# Terrain Following and Applications: *Caenorhabditis elegans* Swims along the Floor using a Bump and Undulate Strategy - Supplemental Information

Jinzhou Yuan[1], Hungtang Ko[1], David M. Raizen[2], and Haim H. Bau[1]

[1]Department of Mechanical Engineering and Applied Mechanics, and [2]Department of Neurology, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA 19104
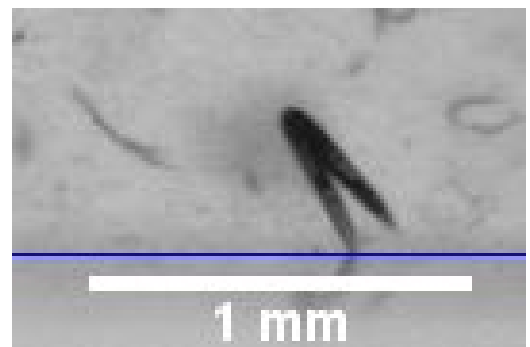
Videos

Video S1: Nematode Settling. The video monitors the sedimentation of wild-type animals in the vertical plane of a cuvette and the interaction of the animals, once settled, with the bottom surface. Recording speed: 12 fps. The blue line denotes the location of the bottom surface. Play speed: Real-time.
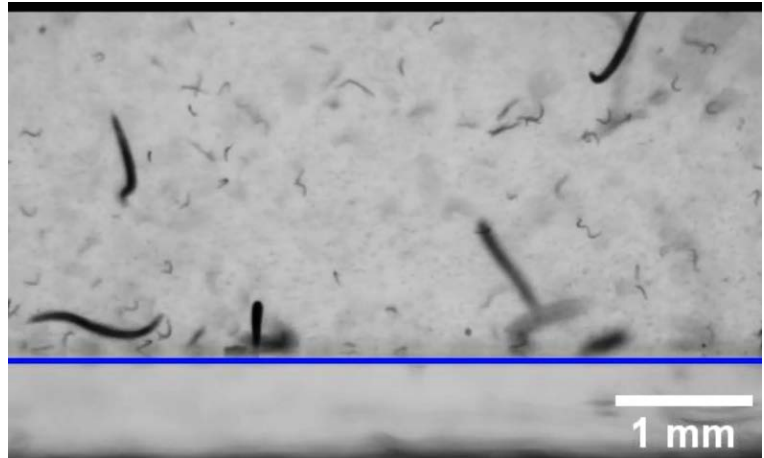
Video S2: Nematode Interaction with Bottom Surface (Side View). A young adult *C. elegans* stay suspended, once settled to the vessel's bottom, by colliding with the bottom surface. Side view. The animal swims from right to left. The video was recorded at 12 fps and the play speed is 1/3X real-time.
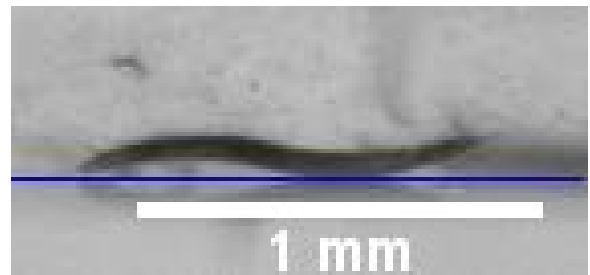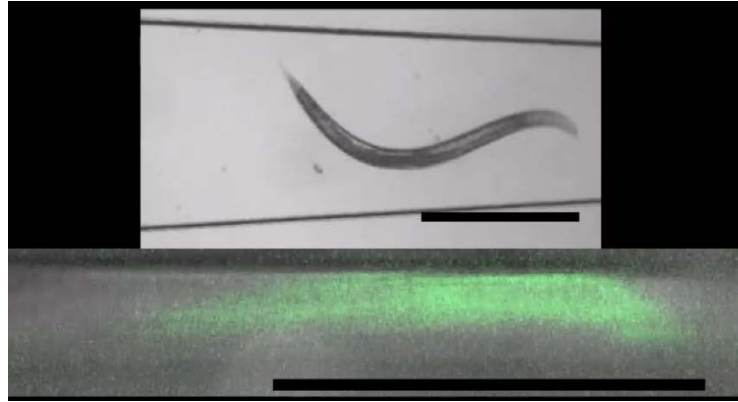

Video S3: Nematode Interaction with Bottom Surface (Rearview). A young adult *C. elegans* stay suspended, once settled to the vessel's bottom, by colliding with the bottom surface (rearview). The animal swims away from the viewer. The video was recorded at 12 fps and the play speed is 1/3X real--time.

