Bibliography

[1] J. J. E. Slotine and W. Li, *Applied Nonlinear Control*. Prentice Hall, 1991. (Cited on pp. 3, 4, 6, 14, 16, 20, 33, 59)

[2] V. Utkin, *Sliding Modes in Control and Optimization*, ser. Communication and Control Engineering. Springer-Verlag, 1992. (Cited on pp. 3, 13, 16, 17, 19, 20, 25, 26, 28, 30, 33, 34, 37, 52, 55, 65, 83, 89, 94, 111, 118, 120, 130, 133, 134, 135, 136, 139, 142, 147, 151, 170, 176, 186, 187, 190, 193, 224, 230, 243)

[3] H. K. Khalil, *Nonlinear Systems*. Prentice Hall, 1996. (Cited on pp. 3, 10, 13, 57, 91)

[4] C. Edwards and S. Spurgeon, *Sliding Mode Control: Theory and Applications*, ser. Systems and Control. Taylor & Francis, 1998. (Cited on pp. 3, 15, 17, 20, 55, 65, 83, 89, 94, 111, 130, 170, 186, 243)

[5] A. Isidori, *Nonlinear Control Systems*. Springer-Verlag London, 1995. (Cited on p. 10)

[6] Y. Shtessel, C. Edwards, L. Fridman, and A. Levant, *Sliding Mode Control and Observation*, ser. Control Engineering. Birkhäuser, 2014. (Cited on p. 15)

[7] A. F. Filippov, *Differential Equations with Discontinuous Right-Hand Sides*, ser. Mathematics and Its Applications. Springer, 1988, vol. 18. (Cited on pp. 17, 18, 61)

[8] B. Draženović, "The invariance conditions in variable structure systems," *Automatica*, vol. 5, pp. 287–295, 1969. (Cited on p. 19)

[9] R. A. De Carlo, S. H. Zak, and G. P. Matthews, "Variable structure control of nonlinear multivariable systems: A tutorial," *Proceedings of the IEEE*, vol. 76, pp. 212–232, 1988. (Cited on p. 20)

[10] G. Bartolini, E. Punta, and T. Zolezzi, "Approximability properties for second-order sliding mode control systems," *IEEE Transactions on Automatic Control*, vol. 52, pp. 1813–1825, 2007. (Cited on p. 25)

[11] V. I. Utkin and J. Shi, "Integral sliding mode in systems operating under uncertainty conditions," in *Proc. 35th IEEE Conference on Decision and Control*, vol. 4, Kobe, Japan, 1996, pp. 4591–4596. (Cited on pp. 28, 30, 51, 83, 86, 186, 190, 193)

[12] A. Levant, "Chattering analysis," *IEEE Transactions on Automatic Control*, vol. 55, pp. 1380–1389, 2010. (Cited on pp. 30, 33, 83, 111)

[13] L. Fridman, "Singularly perturbed analysis of chattering in relay control systems," *IEEE Transactions on Automatic Control*, vol. 47, pp. 2079–2084, 2002. (Cited on pp. 33, 111)

[14] I. Boiko, L. Fridman, A. Pisano, and E. Usai, "Analysis of chattering in systems with second-order sliding modes," *IEEE Transactions on Automatic Control*, vol. 52, pp. 2085–2102, 2007. (Cited on pp. 33, 55, 83, 111)

[15] I. Boiko, "Analysis of chattering in sliding mode control systems with continuous boundary layer approximation of discontinuous control," in *Proc. American Control Conference*, San Francisco, CA, USA, 2011, pp. 757–762. (Cited on pp. 33, 55, 111)

[16] G. Bartolini, A. Ferrara, V. I. Utkin, and T. Zolezzi, "A control vector approach to variable structure control of nonlinear systems," *International Journal of Robust and Nonlinear Control*, vol. 7, pp. 321–335, 1997. (Cited on pp. 33, 35, 166)

[17] G. Bartolini, A. Ferrara, and E. Usai, "Output tracking control of uncertain nonlinear second-order systems," *Automatica*, vol. 33, pp. 2203–2212, 1997. (Cited on pp. 33, 36, 37, 38, 48, 49, 89, 111, 166)

[18] G. Bartolini, A. Ferrara, E. Usai, and V. I. Utkin, "On multi-input chattering-free second-order sliding mode control," *IEEE Transactions on Automatic Control*, vol. 45, pp. 1711–1717, 2000. (Cited on pp. 33, 35, 83, 111, 166)

[19] A. Levant, "Higher-order sliding modes, differentiation and output-feedback control," *International Journal of Control*, vol. 76, pp. 924–941, 2003. (Cited on pp. 33, 35, 36, 37, 48, 49, 83, 111, 145, 166, 238, 239)

[20] T. Floquet, J.-P. Barbot, and W. Perruquetti, "Higher-order sliding mode stabilization for a class of nonholonomic perturbed systems," *Automatica*, vol. 39, pp. 1077–1083, 2003. (Cited on pp. 33, 35, 166)

[21] A. Levant, "Quasi-continuous high-order sliding-mode controllers," *IEEE Transactions on Automatic Control*, vol. 50, pp. 1812–1816, 2005. (Cited on pp. 33, 35, 111, 166)

[22] F. Dinuzzo and A. Ferrara, "Higher order sliding mode controllers with optimal reaching," *IEEE Transactions on Automatic Control*, vol. 54, pp. 2126–2136, 2009. (Cited on pp. 33, 35, 45, 46, 56, 60, 61, 62, 83, 89, 104, 111, 158, 166, 225, 239)

[23] V. I. Utkin, J. Guldner, and J. Shi, *Sliding Model Control in Electromechanical Systems*. Taylor & Francis, 1999. (Cited on pp. 33, 36, 83, 89, 129, 166, 193, 230, 243)

[24] G. Bartolini, A. Pisano, E. Punta, and E. Usai, "A survey of applications of second-order sliding mode control to mechanical systems," *International Journal of Control*, vol. 76, pp. 875–892, 2003. (Cited on pp. 33, 166)

[25] L. M. Capisani, A. Ferrara, and L. Magnani, "Design and experimental validation of a second-order sliding-mode motion controller for robot manipulators," *International Journal of Control*, vol. 82, pp. 365–377, 2009. (Cited on pp. 33, 166, 170)

[26] L. M. Capisani, T. Facchinetti, and A. Ferrara, "Real-time networked control of an industrial robot manipulator via discrete-time second-order sliding modes," *International Journal of Control*, vol. 83, pp. 1595–1611, 2010. (Cited on pp. 33, 166)

[27] L. M. Capisani and A. Ferrara, "Trajectory planning and second-order sliding mode motion/interaction control for robot manipulators in unknown environments," *IEEE Transactions on Industrial Electronics*, vol. 59, pp. 3189–3198, 2012. (Cited on pp. 33, 166)

[28] J. P. Aubin and A. Cellina, *Differential Inclusions*. Springer-Verlag, 1984. (Cited on p. 35)

[29] G. Bartolini, A. Ferrara, and E. Usai, "Chattering avoidance by second-order sliding mode control," *IEEE Transactions on Automatic Control*, vol. 43, pp. 241–246, 1998. (Cited on pp. 36, 37, 38, 48, 50, 83, 89, 111, 223, 239, 251)

[30] A. Ferrara and L. Giacomini, "On modular backstepping design with second order sliding modes," *Automatica*, vol. 37, pp. 129–135, 2001. (Cited on p. 37)

[31] G. Bartolini, A. Ferrara, and E. Usai, "On boundary layer dimension reduction in sliding mode control of SISO uncertain nonlinear systems," in *Proc. IEEE International Conference on Control Applications*, vol. 1, Trieste, Italy, 1998, pp. 242–247. (Cited on pp. 37, 89, 145, 146, 147, 148, 149, 236, 250)

[32] A. Levant, "Sliding order and sliding accuracy in sliding mode control," *International Journal of Control*, vol. 58, pp. 1247–1263, 1993. (Cited on pp. 41, 42, 44, 56)

[33] A. Ferrara (Ed.), *Sliding Mode Control of Vehicle Dynamics*, IET, 2017. (Cited on p. 41)

[34] J. A. Moreno and M. Osorio, "Strict Lyapunov functions for the super-twisting algorithm," *IEEE Transactions on Automatic Control*, vol. 57, pp. 1035–1040, 2012. (Cited on p. 44)

