indoor temperature prediction - using real datas to fit a RC analog model

Alexandre CUER
Dromotherm@Cerema
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I. INDOOR TEMPERATURE FORECASTING WITH AN RC MODEL

$$f(p) = \frac{1}{2}\sum_{i=1}^{N}(T_p^i[0] - \theta^i[1])^2$$

$$A = \begin{vmatrix} -\frac{1}{c_{res}}(\frac{1}{r_i} + \frac{1}{r_f}) & \frac{1}{c_{res}r_i} \\ \frac{1}{c_s r_i} & -\frac{1}{c_s}(\frac{1}{r_i} + \frac{1}{r_0}) \end{vmatrix}$$

$$\frac{dA}{dc_{res}} = \begin{vmatrix} \frac{1}{c_{res}^2}(\frac{1}{r_i} + \frac{1}{r_f}) & -\frac{1}{c_{res}^2 r_i} \\ 0 & 0 \end{vmatrix}$$

$$\frac{dA}{dc_s} = \begin{vmatrix} 0 & 0 \\ -\frac{1}{c_s^2 r_i} & \frac{1}{c_s^2}(\frac{1}{r_i} + \frac{1}{r_0}) \end{vmatrix}$$

$$\frac{dA}{dr_i} = \begin{vmatrix} \frac{1}{c_{res}r_i^2} & -\frac{1}{c_{res}r_i^2} \\ -\frac{1}{c_s r_i^2} & \frac{1}{c_s r_i^2} \end{vmatrix}$$

$$\frac{dA}{dr_0} = \begin{vmatrix} 0 & 0 \\ 0 & \frac{1}{c_s r_0^2}) \end{vmatrix}$$

$$\frac{dA}{dr_f} = \begin{vmatrix} \frac{1}{c_{res}r_f^2} & 0 \\ 0 & 0 \end{vmatrix}$$

with

$$p = [c_{res}, c_s, r_i, r_0, r_f]$$

we have :

$$A = \begin{vmatrix} -\frac{1}{p[0]}(\frac{1}{p[2]} + \frac{1}{p[4]}) & \frac{1}{p[0]p[2]} \\ \frac{1}{p[1]p[2]} & -\frac{1}{p[1]}(\frac{1}{p[2]} + \frac{1}{p[3]}) \end{vmatrix}$$

$$\frac{dA}{dc_{res}} = \begin{vmatrix} \frac{1}{p[0]^2}(\frac{1}{p[2]} + \frac{1}{p[4]}) & -\frac{1}{p[0]^2 p[2]} \\ 0 & 0 \end{vmatrix}$$

$$\frac{dA}{dr_i} = \begin{vmatrix} \frac{1}{p[0]p[2]^2} & -\frac{1}{p[0]p[2]^2} \\ -\frac{1}{p[1]p[2]^2} & \frac{1}{p[1]p[2]^2} \end{vmatrix}$$

$$\frac{dA}{dr_0} = \begin{vmatrix} 0 & 0 \\ 0 & \frac{1}{p[1]p[3]^2} \end{vmatrix}$$

$$\frac{dA}{dr_f} = \begin{vmatrix} \frac{1}{p[0]p[4]^2} & 0 \\ 0 & 0 \end{vmatrix}$$

$$G = \begin{vmatrix} \frac{Q_{res}}{c_{res}} + \frac{T_{ext}}{c_{res} r_f} \\ \frac{Q_s}{c_s} + \frac{T_{ext}}{c_s r_0} \end{vmatrix}$$

$$\frac{dG}{dc_{res}} = \begin{vmatrix} -\frac{1}{c_{res}^2}(Q_{res} + \frac{T_{ext}}{r_f}) \\ 0 \end{vmatrix}$$

$$\frac{dG}{dc_s} = \begin{vmatrix} 0 \\ -\frac{1}{c_s^2}(Q_s + \frac{T_{ext}}{r_0}) \end{vmatrix}$$

$$\frac{dG}{dr_i} = \begin{vmatrix} 0 \\ 0 \end{vmatrix}$$

$$\frac{dG}{dr_0} = \begin{vmatrix} 0 \\ -\frac{T_{ext}}{c_s r_0^2} \end{vmatrix}$$

$$\frac{dG}{dr_f} = \begin{vmatrix} -\frac{T_{ext}}{c_{res} r_f^2} \\ 0 \end{vmatrix}$$

Let’s introduce the ground truths tensor :

$$\theta = [T_{ext}, T_{int}, Q_{res}, Q_s]$$

All temperatures being expressed in °C and all powers in W

$$G = \begin{vmatrix} \frac{\theta^i[2]}{p[0]} + \frac{\theta^i[0]}{p[0]p[4]} \\ \frac{\theta^i[3]}{p[1]} + \frac{\theta^i[0]}{p[1]p[3]} \end{vmatrix}$$

$$\frac{dG}{dc_{res}} = \begin{vmatrix} -\frac{1}{p[0]^2}(\theta^i[2] + \frac{\theta^i[0]}{p[4]}) \\ 0 \end{vmatrix}$$

$$\frac{dG}{dc_s} = \begin{vmatrix} 0 \\ -\frac{1}{p[1]^2}(\theta^i[3] + \frac{\theta^i[0]}{p[3]}) \end{vmatrix}$$

$$\frac{dG}{dr_0} = \begin{vmatrix} 0 \\ -\frac{\theta^i[0]}{p[1]p[3]^2} \end{vmatrix}$$

$$\frac{dG}{dr_f} = \begin{vmatrix} -\frac{\theta^i[0]}{p[0]p[4]^2} \\ 0 \end{vmatrix}$$

With $T_i(t)$ the simulated indoor temperature and $T_s(t)$ the simulated envelope temperature, we define :

$$T_p(t) = \begin{vmatrix} T_i(t) \\ T_s(t) \end{vmatrix}$$

the equation to solve is :

$$\frac{dT_p(t)}{dt} = AT_p(t) + G(t,p)$$

In [33]:
```
cres=9e+6
cs=9e+7
ri=1e-2
r0=1e-2
rf=1e-2
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In [ ]: