Index

Advanced process control (APC) 554
Advanced regulatory control (ARC) 554
Application 497
– chemical reactor 528
– control simulation 508, 539, 544
– controller tuning 508, 544
– distillate concentration control 501, 508
– flue gas oxygen concentration control 529
– furnace load control 501
– gas heated furnace 528
– petrochemical distillation column 499
– predictive constrained linear MIMO control 498, 515, 527
– pressure-compensated temperature control 501, 508, 517
– pressure control 501, 508, 517, 523
– real-time control 511, 523, 549
– stripping column 515
– temperature control 529

Cascade control 581
– application 478, 505, 509
Case study
– ammonium concentration control 489
– distillate composition control 321
– distillation column 318
– forced heating and free convective cooling 375
– heat exchanger 131, 362
– hot air blower 458
– injection molding machine 468
– level control 348, 426
– linear MIMO predictive control 321
– nitrate concentration control 489
– PFC 437
– predictive linearized control 430
– predictive multicontroller 374
– predictive multimodel control 372
– predictive multiparameter control 372
– predictive nonlinear control 429
– predictive on-off control 132, 481
– process identification 459
– temperature control 131, 370, 375, 460, 473
– two-tank pilot plant 424
– two-tank plant 348
– wastewater plant 477, 488
– wastewater quality control 477, 488

Computational effort reduction
– blocking technique 176, 182–183, 580
– coincidence points 179, 183, 580
– cost function 183

Constraint/limit
– application 503, 518, 529, 541
– cost function extension 198
– end-point constraint 213
– feasible solution 576
– hard constraint 198, 206, 502, 575
– physical constraints 193
– prioritization 578
– soft constraint 198, 503, 518, 575
– typical constraint 194

Controlled variable 4
– application 502, 529

Dead time (time delay) 30
Decoupling (static) 300
– by a postcompensator 303, 325
– by a precompensator 301, 323
– by a precompensator and a postcompensator 304, 326

Decoupling of a MIMO process 297
– by changing the control error weighting factors 315

© 2011 WILEY-VCH Verlag GmbH & Co. KGaA. Published 2011 by WILEY-VCH Verlag GmbH & Co. KGaA.
Index

– by control-error-dependent weighting factors 316
– by slowing the reference signal change 312
– by using a dynamic compensator 308
– using a static compensator 300, 323

Difference operator 38

Disturbance
– measurable 29, 36
– unmeasurable 29, 36

Disturbance model 29, 36, 41
– application 504, 519, 533

Disturbance signal
– measurable 10
– nonmeasurable 10

Disturbance variable
– application 518, 530

Economic benefit 565
– application 513, 525

Fusion technique 355

Gaussian validity function 356

Impulse response/weighting function 33

Linear MIMO predictive control
– application 498, 515, 527
– controller tuning 294
– cost function 277
– polynomial form (RST) 284
– with matrix inversion (GPC) 278

Linear SISO predictive control
– control function 158
– controller tuning 172
– cost function 135, 165, 205
– disturbance feed-forward 188
– disturbance/robustness filter 159
– generalized predictive control (GPC) 135
– multiparametric programming 200
– polynomial RST form 145
– quadratic programming 199
– under constraints 202, 204
– with end-point constraint 213
– with end-point weighting 216

m
Manipulated variable 4
– application 502, 517, 529
– future sequence 137

Model
– disturbance model 29, 36, 41
– input/output 29
– linear 29
– MIMO 252
– nonlinear 383
– nonparametric 31
– parametric 36
– process model 29
– SISO 29, 136
– state space 43

Nonlinear predictive control 591
– based on a multicontroller 360
– based on a multimodel 359
– based on a multiparameter model 360
– based on the linearized model 422
– multidimensional iterative optimization 410
– suboptimal (constant control increments) 407
– suboptimal (constant control signal) 406
– using the one-dimensional solution 406

Nonlinear predictive equation
– multimodel approach 359
– multiparameter model approach 359

Nonlinear process model
– LPV model 354
– multimodel 355
– multiparameter model 358
– with direction-dependent parameters 354
– with signal-dependent parameters 354

Nonparametric model
– linear SISO 31
– nonlinear SISO 384

Nonparametric model (linear SISO) 31
– finite impulse response (FIR) 32
– finite step response (FSR) 33

Nonparametric model (nonlinear SISO)
– Hammerstein series 384
– Volterra series 384

On–off control
– nonpredictive with hysteresis 105, 480
– nonpredictive without hysteresis 104
– predictive 103
Index 599