[35] M. Basin, D. Calderon-Alvarez, and A. Ferrara, "Sliding mode regulator as solution to optimal control problem," in 47*th IEEE Conference on Decision and Control (CDC)*, Cancun, Mexico, 2008, pp. 2184–2189. (Cited on p. 45)

[36] A. Levant and L. Alelishvili, "Integral high-order sliding modes," *IEEE Transactions on Automatic Control*, vol. 52, pp. 1278–1282, 2007. (Cited on pp. 46, 48, 49, 83)

[37] A. Levant, "Robust exact differentiation via sliding mode technique," *Automatica*, vol. 34, pp. 379–384, 1998. (Cited on pp. 48, 49)

[38] A. Ferrara and G. P. Incremona, "Design of an integral suboptimal second order sliding mode controller for the robust motion control of robot manipulators," *IEEE Transactions on Control Systems Technology*, vol. 23, pp. 2316–2325, 2015. (Cited on pp. 48, 50, 83, 194)

[39] M. V. Kothare, P. J. Campo, M. Morari, and C. N. Nett, "A unified framework for the study of anti-windup designs," *Automatica*, vol. 30, pp. 1869–1883, 1994. (Cited on p. 55)

[40] S. Galeani, S. Tarbouriech, M. Turner, and L. Zaccarian, "A tutorial on modern anti-windup design," in *Proc. European Control Conference*, Budapest, Hungary, 2009, pp. 306–323. (Cited on p. 55)

[41] J. B. Rawlings and D. Q. Mayne, *Model Predictive Control: Theory and Design*. Nob Hill Publishing, 2009. (Cited on pp. 55, 77, 82)

[42] P. O. M. Scokaert and D. Q. Mayne, "Min-max feedback model predictive control for constrained linear systems," *IEEE Transactions on Automatic Control*, vol. 43, pp. 1136–1142, 1998. (Cited on pp. 55, 82)

[43] D. M. Raimondo, D. Limon, M. Lazar, L. Magni, and E. F. Camacho, "Min-max model predictive control of nonlinear systems: A unifying overview on stability," *European Journal of Control*, vol. 15, pp. 5–21, 2009. (Cited on p. 55)

[44] L. Chisci, J. A. Rossiter, and G. Zappa, "Systems with persistent disturbances: Predictive control with restricted constraints," *Automatica*, vol. 37, pp. 1019–1028, 2001. (Cited on p. 55)

[45] D. Limon, T. Alamo, and E. F. Camacho, "Input-to-state stable MPC for constrained discrete-time nonlinear systems with bounded additive uncertainties," in *Proc.* 41*st IEEE Conference on Decision and Control*, vol. 4, Las Vegas, NV, USA, 2002, pp. 4619–4624. (Cited on pp. 55, 82)

[46] A. Ferrara and M. Rubagotti, "A sub-optimal second order sliding mode controller for systems with saturating actuators," *IEEE Transactions on Automatic Control*, vol. 54, pp. 1082–1087, 2009. (Cited on p. 56)

[47] M. Rubagotti, D. M. Raimondo, A. Ferrara, and L. Magni, "Robust model predictive control with integral sliding mode in continuous-time sampled-data nonlinear systems," *IEEE Transactions on Automatic Control*, vol. 56, pp. 556–570, 2011. (Cited on pp. 56, 83, 87)

[48] A. Ferrara, G. P. Incremona, and L. Magni, "A robust MPC/ISM hierarchical multi-loop control scheme for robot manipulators," in *Proc.* 52*nd IEEE Conference on Decision and Control*, Florence, Italy, 2013, pp. 3560–3565. (Cited on pp. 56, 83)

[49] A. Chakrabarty, V. Dinh, G. T. Buzzard, S. H. Zak, and A. E. Rundell, "Robust explicit nonlinear model predictive control with integral sliding mode," in *Proc. American Control Conference*, Portland, OR, USA, 2014, pp. 2851–2856. (Cited on p. 56)

[50] D. M. Raimondo, M. Rubagotti, C. N. Jones, L. Magni, A. Ferrara, and M. Morari, "Multirate sliding mode disturbance compensation for model predictive control," *International Journal of Nonlinear Control*, vol. 25, pp. 2984–3003, 2014. (Cited on pp. 56, 83, 84, 88)

[51] A. Ferrara, G. P. Incremona, and L. Magni, "Model-based event-triggered robust MPC/ISM," in *Proc. European Control Conference*, Strasbourg, France, 2014, pp. 2931–2936. (Cited on pp. 56, 83, 84, 90)

[52] F. Dinuzzo, "A second order sliding mode controller with polygonal constraints." in *Proc.* 48*th IEEE Conference on Decision and Control*, Shanghai, China, 2009, pp. 6715–6719. (Cited on p. 56)

[53] M. Rubagotti and A. Ferrara, "Second order sliding mode control of a perturbed double integrator with state constraints," in *Proc. American Control Conference*, Baltimore, MD, USA, 2010, pp. 985–990. (Cited on pp. 56, 89)

[54] M. Tanelli and A. Ferrara, "Enhancing robustness and performance via switched second order sliding mode control," *IEEE Transactions on Automatic Control*, vol. 58, pp. 962–974, 2013. (Cited on pp. 56, 111)

[55] M. Tanelli and A. Ferrara, "Switched second-order sliding mode control with partial information: Theory and application," *Asian Journal of Control*, vol. 15, pp. 20–30, 2013. (Cited on p. 56)

[56] A. Ferrara, G. P. Incremona, and M. Rubagotti, "Third order sliding mode control with box state constraints," in *Proc.* 52*nd IEEE Conference on Decision and Control*, Los Angeles, CA, USA, 2014, pp. 4727–4732. (Cited on pp. 56, 83)

[57] G. Bartolini, A. Ferrara, A. Levant, and E. Usai, "On second order sliding mode controllers," in *Variable Structure Systems, Sliding Mode and Nonlinear Control*, ser. Lecture Notes in Control and Information, K. D. Young and Ü. Özgüner, Eds. Springer-Verlag, 1999, pp. 329–350. (Cited on pp. 57, 89, 111)

[58] F. Blanchini and S. Miani, *Set-Theoretic Methods in Control*, ser. Systems & Control: Foundations & Applications. Birkhäuser, 2008. (Cited on pp. 64, 67)

[59] M. Athans and P. L. Falb, *Optimal Control*. McGraw Hill, 1966. (Cited on pp. 66, 158)

[60] S. S. L. Chang, "Optimal control in bounded phase space," *Automatica*, vol. 1, pp. 55–67, 1963. (Cited on p. 66)

[61] M. Grant and S. Boyd, *CVX: Matlab Software for Disciplined Convex Programming*, Version 2.1, http://cvxr.com/cvx, December 2018. (Cited on p. 69)

[62] M. Morari and J. H. Lee, "Model predictive control: Past, present and future," *Computers & Chemical Engineering*, vol. 23, pp. 667–682, 1999. (Cited on p. 77)

[63] D. Q. Mayne, J. B. Rawlings, C. V. Rao, and P. O. M. Scokaert, "Constrained model predictive control: Stability and optimality," *Automatica*, vol. 36, pp. 789–814, 2000. (Cited on p. 77)

[64] J. M. Maciejowski, *Predictive Control with Constraints*. Prentice Hall, 2002. (Cited on pp. 77, 82)

[65] L. Magni and R. Scattolini, "Model predictive control of continuous-time nonlinear systems with piecewise constant control," *IEEE Transactions on Automatic Control*, vol. 49, pp. 900–906, 2004. (Cited on pp. 77, 83, 87)

[66] E. F. Camacho and C. Bordons Alba, *Model Predictive Control*, ser. Advanced Textbooks in Control and Signal Processing. Springer-Verlag, 2007. (Cited on p. 77)

[67] D. Q. Mayne, "Model predictive control: Recent developments and future promise," *Automatica*, vol. 50, pp. 2967–2986, 2014. (Cited on pp. 77, 82)

[68] L. Magni, D. M. Raimondo, and F. Allgöwer, *Nonlinear Model Predictive Control: Towards New Challenging Applications*, ser. Lecture Notes in Control and Information Sciences. Springer Science+Business Media, 2009. (Cited on p. 82)

