

Tutorial proposal for IECON 2018

Model Predictive Control of Power Electronic Converters: Fundamentals and New Applications

1. Presenter(s):

Prof. Jose Rodriguez, Universidad Andres Bello, Chile, jose.rodriguez@unab.cl

Assoc. Prof. Marco Rivera Abarca, University of Talca, Chile, marcoriv@utalca.cl

Assoc. Prof. Tomislav Dragičević, Aalborg University, Denmark, tdr@et.aau.dk

Prof. Sergio Vazquez, University of Seville, Spain, sergi@us.es

2. Brief description (What you are going to present?):

Model Predictive Control (MPC) is a conceptually simple yet powerful methodology to control power converters and electric drives. It has many advantages over traditional linear controllers including (i) faster response, (ii) high robustness to parameter variation (iii) explicit multivariable control accounting for the process and actuator constraints. The advances in processing power of digital signal processors have recently promoted MPC into the first commercial applications, which opened a door towards improved performance and efficiency of power electronic converters and drives demanded by the evolving industry applications. This tutorial will provide the fundamentals required to understand, design and implement state-of-the-art MPC methods in grid-connected power converters, electrical drives and microgrids. The tutorial is aimed for both PhD students and practicing engineers.

3. Outline (How you are going to use 2 hrs time to present your tutorial?):

14:00 – 14:30 Model predictive control (MPC) in power electronics – Jose Rodriguez

14:30 – 15:00 Application of MPC to different converter topologies – Marco Rivera

15:00 – 15:30 Application of MPC to AC and DC microgrids – Tomislav Dragičević

15:30 – 16:00 MPC with fixed switching frequency – Sergio Vazquez

4. Publications (Your publications relevant to the tutorial):

S. Vazquez, J. Rodriguez, M. Rivera, L. G. Franquelo and M. Norambuena, "Model Predictive Control for Power Converters and Drives: Advances and Trends," in IEEE Trans. on Ind. Electron., vol. 64, no. 2, pp. 935-947, Feb. 2017.

T. Dragičević, "Dynamic Stabilization of DC Microgrids with Predictive Control of Point of Load Converters," IEEE Trans. Power Electron., vol. in press, pp. 1–13, 2018.

T. Dragičević, "Model Predictive Control of Power Converters for Robust and Fast Operation of AC Microgrids," IEEE Trans. on Power Electron., vol. 33, pp. 6304–6317, July 2018.

S. Vazquez, A. Marquez, R. Aguilera, D. Quevedo, J. I. Leon and L. G. Franquelo, "Predictive Optimal Switching Sequence Direct Power Control for Grid-Connected Power Converters," in IEEE Trans. on Ind. Electron., vol. 62, no. 4, pp. 2010-2020, April 2015.

C. F. Garcia, M. E. Rivera, J. R. Rodríguez, P. W. Wheeler and R. S. Peña, "Predictive Current Control with Instantaneous Reactive Power Minimization for a Four-Leg Indirect Matrix Converter," in IEEE Trans. on Ind. Electron., vol. 64, no. 2, pp. 922-929, Feb. 2017.

S. Vazquez, J. I. Leon, L. G. Franquelo, J. Rodriguez, H. A. Young, A. Marquez and P. Zanchetta, "Model Predictive Control: A Review of Its Applications in Power Electronics," in IEEE Ind. Electron. Mag., vol. 8, no. 1, pp. 16-31, March 2014.

5. Presenter's biography (IEEE style):

Jose Rodriguez (M'81–SM'94–F'09) received the Electrical Engineer degree from the Universidad Federico Santa Maria, Valparaiso, Chile, in 1977, and the Dr. Ing. degree in electrical engineering from the University of Erlangen, Erlangen, Germany, in 1985. Since 2015, he has been a Professor and a Rector with the Universidad Andres Bello, Santiago, Chile. He has co-authored more than 400 papers published in journals and conference proceedings, more than 100 of them in IEEE journals. His research interests include new converter topologies, multilevel inverters, control of power converters, and adjustable-speed drives. Prof. Rodriguez has received several Best Paper Awards from IEEE journals. He has been an Associate Editor of three IEEE journals. In 2015, he received the IEEE Industrial Electronics Society Dr. Ing. Eugene Mittelmann Achievement Award. He is a member of the Chilean Academy of Engineering.

Marco Rivera (S'09–M'11–SM'17) was born in Talca, Chile, in 1982. He received the B.Sc. degree in electronics engineering and the M.Sc. degree in electrical engineering from the Universidad de Concepcion, Concepcion, Chile, in 2007 and 2008, respectively, and the Ph.D. degree in electronics engineering from the Universidad Tecnica Federico Santa Maria, Valparaiso, Chile, in 2011. Since 2013, he has been with the Energy Conversion and Power Electronics Research Group, Universidad de Talca, Talca, Chile, where he is an Associate Professor in the Department of Electrical Engineering. His research interests include digital control applied to power electronics and model predictive control of power converters for renewable energy applications. Dr. Rivera received the Best Ph.D. Thesis Award in 2012, from the Chilean Academy of Science. He received 2015 Second Prize Paper Award from the IEEE JOURNAL OF EMERGING AND SELECTED TOPICS IN POWER ELECTRONICS.

Tomislav Dragičević (S'09–M'13–SM'17) received the M.E.E. and the industrial Ph.D. degree from the Faculty of Electrical Engineering, Zagreb, Croatia, in 2009 and 2013, respectively. From 2013 until 2016 he has been a Postdoctoral research associate at Aalborg University, Denmark. From March 2016 he is an Associate Professor at Aalborg University, Denmark. His field of interest is design and control microgrids, and application of advanced modelling and control concepts to power electronics systems. He has authored and co-authored more than 120 technical papers and a book in this field. He serves as an Associate Editor in the IEEE TRANS. ON INDUSTRIAL ELECTRONICS.

Sergio Vazquez (S'04–M'08–SM'14) was born in Seville, Spain, in 1974. He received the M.S. and Ph.D. degrees in industrial engineering from the Universidad de Sevilla, Seville, Spain, in 2006 and 2010, respectively. He is an Associate Professor with the Universidad de Sevilla. His research interests include modelling, modulation, and control of power electronics converters for renewable energy systems. Dr. Vazquez received the 2012 Best Paper Award as a co-author from the IEEE Trans. on Industrial Electronics and the 2015 Best Paper Award from the IEEE INDUSTRIAL ELECTRONICS MAGAZINE. He is currently an Associate Editor of the IEEE TRANS. ON INDUSTRIAL ELECTRONICS.