Video S4: Nematode in a Conduit (Top and Side Views). A wild-type *C. elegans* swimming in a conduit while interacting with the conduit's floor and ceiling. When looking from above, the animal appears to swim entirely suspended in the liquid. The side view reveals that the animal avoids settling to the conduit's bottom by occasionally colliding with the floor. In fact the animal does not swim in the horizontal plane, but in a plane inclined with respect to the horizontal plane at a small angle ~8°. Scale bars: 500 µm. Play speed: 0.25X real-time.

Video S5: **Nematode Ratchet.** The video features the motion of wild type, young adult *C. elegans* in the control loop with the smooth bottom (left) and in the patterned ratchet (right). Recording speed: 1 fps. Play speed: 100X real-time. The animals swim randomly clockwise and counter clockwise in the control loop, but only clockwise in the ratchet.
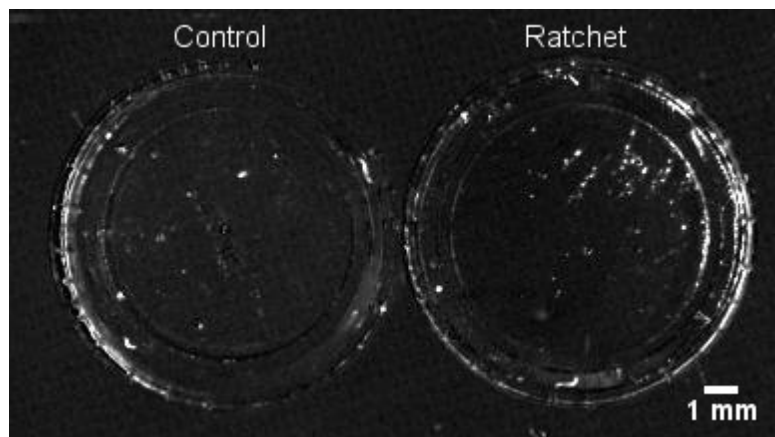
Video S6: **Nematode Sorter**. The video features the motion of *C. elegans* in the sorter with the inclined separation conduit. The sorter is depicted schematically in Fig. 6a. The sorter comprises a holding chamber, an inclined conduit, and a collection chamber. The conduit extends above the collection chamber. The edge of the collection chamber appears fuzzy in the
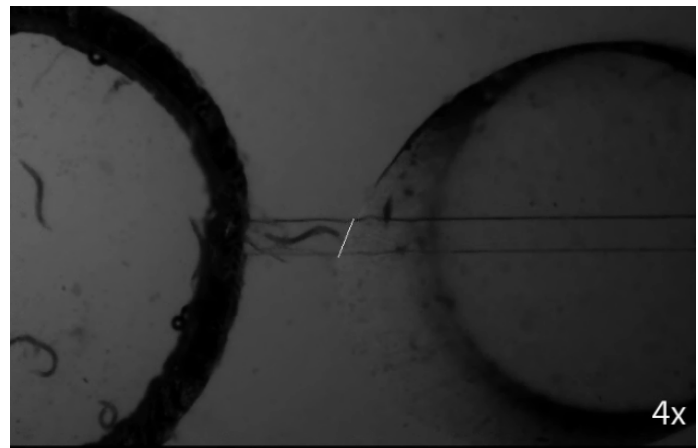
video because the chamber is tapered and tilted with respect to the vertical direction. The location where the conduit enters the collection chamber is indicated with a white line. The holding chamber (on the left) holds a mixture of animals of types A and L. Every once in a while an animal leaves the holding chamber, enters the inclined separation conduit, travels to the collection chamber, and sediments to the bottom of the collection chamber. Play speed: 4X real-time.
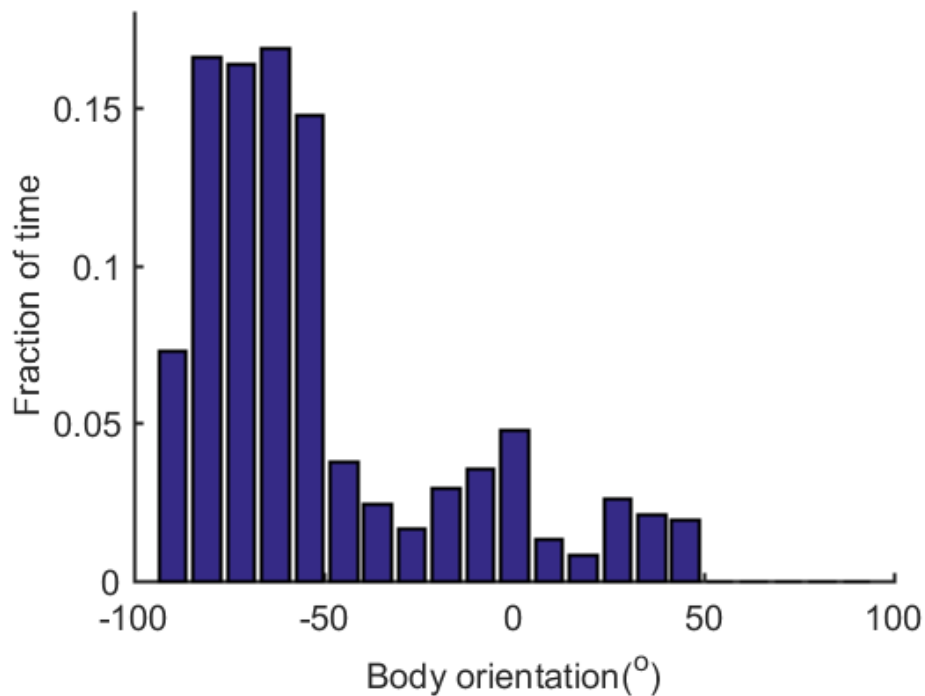
S1. Observations of Nematodes Settling