[69] M. Lazar and W. P. M. H. Heemels, "Predictive control of hybrid systems: Input-to-state stability results for sub-optimal solutions," *Automatica*, vol. 45, pp. 180–185, 2009. (Cited on p. 82)

[70] G. Pin, D. M. Raimondo, L. Magni, and T. Parisini, "Robust model predictive control of nonlinear systems with bounded and state-dependent uncertainties," *IEEE Transactions on Automatic Control*, vol. 54, pp. 1681–1687, 2009. (Cited on p. 82)

[71] F. A. C. C. Fontes and L. Magni, "Min-max model predictive control of nonlinear systems using discontinuous feedbacks," *IEEE Transactions on Automatic Control*, vol. 48, pp. 1750–1755, 2003. (Cited on pp. 82, 191)

[72] A. Bemporad, F. Borrelli, and M. Morari, "Min-max control of constrained uncertain discrete-time linear systems," *IEEE Transactions on Automatic Control*, vol. 48, pp. 1600–1606, 2003. (Cited on p. 82)

[73] L. Magni, G. De Nicolao, R. Scattolini, and F. Allgower, "Robust model predictive control for nonlinear discrete-time systems," *International Journal of Robust and Nonlinear Control*, vol. 13, pp. 229–246, 2003. (Cited on pp. 82, 83)

[74] D. Limon Marruedo, T. Alamo, F. Salas, and E. F. Camacho, "Input to state stability of min-max MPC controllers for nonlinear systems with bounded uncertainties," *Automatica*, vol. 42, pp. 797–803, 2006. (Cited on pp. 82, 191)

[75] D. Mayne, S. Rakovifa, R. Findeisen, and F. Allgower, "Robust output feedback model predictive control of constrained linear systems," *Automatica*, vol. 42, pp. 1217–1222, 2006. (Cited on p. 83)

[76] T. Goggia, A. Sorniotti, L. De Novellis, A. Ferrara, P. Gruber, J. Theunissen, D. Steenbeke, B. Knauder, and J. Zehetner, "Integral sliding mode for the torque-vectoring control of fully electric vehicles: Theoretical design and experimental assessment," *IEEE Transactions on Vehicular Technology*, vol. 64, pp. 1701–1715, 2014. (Cited on p. 83)

[77] K. R. Muske, H. Ashrafiuon, and M. Nikkhah, "A predictive and sliding mode cascade controller," in *American Control Conference*, New York, 2007, pp. 4540–4545. (Cited on p. 83)

[78] W. Garcia-Gabin, D. Zambrano, and E. F. Camacho, "Sliding mode predictive control of a solar air conditioning plant," *Control Engineering Practice*, vol. 17, pp. 652–663, 2009. (Cited on p. 83)

[79] L. Magni, D. M. Raimondo, and R. Scattolini, "Regional input-to-state stability for nonlinear model predictive control," *IEEE Transactions on Automatic Control*, vol. 51, pp. 1548–1553, 2006. (Cited on pp. 83, 87)

[80] P. Tabuada, "Event-triggered real-time scheduling of stabilizing control tasks," *IEEE Transactions on Automatic Control*, vol. 52, pp. 1680–1685, 2007. (Cited on pp. 84, 89, 95, 112)

[81] R. A. Gupta and M.-Y. Chow, "Networked control system: Overview and research trends," *IEEE Transactions on Industrial Electronics*, vol. 57, pp. 2527–2535, 2010. (Cited on pp. 84, 89)

[82] E. Garcia and P. J. Antsaklis, "Model-based event-triggered control with time-varying network delays," in *Proc. 50th IEEE Conference on Decision and Control*, Orlando, FL, USA, 2011, pp. 1650–1655. (Cited on pp. 84, 113)

[83] G. P. Incremona, A. Ferrara, and L. Magni, "Asynchronous networked MPC with ISM for uncertain nonlinear systems," *IEEE Transactions on Automatic Control*, vol. 62, pp. 4305–4317, 2017. (Cited on p. 84)

[84] M. Rubagotti, A. Estrada, F. Castanos, A. Ferrara, and L. Fridman, "Integral sliding mode control for nonlinear systems with matched and unmatched perturbations," *IEEE Transactions on Automatic Control*, vol. 56, pp. 2699–2704, 2011. (Cited on p. 86)

[85] V. I. Utkin, "Sliding modes control in discrete-time and difference systems," in *Variable Structure and Lyapunov Control*, ser. Lecture Notes in Control and Information Sciences. Springer, 1993, vol. 193, pp. 87–107. (Cited on p. 89)

[86] G. Bartolini, A. Ferrara, A. Pisano, and E. Usai, "Adaptive reduction of the control effort in chattering-free sliding-mode control of uncertain nonlinear systems," *International Journal of Applied Mathematics and Computer Science*, vol. 8, pp. 51–57, 1998. (Cited on pp. 89, 145, 147)

[87] Y. Shtessel, C. Edwards, L. Fridman, and A. Levant, "Higher-order sliding mode controllers and differentiators," in *Sliding Mode Control and Observation*, ser. Control Engineering. Springer, 2014, pp. 213–249. (Cited on p. 89)

[88] J. P. Hespanha, P. Naghshtabrizi, and Y. Xu, "A survey of recent results in networked control systems," *Proceedings of the IEEE*, vol. 95, pp. 138–162, 2007. (Cited on p. 89)

[89] F. Y. Wang and D. Liu, *Networked Control Systems: Theory and Applications*. Springer-Verlag, 2008. (Cited on p. 89)

[90] G.-P. Liu, Y. Xia, J. Chen, D. Rees, and W. Hu, "Networked predictive control of systems with random network delays in both forward and feedback channels," *IEEE Transactions on Industrial Electronics*, vol. 54, pp. 1282–1297, 2007. (Cited on p. 89)

[91] W. Zhang, M. Branicky, and S. Phillips, "Stability of networked control systems," *IEEE Control Systems*, vol. 21, pp. 84–99, 2001. (Cited on p. 89)

[92] J. Ludwiger, M. Steinberger, M. Rotulo, M. Horn, A. Luppi, G. Kubin, and A. Ferrara, "Towards networked sliding mode control," in 56*th IEEE Conference on Decision and Control (CDC)*, Melbourne, Australia, 2017, pp. 6021–6026. (Cited on p. 89)

[93] J. Ludwiger, M. Steinberger, M. Horn, G. Kubin, and A. Ferrara, "Discrete time sliding mode control strategies for buffered networked systems," in 57*th IEEE Conference on Decision and Control (CDC)*, Miami Beach, FL, 2018, pp. 6735–6740. (Cited on p. 89)

[94] L. Rogelio and R. Asok, "An observer-based compensator for distributed delays," *Automatica*, vol. 26, pp. 903–908, 1990. (Cited on p. 89)

[95] J. Nilsson and B. Bernhardsson, "Analysis of real-time control systems with time delays," in *Proc. 35th IEEE Conference on Decision and Control*, vol. 3, Kobe, Japan, 1996, pp. 3173–3178. (Cited on p. 89)

[96] M. Mazo and P. Tabuada, "On event-triggered and self-triggered control over sensor/actuator networks," in *Proc.* 47*th IEEE Conference on Decision and Control*, Cancun, Mexico, 2008, pp. 435–440. (Cited on p. 89)

[97] K. J. Aström, "Event based control," in *Analysis and Design of Nonlinear Control Systems*, A. Astolfi and L. Marconi, Eds. Springer, 2008, pp. 127–147. (Cited on p. 89)

[98] W. P. M. H. Heemels, J. H. Sandee, and P. P. J. Van Den Bosch, "Analysis of event-driven controllers for linear systems," *International Journal of Control*, vol. 81, pp. 571–590, 2008. (Cited on p. 89)

[99] H. Yu and P. J. Antsaklis, "Event-triggered real-time scheduling for stabilization of passive and output feedback passive systems," in *Proc. American Control Conference*, San Francisco, CA, USA, 2011, pp. 1674–1679. (Cited on p. 89)

[100] K.-Y. You and L.-H. Xie, "Survey of recent progress in networked control systems," *Acta Automatica Sinica*, vol. 39, pp. 101–117, 2013. (Cited on p. 89)

