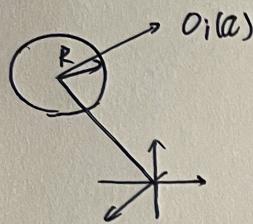


# ECE 470 Pre-lab

① Sphere :



$$O_i(a) = \begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} \rightarrow \text{through forward kinematics}$$

$$b = \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix} + R \frac{O_i(a) - c}{\|O_i(a) - c\|}$$

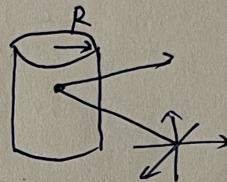
$$\|O_i(a) - c\| = \sqrt{(O_{ix} - cx)^2 + (O_{iy} - cy)^2 + (O_{iz} - cz)^2}$$

$$\text{② when } \|O_i - c\| \geq R : O_i(a) - b = \begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} - \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix} - R \times \frac{\begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} - \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix}}{\sqrt{(O_{ix} - cx)^2 + (O_{iy} - cy)^2 + (O_{iz} - cz)^2}}$$

$$\text{③ when } \|O_i - c\| < R : O_i(a) - b = 0$$

② Cylinder :

$$O_i(a) = \begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix}$$



$$b = \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix} + R * \frac{\begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} - \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix}}{\sqrt{(O_{ix} - cx)^2 + (O_{iy} - cy)^2}}$$

$$\text{④ if } \left\| \begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} - \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix} \right\| \geq R :$$

$$O_i(a) - b = \begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} - \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix} - R * \frac{\begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} - \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix}}{\sqrt{(O_{ix} - cx)^2 + (O_{iy} - cy)^2}}$$

$$\text{⑤ if } \left\| \begin{bmatrix} O_{ix} \\ O_{iy} \\ O_{iz} \end{bmatrix} - \begin{bmatrix} cx \\ cy \\ cz \end{bmatrix} \right\| < R :$$

$$O_i(a) - b = 0$$