Globally Optimal Paths with Curvature Penalization, Applications to Image Segmentation

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Motivated by applications to motion planning and image segmentation, we consider paths models with a data-driven cost and a curvature penalization, such as the Euler/Mumford elasticas, or the Reeds-Shepp car with or without reverse gear. Our numerical strategy, for computing the path of minimal energy joining two given points, involves a dimension lifting in $\mathbb{R}^d \times \mathbb{S}^{d-1}$, $d = 2, 3$, and a strongly anisotropic approximation of the singular metric underlying the model. Specialized variants of the Fast-Marching algorithm are then used to solve the relevant eikonal equations.

We will present recent algorithmic improvements that make our numerical methods more general, faster, and flexible [3, 4], and will discuss applications of this framework to image processing tasks such as object segmentation, tubular structure extraction, and white matter fiber tracking [1, 2].

References

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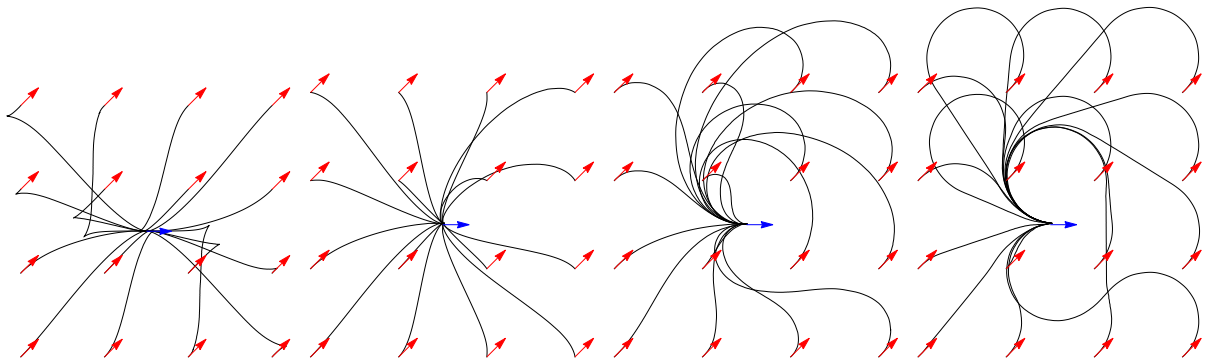

Figure 1: Minimal paths computed with our numerical methods, from the red arrows to the blue arrow, with respect to several curvature penalized models: Reeds-Shepp car, Reeds-Shepp car without reverse gear, Euler-Mumford elastica, Dubins car. In applications to image processing and segmentation, the models are augmented with data driven terms.