[101] W. Heemels, K. Johansson, and P. Tabuada, "An introduction to event-triggered and self-triggered control," in *Proc.* 51*st IEEE Conference on Decision and Control*, Maui, HI, USA, 2012, pp. 3270–3285. (Cited on p. 89)

[102] B. Demirel, V. Gupta, and M. Johansson, "On the trade-off between control performance and communication cost for event-triggered control over lossy networks," in *European Control Conference*, Zürich, Switzerland, 2013, pp. 1168–1174. (Cited on p. 89)

[103] E. Garcia and P. J. Antsaklis, "Model-based event-triggered control for systems with quantization and time-varying network delays," *IEEE Transactions on Automatic Control*, vol. 58, pp. 422–434, 2013. (Cited on p. 90)

[104] L. A. Montestruque and P. Antsaklis, "Stability of model-based networked control systems with time-varying transmission times," *IEEE Transactions on Automatic Control*, vol. 49, pp. 1562–1572, 2004. (Cited on p. 90)

[105] G. P. Incremona and A. Ferrara, "Adaptive model-based event-triggered sliding mode control," *International Journal of Adaptive Control and Signal Processing*, vol. 30, pp. 1298–1316, 2016. (Cited on pp. 90, 130)

[106] A. Ferrara and G. P. Incremona, "Networked model-based event-triggered sliding mode control," in *Recent Trends in Sliding Mode Control*, ser. Control, Robotics & Sensors, IET Digital Library, 2016, vol. 102, ch. 4.3, pp. 317–339. (Cited on pp. 90, 110, 111, 113)

[107] A. Ferrara, S. Sacone, and S. Siri, "Model-based event-triggered control for freeway traffic systems," in *Proc.* 1*st IEEE International Conference on Event-Based Control, Communication, and Signal Processing*, Krakow, Poland, 2015. (Cited on p. 90)

[108] A. Ferrara, S. Sacone, and S. Siri, "Event-triggered strategies for the networked control of freeway traffic systems," in *Proc. European Control Conference*, Strasbourg, France, 2014, pp. 2594–2599. (Cited on p. 90)

[109] A. Ferrara and M. Cucuzzella, *Event-Triggered Sliding Mode Control Strategies for a Class of Nonlinear Uncertain Systems*. Springer International Publishing, 2018, ch. 16, pp. 397–425. (Cited on p. 90)

[110] M. Cucuzzella and A. Ferrara, "Practical second order sliding modes in single-loop networked control of nonlinear systems," *Automatica*, vol. 89, pp. 235–240, 2018. (Cited on p. 90)

[111] M. Cucuzzella, G. P. Incremona, and A. Ferrara, "Event-triggered variable structure control," *International Journal of Control*, to appear. (Cited on p. 90)

[112] M. Cucuzzella, G. P. Incremona, and A. Ferrara, "Event-triggered sliding mode control algorithms for a class of uncertain nonlinear systems: Experimental assessment," in *Proc. American Control Conference*, Boston, MA, USA, 2016, pp. 6549–6554. (Cited on p. 90)

[113] M. Cucuzzella and A. Ferrara, "Event-triggered second order sliding mode control of nonlinear uncertain systems," in *Proc. European Control Conference*, Aalborg, Denmark, 2016, pp. 295–300. (Cited on p. 90)

[114] A. K. Behera and B. Bandyopadhyay, "Event-triggered sliding mode control for a class of nonlinear systems," *International Journal of Control*, vol. 89, pp. 1916–1931, 2016. (Cited on p. 90)

[115] A. van der Schaft and H. Schumacher, *An Introduction to Hybrid Dynamical Systems*, ser. Lecture Notes in Control and Information Sciences. Springer-Verlag, 2000, vol. 251. (Cited on pp. 90, 98)

[116] J. Lunze and F. Lamnabhi-Lagarrigue, Eds., *Handbook of Hybrid Systems Control: Theory, Tools, Applications*. Cambridge University Press, 2009. (Cited on pp. 90, 98)

[117] R. Goebel, R. G. Sanfelice, and A. R. Teel, *Hybrid Dynamical Systems: Modeling, Stability, and Robustness*. Princeton University Press, 2012. (Cited on pp. 90, 98)

[118] K. H. Johansson, J. Lygeros, S. Sastry, and M. Egerstedt, "Simulation of Zeno hybrid automata," in *Proc.* 38*th IEEE Conference on Decision and Control*, vol. 4, Phoenix, AZ, USA, 1999, pp. 3538–3543. (Cited on pp. 90, 96, 98, 107)

[119] A. D. Ames, P. Tabuada, and S. Sastry, *On the Stability of Zeno Equilibria*. Springer Berlin Heidelberg, 2006, pp. 34–48. (Cited on pp. 90, 96, 98, 107)

[120] J. La Salle and S. Lefschetz, *Stability by Lyapunov's Direct Method with Applications*, ser. Mathematics in Science and Engineering. Elsevier, 2012, vol. 4. (Cited on p. 94)

[121] L. Fridman, "The problem of chattering: An averaging approach," in *Variable Structure Systems, Sliding Mode and Nonlinear Control*, ser. Lecture Notes in Control and Information Sciences, K. Young and Ü. Özgüner, Eds. Springer, 1999, vol. 247, pp. 363–386. (Cited on p. 111)

[122] I. Boiko and L. Fridman, "Frequency domain input–output analysis of sliding-mode observers," *IEEE Transactions on Automatic Control*, vol. 51, pp. 1798–1803, 2006. (Cited on p. 111)

[123] H. Lee and V. I. Utkin, "Chattering suppression methods in sliding mode control systems," *Annual Reviews in Control*, vol. 31, pp. 179–188, 2007. (Cited on p. 111)

[124] K. J. Aström and B. M. Bernhardsson, "Comparison of Riemann and Lebesgue sampling for first order stochastic systems," in *Proc.* 41*st IEEE Conference on Decision and Control*, vol. 2, Las Vegas, NV, USA, 2002, pp. 2011–2016. (Cited on p. 112)

[125] F. Plestan, Y. Shtessel, V. Brégeault, and A. Poznyak, "New methodologies for adaptive sliding mode control," *International Journal of Control*, vol. 83, pp. 1907–1919, 2010. (Cited on p. 129)

[126] Y. B. Shtessel, J. A. Moreno, F. Plestan, L. M. Fridman, and A. S. Poznyak, "Super-twisting adaptive sliding mode control: A Lyapunov design," in 49*th IEEE Conference on Decision and Control (CDC)*, 2010, pp. 5109–5113. (Cited on p. 129)

[127] J. Kochalummoottil, Y. B. Shtessel, J. A. Moreno, and L. Fridman, "Output feedback adaptive twisting control: A Lyapunov design," in 2012 *American Control Conference (ACC)*, 2012, pp. 6172–6177. (Cited on p. 129)

[128] V. I. Utkin and A. S. Poznyak, *Adaptive Sliding Mode Control*. Springer, 2013, pp. 21–53. (Cited on p. 129)

[129] A. Pisano, M. Tanelli, and A. Ferrara, "Switched/time-based adaptation for second-order sliding mode control," *Automatica*, vol. 64, pp. 126–132, 2016. (Cited on p. 129)

[130] V. I. Utkin and A. S. Poznyak, "Adaptive sliding mode control with application to super-twist algorithm: Equivalent control method," *Automatica*, vol. 49, pp. 39–47, 2013. (Cited on p. 129)

[131] G. Bartolini, A. Ferrara, and L. Giacomini, "A switching controller for systems with hard uncertainties," *IEEE Transactions on Circuits and Systems* I*, Fundamental Theory and Application*, vol. 50, pp. 984–990, 2003. (Cited on pp. 133, 134, 135)

[132] M.-L. Tseng and M.-S. Chen, "Chattering reduction of sliding mode control by low-pass filtering the control signal," *Asian Journal of Control*, vol. 12, pp. 392–398, 2010. (Cited on p. 142)

[133] J. A. Burton and A. S. I. Zinober, "Continuous approximation of variable structure control," *International Journal of Systems Science*, vol. 17, pp. 875–885, 1986. (Cited on p. 142)

[134] G. P. Incremona, M. Cucuzzella, and A. Ferrara, "Adaptive suboptimal second-order sliding mode control for microgrids," *International Journal of Control*, vol. 89, pp. 1849–1867, 2016. (Cited on p. 145)

