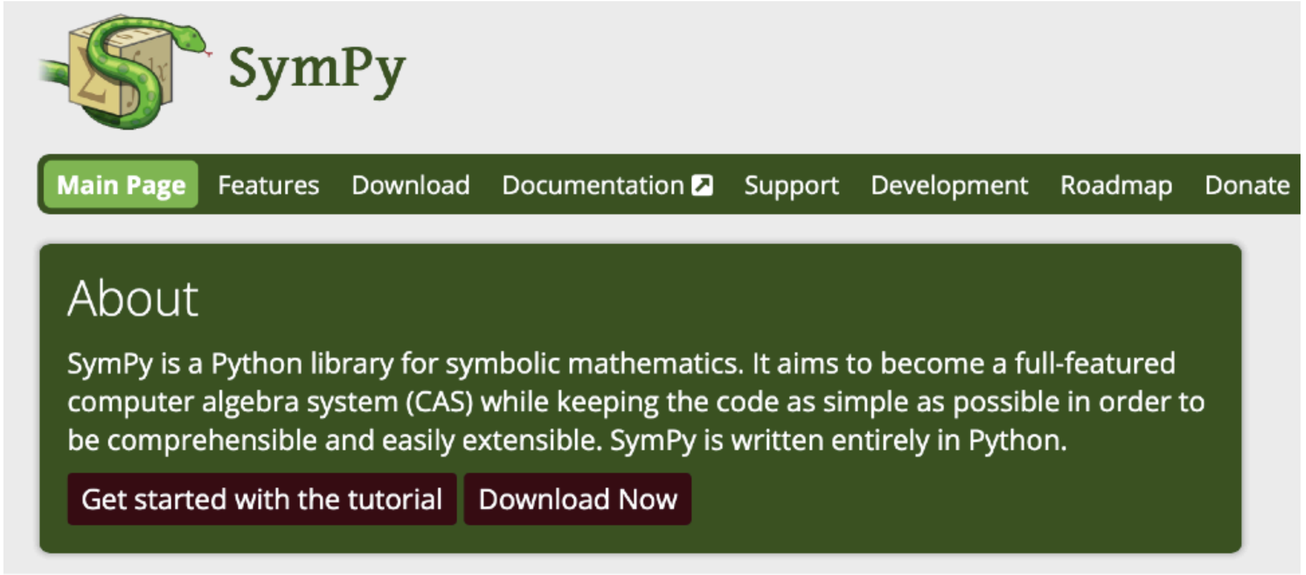
Experiment

Experiment 3: Extended Kalman Filter（每1秒分析一次，使用擴展卡爾曼濾波器）



切線性模型：

$$\theta_{1_i} = \theta_{1_{i-1}} + \dot{\theta}_{1_i}\Delta t$$

$$\theta_{2_i} = \theta_{2_{i-1}} + \dot{\theta}_{2_i}\Delta t$$

$$\dot{\theta}_{1_i} = \dot{\theta}_{1_{i-1}} + \frac{m_2 g \sin\theta_{2_i}\cos(\theta_{1_i}-\theta_{2_i}) - m_2\sin(\theta_{1_i}-\theta_{2_i})(l_1\dot{z}_1^2\cos(\theta_{1_i}-\theta_{2_i}) + l_2\dot{z}_2^2) - (m_1+m_2)g\sin\theta_{1_i}}{l_1(m_1+m_2\sin^2(\theta_{1_i}-\theta_{2_i}))}\Delta t$$

