24th. Oct., 2019

(70)

Assignment (Robotics I, Robotics) 2nd

(M2, M1, B4, B3, others: CIRCLE ONE) Major (Department) ______

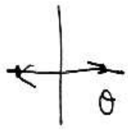
Name(KANJI or English) ______

[1] prove the case of $S_\theta = 0$ for the Euler parameters formula

$$\begin{cases} \psi = \text{arbitrary} \\ \theta = 0 \quad \phi = \mathrm{atan2}(R_{21}, R_{22}) - \psi \\ \theta = \pi \quad \phi = -\mathrm{atan2}(R_{21}, R_{22}) + \psi \end{cases}$$

when $S_\theta = 0$

$= \dfrac{r}{r}$, $r \neq 0$, $r = 0 \rightarrow r = 0 \rightarrow \underline{\theta = 0 \text{ or } \pi\ (-\pi)}$



$\theta = 0$

$= \pi\ (-\pi)$

① When $\theta = 0$, $R_{21} = S_\phi \underset{1}{\underset{\parallel}{C_\theta}} C_\psi + C_\phi S_\psi = S_\phi C_\psi + C_\phi S_\psi$

$R_{22} = -S_\phi C_\theta S_\psi + C_\phi C_\psi = -S_\phi S_\psi + C_\phi C_\psi$

$$\tan(\phi+\psi) = \frac{\sin\phi\cos\psi + \cos\phi\sin\psi}{\cos\phi\cos\psi - \sin\phi\sin\psi} = \frac{R_{21}}{R_{22}}$$

$\rightarrow \phi + \psi = \mathrm{atan2}(R_{21}, R_{22})$

$\phi = \mathrm{atan2}(R_{21}, R_{22}) - \psi$ ⌟

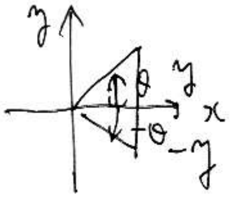
② about ψ, $R_{31} = -\underset{0}{\underline{S_\theta}} C_\psi = 0$, $R_{32} = \underset{0}{\underline{S_\theta}} S_\psi = 0 \Rightarrow$ any value of ψ is ok

$\Downarrow$

ψ is arbitrary ⌟

③ when $\theta = \pi$, $\cos\theta = -1$, $R_{21} = -S_\phi C_\psi + C_\phi S_\psi$

$R_{22} = -S_\phi S_\psi - C_\phi C_\psi$



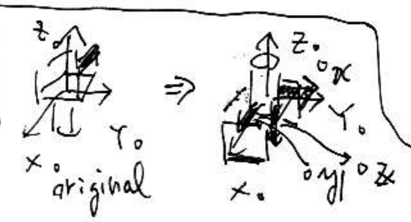
$\tan(-(\phi-\psi)) = -\tan(\phi - \psi)$

$$= -\left\{\frac{\sin\phi\cos\psi - \cos\phi\sin\psi}{\cos\phi\cos\psi + \sin\phi\sin\psi}\right\} = \frac{-R_{21}}{R_{22}}$$

$\Rightarrow \phi - \psi = \mathrm{atan2}(-R_{21}, R_{22}) = -\mathrm{atan2}(R_{21}, R_{22})$

Thus $\phi = -\mathrm{atan2}(R_{21}, R_{22}) + \psi$ ⌟

[2]



$${}^0R = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

$\left(\begin{array}{l} R_{13} = 0,\ R_{23} = 0 \\ R_{33} = -1 \\ R_{21} = 1,\ R_{22} = 0 \end{array}\right)$

$\theta = \mathrm{atan2}(\pm 0, -1) = \pi\ (-\pi) \rightarrow S_\theta = 0 \rightarrow$ using the above $\theta = \pi$ case

$$\begin{cases} \psi = \text{arbitrary} \\ \theta = \pi, \\ \phi = -\mathrm{atan2}(1, 0) + \psi = -\dfrac{\pi}{2} + \psi \end{cases}$$