Pairing of controlled and manipulated variables 287

Parameter estimation
- LS estimation 336
- of predictive equation 335
- of the process model 336

Parametric model
- difference equation 37
- linear MIMO 252
- linear SISO 36
- nonlinear SISO 385–386, 388
- pulse-transfer function 37

Parametric model (linear MIMO)
- CARIMA matrix fraction model 254
- CARIMA state space model 258
- CARMA matrix fraction model 252
- CARMA state space model 256

Parametric model (linear SISO)
- CARIMA (ARIMAX) 51
- CARMA (ARMAX) 41, 48
- incremental 42
- state space model 43

Parametric model (nonlinear SISO)
- bilinear 389
- block-orientated 386
- cascade 385
- generalized Hammerstein 387, 389
- linear-in-parameters 388
- NARMAX 390
- parametric Volterra model 389
- simple Hammerstein 385
- simple Wiener 386

PI(D) control 221

PI(D) controller
- discretization of continuous form 240
- Kuhn’s T-sum rule 241
- set point weighting 242
- Åström and Hägglund’s tuning rules 242

Prediction
- forced response
  12, 59, 73, 81, 97, 100, 136, 274
- free response
  12, 59, 73, 81, 97, 100, 136, 274
- of disturbance 57, 423

Predictive control
- cascade control 581
- controller tuning 17, 151, 566
- cost function 6, 13, 506, 570, 572
- future trends 585
- GPC 138, 278
- implementation 559, 561, 566
- long-range optimal 11
- of linear MIMO processes 251
- of linear SISO processes 135
- of nonlinear SISO processes 406
- one-step-ahead optimal 11
- PFC 437
- practical aspects 553

Predictive equation
- based on MIMO 271
- based on the pulse-transfer function 64
- in the case of autoregressive additive
  noise 74
- in the case of nonautoregressive additive
  noise 81
- in the presence of measurable disturbance 78
- incremental 397, 405
- nonincremental 392
- of Hammerstein series 392
- of the first-order model 65
- of the generalized Hammerstein model
  394, 401
- of the Hammerstein series 398
- of the impulse response model 56
- of the parametric Volterra model
  396, 403
- of the second-order model 68
- of the state space model 93
- of the step response model 61
- of the Volterra series 400
- of Volterra series 393

Predictive equation estimation
- based on one step ahead 337
- long-range optimal (LRPI) 339
- multistep ahead (MSPI) 344

Predictive functional control (PFC)
- constraint handling 454
- of a first-order linear process 443
- of a nonlinear process with
  signal-dependent parameters 457
- of a process with dead time 449
- of a second-order linear process 446
- of the LPV model 457
- reference trajectory 438
- with disturbance feed-forward 451

Predictive on–off control
- gap control 118, 126, 481–482
- set point control 107, 473
- start-up control 112, 473, 475

Predictive on–off control algorithm
- limit-violation-time-point-dependent cost
  function 121
Index

- using genetic optimization 110, 118
- using quasi continuous-time optimization 119
- using the online start-up strategy 124
- using the selection strategy 108
Predictive PI control 222
- long-range horizon algorithm 224
- of a first-order process with dead time 225
- one-step-ahead algorithm 223
Predictive PI(D) control
- equivalence with GPC 234
- robust Smith predictor 246
- robustifying filter 245
- set point weighting 243
- structure 222
- tuning 240
Predictive PID control 221, 228
- long-range horizon algorithm 230
- of a second-order process with dead time 231
- one-step-ahead extended horizon algorithm 229
Predictive SISO linear control
- cost function 137
- using matrix inversion (GPC) 138
Predictive transformation
- by repeated substitution 65
- by solving the Diophantine equation 70, 260, 394
- with filtering of the input and output signals 84
- with the matrix calculation method 88
Process identification 336, 562, 585
- application 504, 531
Process model
- application 504, 519, 530
r
Receding horizon strategy 10
Reference signal 4, 578
- future values 3
- reference trajectory 579
- set point 578
- set range 578
- set range funnel 580
s
Sampling time 30
Scaling of variables 290, 293, 572
Shift operator 32
State space model
- linear MIMO 255
- linear SISO 43
State space model (linear SISO)
- incremental 43–44
- minimal order 44
- nonincremental 43
- nonminimal order 48
State variable 43
Step response 35
t
Three-level control
- nonpredictive 489
- predictive 489
Time delay (dead time) 30
w
Weighting function/impulse response 33
z
Zero-order holding 30