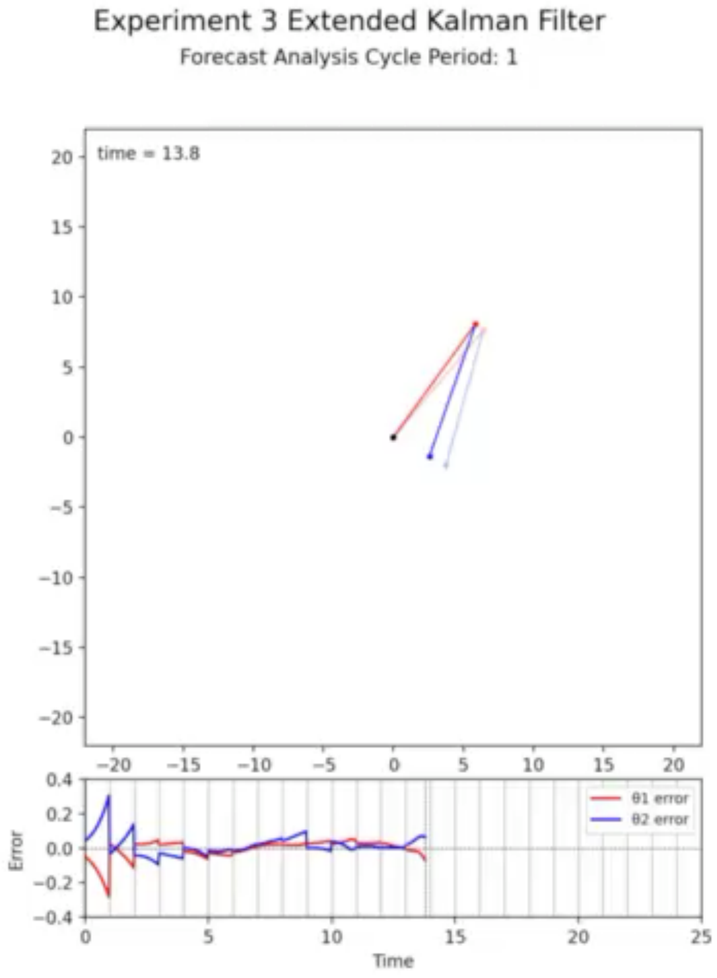
$$\dot{\theta}_{2_i} = \dot{\theta}_{2_{i-1}} + \frac{(m_1+m_2)[l_1\dot{z}_1^2\sin(\theta_{1_i}-\theta_{2_i}) - g\sin\theta_{2_i} + g\sin\theta_{1_i}\cos(\theta_{1_i}-\theta_{2_i})] + m_2 l_2\dot{z}_2^2\sin(\theta_{1_i}-\theta_{2_i})\cos(\theta_{1_i}-\theta_{2_i})}{l_2[m_1+m_2\sin^2(\theta_{1_i}-\theta_{2_i})]}\Delta t$$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ -\frac{2m_2\left(-gm_2\sin(\theta_1-2\theta_2)-g(2m_1+m_2)\sin(\theta_1)-2m_2\left(l_1{\theta_1}^2\cos(\theta_1-\theta_2)+l_2{\theta_2}^2\right)\sin(\theta_1-\theta_2)\right)\sin(2\theta_1-2\theta_2)}{l_1\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)^2} + \frac{-gm_2\cos(\theta_1-2\theta_2)-g(2m_1+m_2)\cos(\theta_1)+2l_1m_2{\theta_1}^2\sin^2(\theta_1-\theta_2)-2m_2\left(l_1{\theta_1}^2\cos(\theta_1-\theta_2)+l_2{\theta_2}^2\right)\cos(\theta_1-\theta_2)}{l_1\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)} & \frac{2m_2\left(-gm_2\sin(\theta_1-2\theta_2)-g(2m_1+m_2)\sin(\theta_1)-2m_2\left(l_1{\theta_1}^2\cos(\theta_1-\theta_2)+l_2{\theta_2}^2\right)\sin(\theta_1-\theta_2)\right)\sin(2\theta_1-2\theta_2)}{l_1\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)^2} + \frac{2gm_2\cos(\theta_1-2\theta_2)-2l_1m_2{\theta_1}^2\sin^2(\theta_1-\theta_2)+2m_2\left(l_1{\theta_1}^2\cos(\theta_1-\theta_2)+l_2{\theta_2}^2\right)\cos(\theta_1-\theta_2)}{l_1\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)} & -\frac{4m_2\theta_1\sin(\theta_1-\theta_2)\cos(\theta_1-\theta_2)}{2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2} & -\frac{4l_2m_2\theta_2\sin(\theta_1-\theta_2)}{l_1\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)} \\ -\frac{4m_2\left(g(m_1+m_2)\cos(\theta_1)+l_1{\theta_1}^2(m_1+m_2)+l_2m_2{\theta_2}^2\cos(\theta_1-\theta_2)\right)\sin(\theta_1-\theta_2)\sin(2\theta_1-2\theta_2)}{l_2\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)^2} + \frac{2\left(-g(m_1+m_2)\sin(\theta_1)-l_2m_2{\theta_2}^2\sin(\theta_1-\theta_2)\right)\sin(\theta_1-\theta_2)}{l_2\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)} + \frac{2\left(g(m_1+m_2)\cos(\theta_1)+l_1{\theta_1}^2(m_1+m_2)+l_2m_2{\theta_2}^2\cos(\theta_1-\theta_2)\right)\cos(\theta_1-\theta_2)}{l_2\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)} & \frac{2m_2{\theta_2}^2\sin^2(\theta_1-\theta_2)}{2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2} + \frac{4m_2\left(g(m_1+m_2)\cos(\theta_1)+l_1{\theta_1}^2(m_1+m_2)+l_2m_2{\theta_2}^2\cos(\theta_1-\theta_2)\right)\sin(\theta_1-\theta_2)\sin(2\theta_1-2\theta_2)}{l_2\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)^2} - \frac{2\left(g(m_1+m_2)\cos(\theta_1)+l_1{\theta_1}^2(m_1+m_2)+l_2m_2{\theta_2}^2\cos(\theta_1-\theta_2)\right)\cos(\theta_1-\theta_2)}{l_2\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)} & \frac{4l_1\theta_1(m_1+m_2)\sin(\theta_1-\theta_2)}{l_2\left(2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2\right)} & \frac{4m_2\theta_2\sin(\theta_1-\theta_2)\cos(\theta_1-\theta_2)}{2m_1-m_2\cos(2\theta_1-2\theta_2)+m_2} \end{bmatrix}$$

