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The dependence of the swimming efficiency of multi-flagellated bacteria on the geometric arrangement of flagella NOBUHIKO WATARI, University of Michigan, Macromolecular Science and Engineering Center, RONALD LARSON, University of Michigan, Department of Chemical Engineering — Multi-flagellated bacteria, such as *Escherichia coli*, often have flagella attached at random locations to the cell body. To study the effect of the number of flagella and the geometric arrangement of them to the swimming efficiency, we develop a simulation method using a bead-spring model to account for the hydrodynamic and the mechanical interactions between multiple flagella and the cell body. First, a modeled bacterium is constructed using beads, which represent the hydrodynamic drag centers of the geometric elements of the bacterium. This modeled bacterium swims by rotating the flagella with constant torques at the bases of them. We have found that for modeled bacteria with two flagella, the swimming speed varies by 30% depending on the position of the base of the flagellum along the cell body, which affects the tightness of the bundling. We have also found that overly rigid flagella can slow migration by inhibiting flagellar bundling, since bundling requires some adjustment in flagellar shape to compensate for helical phase miss-match produced by irregular flagellar positioning. In general, by changing the geometric arrangement and the number of flagella, our simulation enables us to determine the optimal designing of a flagellated micro-swimmer.

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