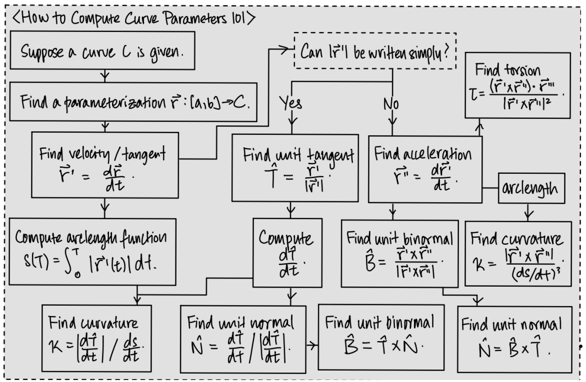


$$\kappa = \frac{|r_t \times r_{tt}|}{|r_t|^3}$$

$$\tau = \frac{(r_t \times r_{tt})\cdot r_{ttt}}{|r_t \times r_{tt}|^2}$$

(both are parameter invariant)

Tangent line: contains $r(t_0), r'(t_0)$

Oscillating plane: contains $r(t_0), r'(t_0), r''(t_0)$

$\frac{ds}{dt} = |r'(t)| \longrightarrow s(t) = \int |r'(t)|\,dt$, $s(\text{initial}) = 0$.

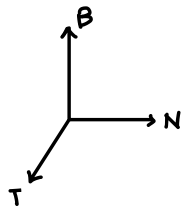
$\|r_s\| = \|r_t \cdot t_s\| = \left\|\frac{ds}{dt}\cdot\frac{dt}{ds}\right\| = 1.$

$\frac{d}{dt}\|\vec{a}(t)\| = \frac{\vec{a}(t)\cdot\vec{a}'(t)}{\|\vec{a}(t)\|}$ $(\|\vec{a}\| \neq 0)$

$T(s) = \vec{r}_s(s)$

$N(s) = \frac{\vec{r}_{ss}(s)}{\|\vec{r}_{ss}(s)\|}$

$B(s) = T(s) \times N(s)$



follow rhr for others.

Center of oscullating circular: $r(t_0) + \hat{N}(t_0)\cdot\rho$ / $y = f(x)$, $x \in [a,b]$, $\int_C g(x,y)\,ds = \int_a^b g(x,f(x))\cdot\sqrt{1+\left(\frac{dy}{dx}\right)^2}\,dx$

$v = \frac{dr}{dt} = \frac{ds}{dt}\cdot\hat{T}$, $\frac{d\hat{T}}{ds} = \kappa\hat{N}$, $\frac{d\hat{T}}{dt} = \kappa\cdot\frac{ds}{dt}\cdot\hat{N}$, $a = \frac{d^2r}{dt^2} = \frac{d^2s}{dt^2}\cdot\hat{T} + \kappa\cdot\left(\frac{ds}{dt}\right)^2\cdot\hat{N}$, $v\times a = \kappa\left(\frac{ds}{dt}\right)^3(\hat{T}\times\hat{N})$

Frenet-Serret Formulae: ① $\frac{d\hat{T}}{ds}(s) = \kappa\cdot\hat{N}(s)$, ② $\frac{d\hat{N}}{ds}(s) = \tau(s)\cdot\hat{B}(s) - \kappa(s)\cdot\hat{T}(s)$, ③ $\frac{d\hat{B}}{ds}(s) = -\tau(s)\cdot\hat{N}(s)$

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scalar: $\int_C f\,dr = \int_a^b f(r(t))\,\|r'(t)\|\,dt$, vector field: $\int_C F\cdot dr = \int_a^b F(r(t))\cdot r'(t)\,dt$

if $\nabla\times F = \vec{0} \xrightarrow{\text{No}}$ not conservative

$\xrightarrow{\text{Yes}}$ domain simply connected? $\xrightarrow{\text{Yes}}$ conservative

$\xrightarrow{\text{No}}$ Inconclusive

Potential Exists? $\xrightarrow{\text{Yes}}$ Conservative

$\xrightarrow{\text{No}}$ Not Conservative

For $\nabla\phi = F$, $\int_C F\cdot dr = \phi(\text{end}) - \phi(\text{start})$

$\nabla\times F = 0 \underset{\text{simple connected}}{\Longleftrightarrow} \int F\cdot dr$ path idp $\underset{\text{path connected}}{\Leftrightarrow}$ F conservative on U (ϕ defined on U)

$\int_C (F+G)\,dr = \int_C F\,dr + \int_C G\,dr$, $\int_{C_1+C_2} F\cdot dr = \int_{C_1} F\cdot dr + \int_{C_2} F\cdot dr$, $\int_C F\cdot dr = -\int_{-C} F\cdot dr$

$ma = F$, $m\cdot v' = F$

$m\cdot v'\cdot v = v\cdot\nabla\phi$

$\frac{d}{dt}\left(\frac{m\cdot v\cdot v}{2}\right) = v\cdot\nabla\phi = \frac{d}{dt}(\phi)$

$\frac{1}{2}m|v|^2 = \phi + \text{constant}$

$\frac{1}{2}m|v|^2 - \phi = \text{constant}.$

$\phi = \frac{1}{2}m|v|^2 - E_0 \geq -E_0.$

$y(x)$, $\kappa = \frac{\left|\frac{d^2y}{dx^2}\right|}{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}}}$