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Modulation of orthogonal body waves enables versatile maneuverability in limbless locomotion[1] DANIEL GOLDMAN, Georgia Tech, A COLLABORATION[2] — Limbless organisms can create different motions by modulating axial undulations that pass through their bodies. Sidewinding snakes generate horizontal and vertical waves, with a phase offset of $\pi/2$, resulting in posteriorly-propagating alternating regions of static contact with the substrate and elevated motion, resulting in a "stepping" motion of body segments. We have discovered that sidewinder rattlesnakes (it Crotalus cerastes) are quite maneuverable and possess at least two turning methods: "differential turning" and "reversal turning." In differential turning, the amplitude of the horizontal wave changes along the body length, resulting in turns of average 25.6 ± 12.9, maximum 86.1°per cycle. In reversal turning, the vertical wave's phase rapidly changes by π, resulting in a sudden, large change in movement direction (average 77.8 ± 27.4, maximum 160.5° per cycle) without body rotation. We applied these control mechanisms to a 16-link snake robot capable of sidewinding on sand. By modulation of horizontal wave amplitude gradient along the body, we replicated differential turning, and by producing a π phase shift in the vertical wave, we replicated a reversal turn. More complex wave modulations lead to enhanced robot maneuverability.

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