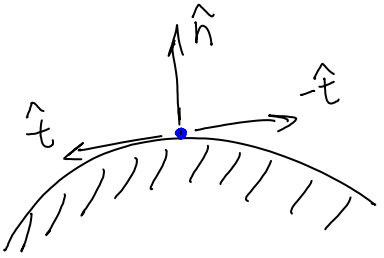
LCP Homework

Thursday, February 14, 2008
7:46 AM

1. Consider a particle in the plane moving in contact with a fixed obstacle.

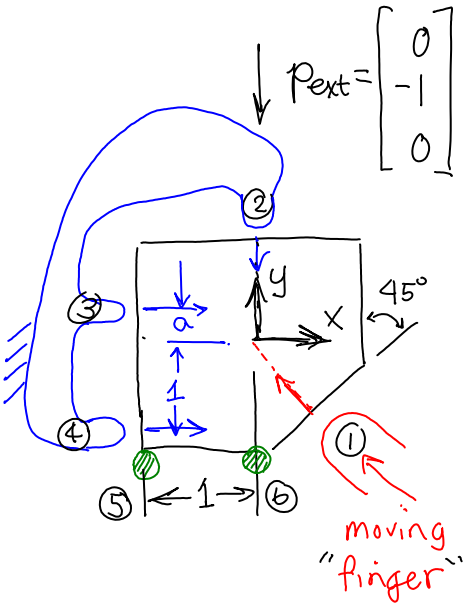


Determine the physical interpretations (sliding left, sliding right, sticking, degenerate sliding, degenerate sticking) of the eight generic solutions of the friction model given by:

$$0 \le \lambda_f \perp G_f^T v + 1s \ge 0$$
$$0 \le s \perp \mu\lambda_n - 1^T\lambda_f \ge 0$$

where λ_{f_1} is in the $\hat{t}$ direction
λ_{f_2} is in the $-\hat{t}$ direction

2. It is desired to assemble the parts shown. The polygonal part is initially at rest on two shaded pegs. (contacts 5 & 6). Assembly is successful when contact between the E-shaped body at all three



E-shaped body at all three nubs and contact with the moveable "finger" have been achieved. We would like to complete the assembly in one time step.

Assume $\mu = 0$, $h = 1$, $m = 1$, $J = 1$, $a = 0.2$, and the gaps at contacts 1, 2, 3, & 4 are initially of size 0.1. As defined in the figure, $p_{ext} = [0 \ -1 \ 0]^T$.

(A) Write the time-stepping LCP that models this situation and define the quantities, G_n, G_f, E, 1, ψ_n^l, $\frac{\partial \psi_n^l}{\partial t}$.

(B) Choose inequalities to be zero and positive such that, if satisfied, the parts will be properly assembled.

(C) Solve for the nonzero element of $\frac{\partial \psi_n}{\partial t}$, v^{l+1}, and p_n^{l+1}, such that the time stepping equations are satisfied and p_n^{l+1} is small.

Hint: certain quantities must be zero at the end of the time step. This gives four equations that can be solved, $A p_n^{l+1} = b$, where $A_{(4\times4)}$ is of rank 3. Therefore solve by $p_n^{l+1} = A^+ b + N(A)\alpha$. Use the scalar α to guarantee $p_n^{l+1} \geq 0$ ← scalar

(D) Redo part (C) with contact 3 shifted downward by $2a$. You will find that it is impossible to make $p_n^{l+1} \geq 0$.

Relate this problem to grasping. What sort of grasps do the assemblies form in part Ⓒ & Ⓓ ?