$$J\dot{\theta} = \dot{x}$$

$$\begin{bmatrix} \varepsilon & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \end{bmatrix} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} \qquad K = \frac{1}{\varepsilon}$$

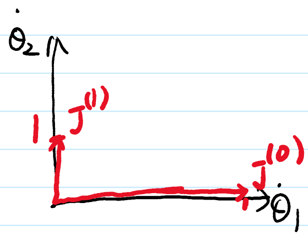
DLS :

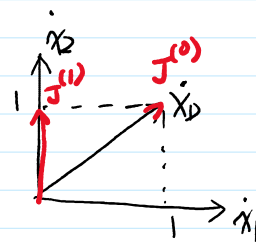
$$\begin{bmatrix} \frac{\varepsilon}{\varepsilon^2+\lambda^2} & 0 \\ 0 & \frac{1}{1+\lambda^2} \end{bmatrix} \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \end{bmatrix}$$

$\lambda = 0$

$\lambda = 1$

$\lambda = \infty$





$\lambda = 0$

$$\begin{bmatrix} \frac{1}{\varepsilon} & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{1}{\varepsilon} \\ 1 \end{bmatrix} = \begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \end{bmatrix}$$

$$\dot{x} = J\dot{\theta} = \begin{bmatrix} \varepsilon & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{1}{\varepsilon} \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$\lambda = 1$

$$\begin{bmatrix} \frac{\varepsilon}{\varepsilon^2+1} & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \begin{bmatrix} \varepsilon & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \begin{bmatrix} \varepsilon \\ 1 \end{bmatrix} = \begin{bmatrix} \dot{\theta}_1 \\ \dot{\theta}_2 \end{bmatrix}$$

$$\dot{x} = J\dot{\theta} = \begin{bmatrix} \varepsilon & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon \\ 1 \end{bmatrix} = \begin{bmatrix} \varepsilon^2 \\ 1 \end{bmatrix}$$

Computer project #1

```
for i=1 : nXd
    thi = DLS ( njoints, λ, L, tho, Xd)
    th = [th ; thi]
end

th = DLS (njoints, λ, L, tho, Xd)
while 1
```

[illegible]

while 1

X_A = Forward (L, th)

$$\begin{cases} x_A = l_1\cos(\theta_1) + l_2\cos(\theta_1+\theta_2) + l_3\cos(\theta_1+\theta_2+\theta_3) + l_4\cos(\theta_1+\theta_2+\theta_3+\theta_4) \\ y_A = l_1\sin(\theta_1) + l_2\sin(\theta_1+\theta_2) + l_3\sin(\theta_1+\theta_2+\theta_3) + l_4\sin(\theta_1+\theta_2+\theta_3+\theta_4) \end{cases}$$

$dx = X_D - X_A$

J = Jacobian(L, th)

$$J = \begin{bmatrix} -l_1\sin\theta_1 - l_2\sin(\theta_1+\theta_2) - l_3\sin(\theta_1+\theta_2+\theta_3) - l_4\sin(\theta_1+\theta_2+\theta_3+\theta_4) & J_2 & J_3 & J_4 \\ l_1\cos(\theta_1) + l_2\cos(\theta_1+\theta_2) + l_3\cos(\theta_1+\theta_2+\theta_3) + l_4\cos(\theta_1+\theta_2+\theta_3+\theta_4) & & & \end{bmatrix}$$

$dth = J^T(JJ^T + \lambda^2 I)^{-1}\, dx$

if norm(dth, 2) < ε $\quad \varepsilon = 10^{-3}$, or 10^{-6}

break

end

th = th + dth

end