An Analysis of Three-Dimensional Locomotory Behavior in the Nematode Caenorhabditis elegans

Abstract

The roundworm C. elegans is an important model system for understanding the genetic and cellular basis of behavior. C. elegans exhibits a wide variety of behaviors, including foraging, locomotion, chemotaxis, thermotaxis, and mating. All studies to date of C. elegans behaviors have been conducted exclusively in two-dimensional environments, which are very different from the worms' three-dimensional natural habitat. In this thesis I develop a quantitative methodology for characterizing three-dimensional locomotory behaviors, using an optical system composed of three orthogonally oriented cameras. I use machine vision algorithms to reconstruct the three-dimensional posture of the worm and obtain postural metrics used to describe locomotory behavior. Using this system, I show that worms exhibit a previously undescribed three-dimensional rolling behavior when swimming in fluid environments. By analyzing the detailed three-dimensional posture of the worms, I show that this rolling behavior results from a counter-rotating movement of the worm's head during swimming. My findings show that lateral head movements, previously shown to be important in feeding behaviors, also play an important role in locomotion. This study represents a first step toward describing C.elegans' three-dimensional locomotory behavior and its neural basis.

Return to 2010 Thesis