[135] G. P. Incremona, M. Cucuzzella, and A. Ferrara, "Second order sliding mode control for nonlinear affine systems with quantized uncertainty," *Automatica*, vol. 86, pp. 46–52, 2017. (Cited on p. 150)

[136] G. P. Incremona, M. Rubagotti, and A. Ferrara, "Sliding mode control of constrained nonlinear systems," *IEEE Transactions on Automatic Control*, vol. 62, pp. 2965–2972, 2016. (Cited on pp. 56, 67, 157)

[137] S. Lloyd, "Measures of complexity: A nonexhaustive list," *IEEE Control Systems Magazine*, vol. 21, pp. 7–8, 2001. (Cited on p. 165)

[138] D. Braha, A. A. Minai, and Y. Bar-Yam, Eds., *Complex Engineered Systems*, 1st ed., ser. Understanding Complex Systems. Springer-Verlag, 2006, vol. 6. (Cited on p. 165)

[139] P. A. Ioannou and A. Pitsillides, *Modeling and Control of Complex Systems*. CRC Press, 2007. (Cited on pp. 165, 166)

[140] A. A. Minai, D. Braha, and Y. Bar-Yam, Eds., *Unifying Themes in Complex Systems IX*, 1st ed., ser. Springer Proceedings in Complexity. Springer-Verlag, 2008, vol. 6. (Cited on p. 165)

[141] F. Lamnabhi-Lagarrigue, A. Annaswamy, S. Engell, A. Isaksson, P. Khargonekar, R. M. Murray, H. Nijmeijer, T. Samad, D. Tilbury, and P. V. den Hof, "Systems and control for the future of humanity, research agenda: Current and future roles, impact and grand challenges," *Annual Reviews in Control*, vol. 43, pp. 1–64, 2017. (Cited on p. 165)

[142] M. W. Spong and S. Hutchinson, *Robot Modeling and Control*. Wiley, 2005. (Cited on p. 166)

[143] G. Bartolini, W. Caputo, M. Cecchi, A. Ferrara, and L. Fridman, "Vibration damping in elastic robotic structures via sliding modes," *Journal of Robotic Systems*, vol. 14, pp. 675–696, 1997. (Cited on p. 166)

[144] A. Ferrara and L. Giacomini, "Control of a class of mechanical systems with uncertainties via a constructive adaptive/second order VSC approach," *ASME Journal on Dynamic Systems, Measurement and Control*, vol. 122, pp. 33–39, 2000. (Cited on p. 166)

[145] A. Ferrara, L. Magnani, and R. Scattolini, "A switching scheme for mixed PZT-based/jet thrusters control of a large flexible structure," *ASME Journal on Dynamic Systems, Measurement and Control*, vol. 123, pp. 722–727, 2000. (Cited on p. 166)

[146] A. Ferrara and C. Lombardi, "Interaction control of robotic manipulators via second order sliding modes," *International Journal on Adaptive Control and Signal Processing*, vol. 21, pp. 708–730, 2007. (Cited on p. 166)

[147] A. Ferrara and M. Rubagotti, "Second-order sliding-mode control of a mobile robot based on a harmonic potential field," *IET Control Theory and Applications*, vol. 2, pp. 807–818, 2008. (Cited on p. 166)

[148] J. Davila, L. Fridman, and A. Levant, "Second-order sliding-mode observer for mechanical systems," *IEEE Transactions on Automatic Control*, vol. 50, pp. 1785–1789, 2005. (Cited on p. 166)

[149] J. Davila, L. Fridman, and A. Poznyak, "Observation and identification of mechanical systems via second order sliding modes," *International Journal of Control*, vol. 79, pp. 1251–1262, 2007. (Cited on p. 166)

[150] E. Cruz-Zavala, J. A. Moreno, and L. Fridman, "Uniform second-order sliding mode observer for mechanical systems," in *Proc. 11th International Workshop on Variable Structure Systems (VSS)*, Mexico City, Mexico, 2010, pp. 14–19. (Cited on p. 166)

[151] B. Siciliano and O. Khatib, Eds., *The Handbook of Robotics*. Springer, 2008. (Cited on pp. 167, 171, 172, 173, 197)

[152] B. Siciliano, L. Sciavicco, L. Villani, and G. Oriolo, *Robotics-Modelling, Planning and Control*, 3rd ed. Springer-Verlag, 2009, pp. 248–302. (Cited on pp. 167, 168, 169, 173, 175, 177, 183, 185, 192)

[153] A. Calanca, L. M. Capisani, A. Ferrara, and L. Magnani, "MIMO closed loop identification of an industrial robot," *IEEE Transactions on Control Systems Technology*, vol. 19, pp. 1214–1224, 2011. (Cited on pp. 168, 194)

[154] G. P. Incremona, G. De Felici, A. Ferrara, and E. Bassi, "A supervisory sliding mode control approach for cooperative robotic system of systems," *IEEE Systems Journal*, vol. 9, pp. 263–272, 2015. (Cited on pp. 169, 176)

[155] J. Boardman and B. Sauser, "System of systems—The meaning of," in *Proc. IEEE/SMC International Conference on System of Systems Engineering*, Los Angeles, CA, USA, 2006, pp. 118–123. (Cited on p. 169)

[156] A. Gorod, B. Sauser, and J. Boardman, "System-of-systems engineering management: A review of modern history and a path forward," *IEEE Systems Journal*, vol. 2, pp. 484–499, 2008. (Cited on p. 169)

[157] D. Williams and O. Khatib, "The virtual linkage: A model for internal forces in multi-grasp manipulation," in *Proc. International Conference on Robotics and Automation*, vol. 1, Atlanta, GA, USA, 1993, pp. 1025–1030. (Cited on p. 170)

[158] D. Williams and O. Khatib, "Multi-grasp manipulation," in *Proc. International Conference on Robotics and Automation*, vol. 3, Nagoya, Aichi, Japan, 1995, p. 9. (Cited on p. 170)

[159] K. S. Chang, R. Holmberg, and O. Khatib, "The augmented object model: Cooperative manipulation and parallel mechanism dynamics," in *Proc. International Conference on Robotics and Automation*, vol. 1, San Francisco, CA, USA, 2000, pp. 470–475. (Cited on p. 170)

[160] M. Uchiyama and P. Dauchez, "A symmetric hybrid position/force control scheme for the coordination of two robots," in *Proc. International Conference on Robotics and Automation*, vol. 1, Philadelphia, PA, USA, 1988, pp. 350–356. (Cited on pp. 170, 172)

[161] E. Bassi, F. Benzi, L. Capisani, D. Cuppone, and A. Ferrara, "Characterization of the dynamical model of a force sensor for robot manipulators," in *Robot Motion and Control* 2009, ser. Lecture Notes in Control and Information Sciences, K. Kozlowski, Ed. Springer, 2009, vol. 396, pp. 243–253. (Cited on pp. 170, 174)

[162] A. Ferrara and G. P. Incremona, "Robust motion control of a robot manipulator via integral suboptimal second order sliding modes," in *Proc. 52nd IEEE Conference on Decision and Control*, Florence, Italy, 2013, pp. 1107–1112. (Cited on p. 182)

[163] G. P. Incremona, A. Ferrara, and L. Magni, "MPC for robot manipulators with integral sliding modes generation," *IEEE/ASME Transactions on Mechatronics*, vol. 22, pp. 1299–1307, 2017. (Cited on p. 192)

[164] A. Ferrara, G. P. Incremona, and B. Sangiovanni, "Integral sliding mode based switched structure control scheme for robot manipulators," in *15th International Workshop on Variable Structure Systems (VSS)*, Graz, Austria, 2018, pp. 168–173. (Cited on p. 196)

[165] B. Sangiovanni, G. P. Incremona, A. Ferrara, and M. Piastra, "Deep reinforcement learning based self-configuring integral sliding mode control scheme for robot manipulators," in *57th IEEE Conference on Decision and Control (CDC)*, Miami Beach, FL, 2018, pp. 5969–5974. (Cited on p. 198)

[166] B. Sangiovanni, A. Rendiniello, G. P. Incremona, A. Ferrara, and M. Piastra, "Deep reinforcement learning for collision avoidance of robotic manipulators," in *European Control Conference (ECC)*, Limassol, Cyprus, 2018, pp. 2063–2068. (Cited on p. 198)

