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Modulation of orthogonal body waves enables high maneuverability in sidewinding locomotion HENRY ASTLEY, Georgia Institute of Technology, CHAOHUI GONG, MATT TRAVERS, Carnegie Mellon University, MIGUEL SERRANO, PATRICIO VELA, Georgia Institute of Technology, HOWIE CHOSET, Carnegie Mellon University, JOSEPH MENDELSON III[1], DAVID HU, DANIEL GOLDMAN, Georgia Institute of Technology — To simplify control of high degree of freedom bodies, organisms may target a set of simple shape changes (a "template"). Recent work has revealed that the locomotion of sidewinder rattlesnakes can be described by a combination of horizontal and vertical body waves with a phase difference of $\pm\pi/2$, representing a possible control template. These animals display high maneuverability which we hypothesize emerges from their ability to independently modulate these waves. Snakes used two distinct turning methods which we term differential turning (24° turn per cycle) and reversal turning (80°). Kinematic data suggested that during differential turning the animals imposed an amplitude modulation in the horizontal wave while in reversal turning they shifted the phase of the vertical wave by π. We tested these mechanisms in the robot, generating differential and reversal turning. Further manipulations of the two-wave system revealed a third turning mode, "frequency turning," not observed in biological snakes which allowed the robot to execute large (127°) in-place turns. The two-wave system enables unprecedented maneuverability of high degree-of-freedom systems, revealing a practical benefits of the search for control templates.

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