

List of symbols

$\mathbf{x}_k$	estimated state vector at time k
$\mathbf{y}_k$	measurement vector at time k
$\mathbf{u}_k$	input vector at time k
$\mathbf{v}_k$	model noise at time k
$\mathbf{w}_k$	measurement noise at time k
$f()$	state transfer function
$h()$	measurement function
N_S	number of particles
$\mathbf{x}_0^i$	initial state vector of the i th particle
ω_0^i	initial weight of the i th particle
$\mathbf{x}_k^i$	estimated state vector of the i th particle at time k
ω_k^i	weight of the i th particle at time k
$\mathbf{y}_{1:k}$	measurement data points from time 1 to time k
$\delta()$	Dirac delta function
N_{eff}	effective sample size
N_t	threshold of N_{eff}
$\mathbf{x}_{kH}^l$	large-weight particles before crossover step at time k
$\mathbf{x}_{kL}^j$	small-weight particles before crossover step at time k
$\mathbf{x}_{kC}^j$	new particles after crossover step at time k
$\mathbf{x}_{kM}^j$	new particles after mutation step at time k
α	parameter of the IPF's crossover step
p_M	parameter of the IPF's mutation step
N_r	number of simulations
T	number of time steps
e_{uk}	absolute error at time k in the u th simulation
e_{av}	average absolute error
L_k	average likelihood of the measurement by particles at time k
M	sliding window
d_k	normalized fault decision function at time k
h	fault threshold
F	flowrate
R	recycle ratio
S_i	substrate concentration in the i th reactor
X_i	concentration of microorganisms in i th reactor
S_0	substrate concentration of the feed entering the first reactor
w	waste factor
t	time

V	reactor volume
μ_m	maximum specific growth rate
β	yield factor
K_S	Monod constant
C	concentration factor
k_d	death coefficient
n	volume ratio of the two reactors
b_{SRC}	parameter for calculating critical residence time
τ_{min}^*	dimensionless critical residence time
$S_{i,0}$	initial substrate concentration in the i th reactor
$X_{i,0}$	initial concentration of microorganisms in the i th reactor
σ_v	deviation of the model noise
σ_w	deviation of the measurement noise
$\mathbf{f}$	fault