[167] H. B. Puttgen, P. R. MacGregor, and F. C. Lambert, "Distributed generation: Semantic hype or the dawn of a new era?" *IEEE Power and Energy Magazine*, vol. 1, pp. 22–29, 2003. (Cited on p. 205)

[168] R. H. Lasseter and P. Paigi, "Microgrid: A conceptual solution," in *Proc. 35th IEEE Power Electronics Specialists Conference*, vol. 6, Aachen, Germany, 2004, pp. 4285–4290. (Cited on pp. 205, 227)

[169] J. M. Guerrero, P. C. Loh, T.-L. Lee, and M. Chandorkar, "Advanced control architectures for intelligent microgrids—Part II: Power quality, energy storage, and AC/DC microgrids," *IEEE Transactions on Industrial Electronics*, vol. 60, pp. 1263–1270, 2013. (Cited on pp. 205, 217, 227, 228)

[170] F. Katiraei, M. R. Iravani, and P. W. Lehn, "Micro-grid autonomous operation during and subsequent to islanding process," *IEEE Transactions on Power Delivery*, vol. 20, pp. 248–257, 2005. (Cited on p. 205)

[171] P. Piagi and R. H. Lasseter, "Autonomous control of microgrids," in *Proc. Power Engineering Society General Meeting*, Montréal, Canada, 2006, p. 8. (Cited on p. 205)

[172] M. H. Zamani, G. H. Riahy, and A. J. Ardakani, "Modifying power curve of variable speed wind turbines by performance evaluation of pitch-angle and rotor speed controllers," in *Proc. Electrical Power Conference*, Montréal, Canada, 2007, pp. 347–352. (Cited on p. 205)

[173] H. Karimi, H. Nikkhajoei, and R. Iravani, "Control of an electronically-coupled distributed resource unit subsequent to an islanding event," *IEEE Transactions on Power Delivery*, vol. 23, pp. 493–501, 2008. (Cited on pp. 205, 217)

[174] H. Karimi, E. Davison, and R. Iravani, "Multivariable servomechanism controller for autonomous operation of a distributed generation unit: Design and performance evaluation," *IEEE Transactions on Power Systems*, vol. 25, pp. 853–865, 2010. (Cited on pp. 205, 217)

[175] M. Hamzeh, H. Karimi, and H. Mokhtari, "A new control strategy for a multi-bus MV microgrid under unbalanced conditions," *IEEE Transactions on Power Systems*, vol. 27, pp. 2225–2232, 2012. (Cited on p. 205)

[176] M. Hamzeh, A. Ghazanfari, H. Mokhtari, and H. Karimi, "Integrating hybrid power source into an islanded MV microgrid using CHB multilevel inverter under unbalanced and nonlinear load conditions," *IEEE Transactions on Energy Conversion*, vol. 28, pp. 643–651, 2013. (Cited on p. 205)

[177] M. Babazadeh and H. Karimi, "A robust two-degree-of-freedom control strategy for an islanded microgrid," *IEEE Transactions on Power Delivery*, vol. 28, pp. 1339–1347, 2013. (Cited on pp. 205, 217)

[178] K. De Brabandere, B. Bolsens, J. Van den Keybus, A. Woyte, J. Driesen, and R. Belmans, "A voltage and frequency droop control method for parallel inverters," *IEEE Transactions on Power Electronics*, vol. 22, pp. 1107–1115, 2007. (Cited on p. 205)

[179] C.-T. Lee, C.-C. Chu, and P.-T. Cheng, "A new droop control method for the autonomous operation of distributed energy resource interface converters," *IEEE Transactions on Power Electronics*, vol. 28, pp. 1980–1993, 2013. (Cited on p. 205)

[180] R. Palma-Behnke, C. Benavides, F. Lanas, B. Severino, L. Reyes, J. Llanos, and D. Saez, "A microgrid energy management system based on the rolling horizon strategy," *IEEE Transactions on Smart Grid*, vol. 4, pp. 996–1006, 2013. (Cited on p. 205)

[181] A. Parisio, E. Rikos, and L. Glielmo, "A model predictive control approach to microgrid operation optimization," *IEEE Transactions on Control Systems Technology*, vol. 22, pp. 1813–1827, 2014. (Cited on p. 205)

[182] D. Salomonsson, L. Soder, and A. Sannino, "An adaptive control system for a DC microgrid for data centers," *IEEE Transactions on Industry Applications*, vol. 44, pp. 1910–1917, 2008. (Cited on p. 205)

[183] A. Bidram, A. Davoudi, F. L. Lewis, and S. S. Ge, "Distributed adaptive voltage control of inverter-based microgrids," *IEEE Transactions on Energy Conversion*, vol. 29, pp. 862–872, 2014. (Cited on p. 205)

[184] T. Hornik and Q.-C. Zhong, "A current-control strategy for voltage-source inverters in microgrids based on H^∞ and repetitive control," *IEEE Transactions on Power Electronics*, vol. 26, pp. 943–952, 2011. (Cited on p. 205)

[185] M. S. Sadabadi, Q. Shafiee, and A. Karimi, "Plug-and-play voltage stabilization in inverter-interfaced microgrids via a robust control strategy," *IEEE Transactions on Control Systems Technology*, vol. 25, pp. 781–791, 2017. (Cited on pp. 205, 217, 227)

[186] M. Cucuzzella, G. P. Incremona, and A. Ferrara, "Master-slave second order sliding mode control for microgrids," in *Proc. American Control Conference*, Chicago, IL, USA, 2015, pp. 5188–5193. (Cited on pp. 206, 209, 210)

[187] M. Cucuzzella, G. P. Incremona, and A. Ferrara, "Third order sliding mode voltage control in microgrids," in *Proc. European Control Conference*, Linz, Austria, 2015, pp. 2384–2389. (Cited on pp. 206, 209, 210)

[188] M. Cucuzzella, G. P. Incremona, and A. Ferrara, "Design of robust higher order sliding mode control for microgrids," *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, vol. 5, pp. 393–401, 2015. (Cited on pp. 206, 209, 210)

[189] R. H. Park, "Two-reaction theory of synchronous machines generalized method of analysis—Part I," *Transactions of the American Institute of Electrical Engineers*, vol. 48, pp. 716–727, 1929. (Cited on p. 206)

[190] R. J. Vijayan, S. Ch, and R. Roy, "Dynamic modeling of microgrid for grid connected and intentional islanding operation," in *Proc. International Conference on Advances in Power Conversion and Energy Technologies*, Mylavaram, Andhra Pradesh, India, 2012, pp. 1–6. (Cited on p. 207)

[191] I. J. Balaguer, Q. Lei, S. Yang, U. Supatti, and F. Z. Peng, "Control for grid-connected and intentional islanding operations of distributed power generation," *IEEE Transactions on Industrial Electronics*, vol. 58, pp. 147–157, 2011. (Cited on p. 207)

[192] M. Cucuzzella, S. Trip, C. De Persis, and A. Ferrara, "Distributed second order sliding modes for optimal load frequency control," in *Proc.* 2017 *American Control Conference (ACC)*, Seattle, WA, USA, 2017, pp. 3451–3456. (Cited on p. 207)

[193] S. Trip, M. Cucuzzella, A. Ferrara, and C. De Persis, "An energy function based design of second order sliding modes for automatic generation control," in *Proc.* 20*th IFAC World Congress*, Toulouse, France, 2017, pp. 11 613–11 618. (Cited on p. 207)

[194] G. Rinaldi, M. Cucuzzella, and A. Ferrara, "Third order sliding mode observer-based approach for distributed optimal load frequency control," *IEEE Control Systems Letters*, vol. 1, pp. 215–220, 2017. (Cited on p. 207)

[195] M. Gholami, A. Pilloni, A. Pisano, Z. A. S. Dashti, and E. Usai, "Robust consensus-based secondary voltage restoration of inverter-based islanded microgrids with delayed communications," in *Proc. IEEE Conference on Decision and Control*, Miami Beach, FL, USA, 2018, pp. 811–816. (Cited on p. 207)

[196] S. Trip, M. Cucuzzella, C. D. Persis, A. van der Schaft, and A. Ferrara, "Passivity-based design of sliding modes for optimal load frequency control," *IEEE Transactions on Control Systems Technology*, to appear. (Cited on p. 207)

