated gait analysis in mice," *PLoS One,* vol. 8, p. e76772, 2013.

[4] S. S. Parvathy and W. Masocha, "Gait analysis of C57BL/6 mice with complete Freund's adjuvant-induced arthritis using the CatWalk system," *Bmc Musculoskeletal Disorders,* vol. 14, Jan 8 2013.

[5] J. B. Mignardot, T. Deschamps, E. Barrey, B. Auvinet, G. Berrut, C. Cornu*, et al.*, "Gait disturbances as specific predictive markers of the first fall onset in elderly people: a two-year prospective observational study," *Frontiers in Aging Neuroscience,* vol. 6, Feb 25 2014.

[6] A. J. Spence, G. Nicholson-Thomas, and R. Lampe, "Closing the loop in legged neuromechanics: an open-source computer vision controlled treadmill," *J Neurosci Methods,* vol. 215, pp. 164-9, May 15 2013.