Undulatory locomotion of polychaete annelids: mechanics, neural control and robotic prototypes[†]

Dimitris P. Tsakiris

Institute of Computer Science – FORTH
Vassilika Vouton, P.O. Box 1385, GR-71110 Heraklion, Greece
tsakiris@ics.forth.gr

Abstract

The undulatory locomotion of polychaete annelid worms is studied as a biological paradigm of a versatile body morphology and effective motion control, adaptable to a large variety of unstructured and tortuous environmental conditions (water, sand, mud, sediment, etc.).

Computational models of this type of locomotion have been developed, based on the Lagrangian dynamics of the system, on resistive force models of its interaction with the environment (emulating aquatic swimming and terrestrial crawling) and on neural control using central pattern generators and joint actuation by antagonistic muscles.

Simulation studies demonstrate the possibility to generate undulatory gaits, which are characterized by essential features of polychaete locomotion, based on these models. A block-based simulation environment has been developed on top of Matlab/ Simulink™, to facilitate research into various aspects of undulatory robotic locomotion in biology and robotics, including assessing the effect of different body configurations on gait generation.

Lightweight robotic prototypes have been developed, whose undulatory actuation achieves propulsion on sand and other unstructured environments.

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