[197] G. Rinaldi, M. Cucuzzella, and A. Ferrara, "Sliding mode observers for a network of thermal and hydroelectric power plants," *Automatica*, vol. 98, pp. 51–57, 2018. (Cited on p. 207)

[198] S. Trip, M. Cucuzzella, C. De Persis, A. Ferrara, and J. M. A. Scherpen, "Robust load frequency control of nonlinear power networks," *International Journal of Control*, to appear. (Cited on p. 207)

[199] P. Pillay and M. Manyage, "Definitions of voltage unbalance," *IEEE Power Engineering Review*, vol. 21, pp. 50–51, 2001. (Cited on p. 210)

[200] IEEE, *Recommended Practice for Monitoring Electric Power Quality*, IEEE Std 1159-2009 (Revision of IEEE Std 1159-1995), 2009. (Cited on pp. 210, 211)

[201] J. G. Ziegler and N. B. Nichols, "Optimum settings for automatic controllers," *ASME Journal of Dynamic Systems*, vol. 64, pp. 759–768, 1942. (Cited on p. 211)

[202] M. Cucuzzella, G. P. Incremona, M. Guastalli, and A. Ferrara, "Sliding mode control for maximum power point tracking of photovoltaic inverters in microgrids," in *Proc. IEEE* 55*th Conference on Decision Control*, Las Vegas, NV, USA, 2016, pp. 7294–7299. (Cited on pp. 215, 217)

[203] R. H. Lasseter, "Microgrids," in *Proc. IEEE Power Engineering Society Winter Meeting*, vol. 1, New York, 2002, pp. 305–308. (Cited on p. 217)

[204] E. Planas, A. Gil-de Muro, J. Andreu, I. Kortabarria, and I. M. de Alegría, "General aspects, hierarchical controls and droop methods in microgrids: A review," *Renewable and Sustainable Energy Reviews*, vol. 17, pp. 147–159, 2013. (Cited on p. 217)

[205] O. Palizban, K. Kauhaniemi, and J. M. Guerrero, "Microgrids in active network management—Part I: Hierarchical control, energy storage, virtual power plants, and market participation," *Renewable and Sustainable Energy Reviews*, vol. 36, pp. 428–439, 2014. (Cited on p. 217)

[206] S. M. Amin and B. F. Wollenberg, "Toward a smart grid: Power delivery for the 21st century," *IEEE Power and Energy Magazine*, vol. 3, pp. 34–41, 2005. (Cited on p. 217)

[207] S. Trip, M. Bürger, and C. De Persis, "An internal model approach to frequency regulation in inverter-based microgrids with time-varying voltages," in *Proc. 53rd IEEE Conference on Decision and Control*, Los Angeles, CA, USA, 2014, pp. 223–228. (Cited on pp. 217, 227)

[208] C. De Persis and N. Monshizadeh, "Bregman storage functions for microgrid control," *IEEE Transactions on Automatic Control*, vol. 63, pp. 53–68, 2017. (Cited on pp. 217, 227)

[209] G. P. Incremona, M. Cucuzzella, L. Magni, and A. Ferrara, "MPC with sliding mode control for the energy management system of microgrids," in *Proc. 20th IFAC World Congress*, Toulouse, France, 2017, pp. 7397–7402. (Cited on p. 217)

[210] G. P. Incremona, M. Cucuzzella, A. Ferrara, and L. Magni, "Model predictive control and sliding mode control for current sharing in microgrids," in *Proc. IEEE 56th Conf. Decision Control*, Melbourne, Australia, 2016, pp. 2661–2666. (Cited on p. 217)

[211] M. Cucuzzella, S. Trip, A. Ferrara, and J. M. A. Scherpen, "Cooperative Voltage Control in AC Microgrids," in *Proc. IEEE 57th Conf. Decision Control*, Miami Beach, FL, USA, 2018, pp. 6723–6728. (Cited on p. 217)

[212] J. Zhao and F. Dörfler, "Distributed control and optimization in DC microgrids," *Automatica*, vol. 61, pp. 18–26, 2015. (Cited on pp. 219, 230, 243, 246)

[213] F. Dörfler and F. Bullo, "Kron reduction of graphs with applications to electrical networks," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 60, pp. 150–163, 2013. (Cited on pp. 219, 232, 246)

[214] M. Cucuzzella, G. P. Incremona, and A. Ferrara, "Decentralized sliding mode control of islanded AC microgrids with arbitrary topology," *IEEE Transactions on Industrial Electronics*, vol. 64, pp. 6706–6713, 2017. (Cited on p. 220)

[215] J. J. Justo, F. Mwasilu, J. Lee, and J.-W. Jung, "AC-microgrids versus DC-microgrids with distributed energy resources: A review," *Renewable and Sustainable Energy Reviews*, vol. 24, pp. 387–405, 2013. (Cited on p. 228)

[216] X. Liu, P. Wang, and P. C. Loh, "A hybrid AC/DC microgrid and its coordination control," *IEEE Transactions on Smart Grid*, vol. 2, pp. 278–286, 2011. (Cited on p. 228)

[217] N. Flourentzou, V. G. Agelidis, and G. D. Demetriades, "VSC-based HVDC power transmission systems: An overview," *IEEE Transactions on Power Electronics*, vol. 24, pp. 592–602, 2009. (Cited on p. 228)

[218] E. Benedito, D. del Puerto-Flores, A. Dòria-Cerezo, O. van der Feltz, and J. M. A. Scherpen, "Strictly convex loss functions for port-Hamiltonian based optimization algorithm for MTDC networks," in *Proc. 55th IEEE Conference on Decision and Control*, Las Vegas, NV, USA, 2016, pp. 7483–7488. (Cited on p. 228)

[219] M. Andreasson, R. Wiget, D. V. Dimarogonas, K. H. Johansson, and G. Andersson, "Distributed frequency control through MTDC transmission systems," *IEEE Transactions on Power Systems*, vol. 32, pp. 250–260, 2017. (Cited on p. 228)

[220] D. Zonetti, R. Ortega, and J. Schiffer, "A tool for stability and power sharing analysis of a generalized class of droop controllers for high-voltage direct-current transmission systems," *IEEE Transactions on Control of Network Systems*, vol. 5, pp. 1110–1119, 2018. (Cited on p. 228)

[221] J. M. Guerrero, J. C. Vasquez, J. Matas, L. G. de Vicuna, and M. Castilla, "Hierarchical control of droop-controlled AC and DC microgrids—A general approach toward standardization," *IEEE Transactions on Industrial Electronics*, vol. 58, pp. 158–172, 2011. (Cited on p. 229)

[222] X. Lu, J. M. Guerrero, K. Sun, and J. C. Vasquez, "An improved droop control method for DC microgrids based on low bandwidth communication with DC bus voltage restoration and enhanced current sharing accuracy," *IEEE Transactions on Power Electronics*, vol. 29, pp. 1800–1812, 2014. (Cited on p. 229)

[223] S. Anand, B. G. Fernandes, and J. Guerrero, "Distributed control to ensure proportional load sharing and improve voltage regulation in low-voltage DC microgrids," *IEEE Transactions on Power Electronics*, vol. 28, pp. 1900–1913, 2013. (Cited on pp. 230, 243)

[224] V. Nasirian, S. Moayedi, A. Davoudi, and F. L. Lewis, "Distributed cooperative control of DC microgrids," *IEEE Transactions on Power Electronics*, vol. 30, pp. 2288–2303, 2015. (Cited on pp. 230, 243)

[225] M. Hamzeh, A. Ghazanfari, Y. A. R. I. Mohamed, and Y. Karimi, "Modeling and design of an oscillatory current-sharing control strategy in DC microgrids," *IEEE Transactions on Industrial Electronics*, vol. 62, pp. 6647–6657, 2015. (Cited on pp. 230, 243)

[226] C. De Persis, E. Weitenberg, and F. Dörfler, "A power consensus algorithm for DC microgrids," *Automatica*, vol. 89, pp. 364–375, 2018. (Cited on pp. 230, 243)

[227] S. Trip, M. Cucuzzella, X. Cheng, and J. Scherpen, "Distributed averaging control for voltage regulation and current sharing in DC microgrids," *IEEE Control Systems Letters*, vol. 3, pp. 174–179, 2019. (Cited on p. 230)

