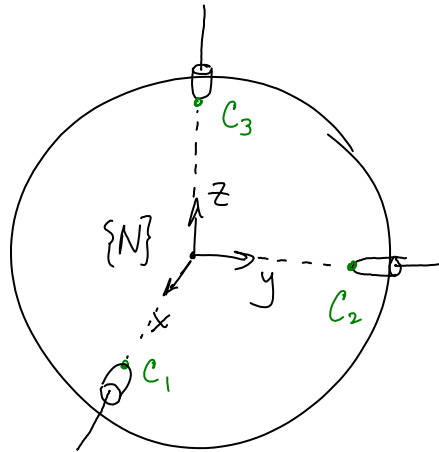


## Soln grsp-2

Thursday, January 29, 2009  
7:40 PM

We want to grasp  
a sphere of radius 1.  
The origin of the  
inertial frame is  
coincident with the  
center of the sphere.



For your  
analysis, assume there  
are three contacts at:

$$c_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \quad c_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} \quad c_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

Provided Matlab code  
may be helpful.

- ④ Choose contact models such that a sufficiently dexterous hand could impart any twist and net wrench to the object.

$$\text{Need } \text{rank}(G) = 6$$

$\therefore$  Need at least 2 HF or 1 SF.

a.) 2HF, 1 Pwof  $\Rightarrow G$  is  $(6 \times 7)$

Recall 2 HF's allow rotation of the sphere about an axis,  $A$ , thru the 2 points.

As long as the normal of the Pwof does not pass thru the axis  $A$ , then  $\text{rank}(G)=6$

b.) 3 HF  $\Rightarrow G$  is  $(6 \times 9)$

As long as the 3 pts are distinct,  $\text{rank}(G)=6$ .

c.) 1 SF, 2 Pwof  $\Rightarrow G$  is  $(6 \times 6)$

As long as the plane formed by the 3 pts does not include the  $\hat{n}$  of the Pwof, then  $\text{rank}(G)=6$

d.) 1 SF, 1 HF  $\Rightarrow G$  is  $(6 \times 7)$

$\text{rank}(G)=6$ , so the 3rd contact can be of any type

e.) 2 SF  $\Rightarrow G$  is  $(6 \times 8)$

$\text{rank}(G)=6$ , so 3rd contact model is arbitrary

ⓑ Does the initial grasp have form closure? Why?

It cannot! There are only 3 contacts.

ⓒ How could you change the number and/or

locations of the contacts to reverse your answer to question (B)?

You can't change the answer because the last 3 rows of  $G$  are zero for a sphere with any # of contacts!

① Assume all contacts are of type HF with identical friction coefficient,  $\mu$ .

Determine the minimum  $\mu$  such that the grasp has force closure.

See Matlab code: `grasping_hw_sphere_solns.m`

Using  $n_g=3$ , inscribed=1, offset=0  $\Rightarrow \mu \geq 1.01$

Using  $n_g=10$ , " , "  $\Rightarrow \mu \geq 0.73$   
50  $\Rightarrow \mu \geq 0.71$

② Design fingers such that all object twists and wrenches (net and internal) could be controlled.

I chose 3 fingers each w/ mutually perpendicular prismatic joints (to make  $J$  simple).

See same code.

③ Remove contact 3 from consideration. Does the grasp with only 2 fingers have force closure? Why or why not?

See answer above.

Test with same code.

Test with same code.