

Flexible rod

Consider the flexible rod depicted in (A):

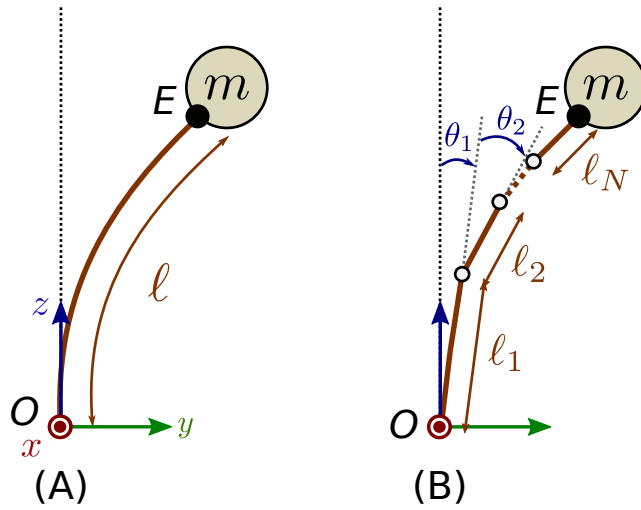


Figure 1: Flexible rod and its discretization.

We discretize it into N segments, as shown in (B), with ℓ_i the length of segment i and θ_i the angle it makes with its parent segment (or the vertical for θ_1).

Our goal is to compute the position ${}_W p_E$ of the end-effector point E with in the inertial frame W whose origin is the point O .

1. Attach a frame to each link, and write down the transform $T_{i,i+1}$ from link $i+1$ to its parent link i .
2. Calculate the transform $T_{W,N}$ from the last link N to the inertial frame W , and then p_E .

Let's consider the case where all segments have the same length $\ell_i = \frac{\ell}{N}$ and the rod has uniform curvature, so that all relative orientations θ_i are equal to $\frac{\Theta}{N}$.

3. Calculate in closed form the expression of p_E when the number of segments $N \rightarrow \infty$.
4. What value of Θ maximizes the distance between E and O ? What value minimizes it?