[228] S. Trip, R. Han, M. Cucuzzella, X. Cheng, J. M. A. Scherpen, and J. Guerrero, "Distributed averaging control for voltage regulation and current sharing in DC microgrids: Modelling and experimental validation," in 7*th IFAC Workshop on Distributed Estimation and Control in Networked Systems*, Groningen, Netherlands, 2018, pp. 242–247. (Cited on p. 230)

[229] M. Cucuzzella, S. Trip, and J. M. A. Scherpen, "A consensus-based controller for DC power networks," in 5*th IFAC Conference on Analysis and Control of Chaotic Systems*, Eindhoven, Netherlands, 2018, pp. 205–210. (Cited on p. 230)

[230] M. Cucuzzella, K. C. Kosaraju, and J. M. A. Scherpen, "Distributed passivity-based control of DC microgrids," in *Proc. American Control Conference*, Philadelphia, PA, USA, to appear. (Cited on p. 230)

[231] X.-G. Yan, S. K. Spurgeon, and C. Edwards, "Application of decentralised sliding mode control to multimachine power systems," in *Variable Structure Control of Complex Systems*. Springer, 2017, pp. 297–313. (Cited on p. 230)

[232] S. Trip, M. Cucuzzella, C. De Persis, X. Cheng, and A. Ferrara, "Sliding modes for voltage regulation and current sharing in DC microgrids," in *Proc. American Control Conference*, Milwaukee, WI, USA, 2018, pp. 6778–6783. (Cited on p. 230)

[233] M. Cucuzzella, S. Trip, C. De Persis, X. Cheng, A. Ferrara, and A. van der Schaft, "A robust consensus algorithm for current sharing and voltage regulation in DC microgrids," *IEEE Transactions on Control Systems Technology*, 2018. (Cited on pp. 231, 233)

[234] V. Venkatasubramanian, H. Schattler, and J. Zaborszky, "Fast time-varying phasor analysis in the balanced three-phase large electric power system," *IEEE Transactions on Automatic Control*, vol. 40, pp. 1975–1982, 1995. (Cited on pp. 231, 246)

[235] C. Zhao, E. Mallada, and F. Dörfler, "Distributed frequency control for stability and economic dispatch in power networks," in *Proc. American Control Conference*, Chicago, IL, USA, 2015, pp. 2359–2364. (Cited on p. 232)

[236] D. S. Bernstein, *Matrix Mathematics: Theory, Facts, and Formulas with Application to Linear Systems Theory*. Princeton University Press, 2005, vol. 41. (Cited on p. 241)

[237] D. Bernstein and S. Bhat, "Lyapunov stability, semistability, and asymptotic stability of matrix second-order systems," *Journal of Vibration and Acoustics*, vol. 117, pp. 145–153, 1995. (Cited on p. 241)

[238] M. Cucuzzella, S. Rosti, A. Cavallo, and A. Ferrara, "Decentralized sliding mode voltage control in DC microgrids," in *Proc. American Control Conference (ACC)*, Seattle, WA, USA, 2017, pp. 3445–3450. (Cited on p. 242)

[239] G. Canciello, A. Cavallo, M. Cucuzzella, and A. Ferrara, "Fuzzy scheduling of robust controllers for islanded DC microgrids applications," *International Journal of Dynamics and Control*, to appear. (Cited on p. 242)

[240] B. J. Cardoso, A. F. Moreira, B. R. Menezes, and P. C. Cortizo, "Analysis of switching frequency reduction methods applied to sliding mode controlled DC-DC converters," in *Applied Power Electronics Conference and Exposition*, 1992, pp. 403–410. (Cited on p. 244)

[241] A. Bartoszewicz, "Discrete-time quasi-sliding-mode control strategies," *IEEE Transactions on Industrial Electronics*, vol. 45, pp. 633–637, 1998. (Cited on p. 244)

[242] H. E. Fadil, F. Giri, and H. Ouadi, "Adaptive sliding mode control of PWM boost DC-DC converters," in *IEEE Conference on Computer Aided Control System Design, IEEE International Conference on Control Applications, IEEE International Symposium on Intelligent Control*, 2006, pp. 3151–3156. (Cited on p. 244)

[243] S. Oucheriah and L. Guo, "PWM-based adaptive sliding-mode control for boost DC–DC converters," *IEEE Transactions on Industrial Electronics*, vol. 60, pp. 3291–3294, 2013. (Cited on p. 244)

[244] M. Cucuzzella, R. Lazzari, S. Trip, S. Rosti, C. Sandroni, and A. Ferrara, "Sliding mode voltage control of boost converters in DC microgrids," *Control Engineering Practice*, vol. 73, pp. 161–170, 2018. (Cited on p. 245)

[245] M. Cucuzzella, R. Lazzari, S. Trip, C. Sandroni, and A. Ferrara, "Robust voltage regulation of boost converters in DC microgrids," in *Proc. European Control Conference*, Limassol, Cyprus, 2018, pp. 2350–2355. (Cited on p. 245)

[246] D. Ronchegalli and R. Lazzari, "Development of the control strategy for a direct current microgrid: A case study," in *AEIT International Annual Conference*, 2016, pp. 1–6. (Cited on p. 245)

[247] H. Akagi, E. H. Watanabe, and M. Aredes, *Instantaneous Power Theory and Applications to Power Conditioning*. John Wiley & Sons, 2006. (Cited on p. 246)

Index

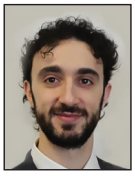
A compendium of the authors' recently published results, this book discusses sliding mode control of uncertain nonlinear systems, with a particular emphasis on advanced and optimization based algorithms. The authors survey classical sliding mode control theory and introduce four new methods of advanced sliding mode control. They analyze classical theory and advanced algorithms, with numerical results complementing the theoretical treatment. Case studies examine applications of the algorithms to complex robotics and power grid problems.

Advanced and Optimization Based Sliding Mode Control: Theory and Applications

- is the first book to systematize the theory of optimization based higher order sliding mode control and illustrate advanced algorithms and their applications to real problems;
- presents systematic treatment of event-triggered and model based event-triggered sliding mode control schemes, including schemes in combination with model predictive control;
- presents adaptive algorithms as well as algorithms capable of dealing with state and input constraints; and
- includes simulations and experimental results obtained by applying the presented control strategies to real complex systems.

This book is suitable for students and researchers interested in control theory. It will also be attractive to practitioners interested in implementing the illustrated strategies. It is accessible to anyone with a basic knowledge of control engineering, process physics, and applied mathematics.

A. Ferrara is full professor of automatic control in the department of electrical, computer, and biomedical engineering (ECBE) at the University of Pavia. She has authored or co-authored more than 380 scientific papers and three scientific books, and she has contributed invited chapters to 23 edited volumes. She is associate editor of *IEEE Control Systems Magazine*, subject editor of *International Journal of Robust and Nonlinear Control*, and associate editor of *Automatica*. She is chair of the European Control Association (EUCA) Conference Editorial Board. Her research activities focus on sliding mode control and nonlinear control with applications to the automotive industry, robotics, power networks, process control, and vehicular traffic systems.



G. P. Incremona is assistant professor of automatic control at the Politecnico di Milano. He is a recipient of the 2018 Best Young Author Paper Award from the Italian chapter of the IEEE Control Systems Society and a member of the conference editorial boards of the IEEE Control Systems Society and the European Control Association. His research focuses on variable structure control, optimal control, and networked control with applications to robotics, power systems, and glycemia control in diabetic subjects.

M. Cucuzzella is a postdoctoral researcher at the University of Groningen. He received his PhD in electronics, computer science, and electrical engineering from the University of Pavia under the supervision of Professor Ferrara. He received the IEEE Italy Section Award for the best PhD thesis on new technological challenges in energy and industry and the SIDRA Award for the best PhD thesis in the field of systems and control engineering. He is an associate editor for the European Control Conference. His research focuses on nonlinear control with applications to power networks.

For more information about SIAM books, journals, conferences, memberships, or activities, contact:

siam

Society for Industrial and Applied Mathematics
3600 Market Street, 6th Floor
Philadelphia, PA 19104-2688 USA
+1-215-382-9800 • Fax +1-215-386-7999
siam@siam.org • *www.siam.org*

ISBN 978-1-611975-83-3
90000
9781611975833

DC34