Optimal control theory, sub-Riemannian geometry and swimming of copepod

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We show that the frame of optimal control theory and sub-Riemannian geometry provide powerful tools to tackle the swimming problem at low Reynolds number, focusing on a symmetric 2-link swimmer called the copepod [1]. The Maximum principle is used to select two types of periodic control candidates as minimizers: sinusoidal up to time reparameterization and the sequential paddling, interpreted as an abnormal stroke in sub-Riemannian geometry. Geometric analysis combined with numerical simulations are decisive tools to compute the optimal solutions. A family of simple strokes with small amplitudes emanating from a center is characterized as an invariant of sub-Riemannian geometry and allow to identify the metric used by the swimmer.

Références

[1] Piernicola Bettiol, Bernard Bonnard, Alice Nolot, Jérémy Rouot, *Optimal control theory and the efficiency of the swimming mechanism of the Copepod Zooplankton*, preprint (2016), https://hal.archives-ouvertes.fr/hal-01387423v2.

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