還好我沒有用手算^^

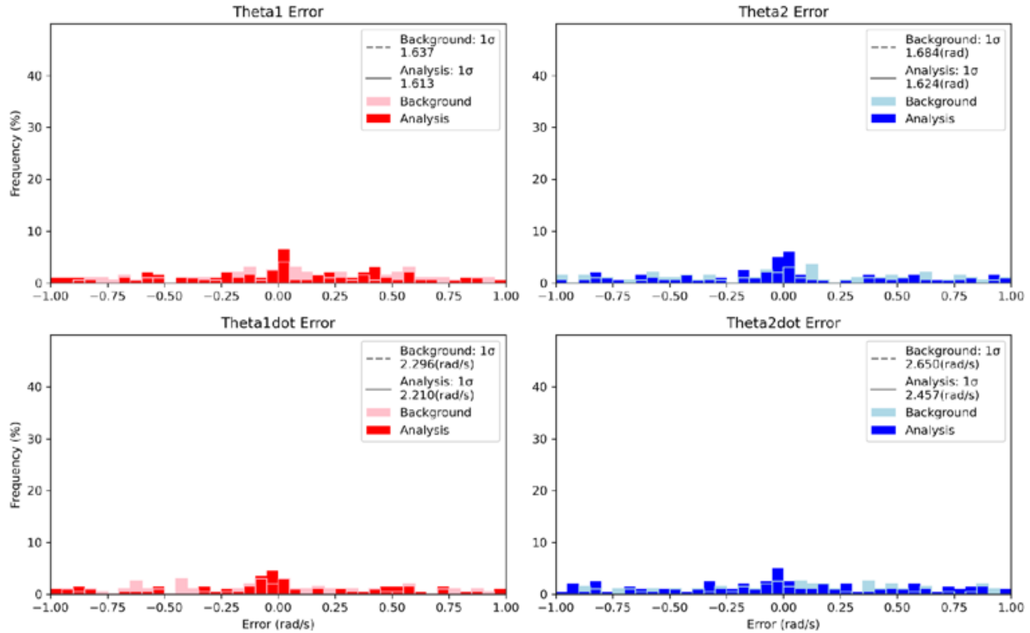
Experiment

Experiment 3: Extended Kalman Filter（每1秒分析一次，使用擴展卡爾曼濾波器）



註：初始的$\mathbf{B} = \mathbf{R}$

分析誤差相較於**背景誤差**改變了多少？



此實驗相較於**觀測即分析**時

θ_1分析標準差：~~0.036~~1.613 (rad)

$\dot{\theta}_1$分析標準差：~~0.048~~2.210 (rad/s)

θ_2分析標準差：~~0.036~~1.624 (rad)

$\dot{\theta}_2$分析標準差：~~0.048~~2.457 (rad/s)