Fig. S1: A histogram of animals' body orientation: The fraction of time during which animals propelled in the direction between $\phi-\Delta\phi/2$ and $\phi+\Delta\phi/2$. ϕ is the angle between the animal's direction of motion and the horizontal plane. The angle $\phi=-90$ corresponds to the direction of the gravity vector. Only animals that were actively swimming (N=14) were included in this analysis.
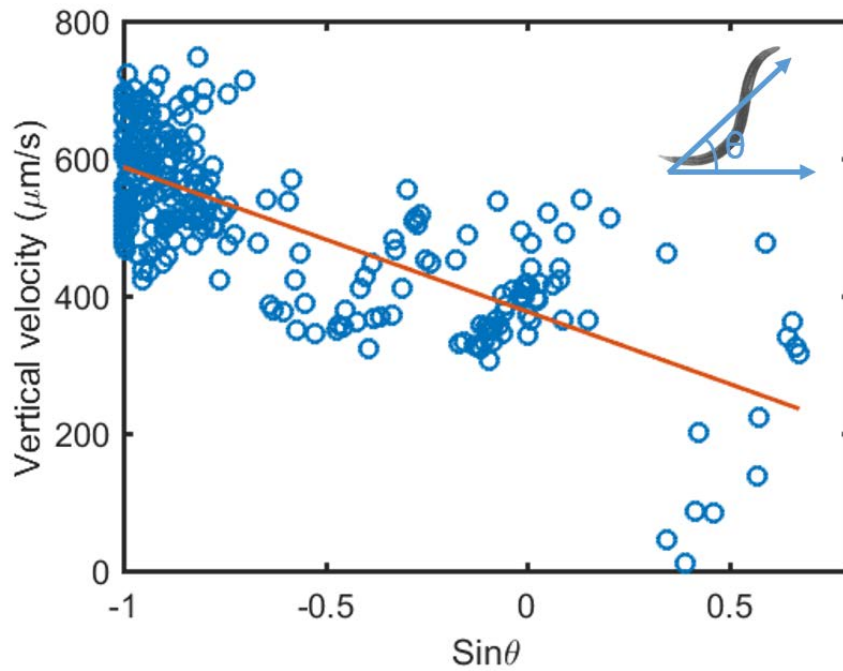
Fig. S2: Vertical velocity of settling nematodes as a function of the nematodes' body orientation θ measured from the horizontal plane. The symbols correspond to experimental data and the solid line is the best fit line $U = U_0 - U_S \sin(\theta)$, where U_0=377μm/s and U_s=210μm/s.
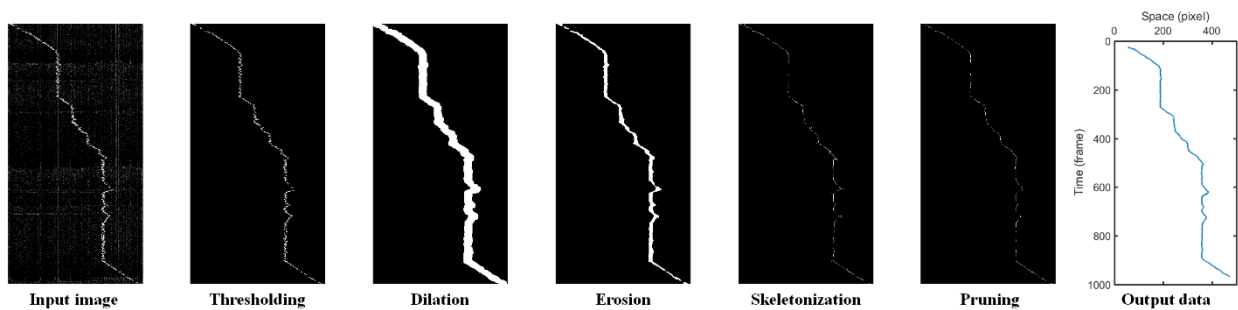
S2. Analysis of Ratchet Data

Fig. S3: Automated image processing workflow. The process was carried out with Matlab.