Robust Control using Extended Kalman Filter and its Variations Combined

with

Sliding Mode Control

Lectures held by Prof. Paolo Mercorelli from the 5th until the 9th of February 2024 at the University of Miskolc, Hungary

Content

The lectures are aimed at illustrating the basic concepts and computational tools needed to effectively investigate the structure of a robust control loop which can consist of a Kalman filter as a robust estimator and a Sliding Mode control strategy as a robust controller. During the lectures different Kalman Filters are used as state estimators. In particular, starting from linear cases, the famous Extended Kalman Filter structure will be analysed together with some of its variation structures: Cascade Kalman Filters and Dual Kalman Filters combined with Sliding Mode Control. The course is aimed at pointing out specific needs and priorities related to the conceptual understanding of the Kalman Filter structures in strict connection with applications in control. The applications in control and in particular with Sliding Mode Control and its variations with their peculiar robustness are pointed out. The 20-hours contact teaching course is primarily intended for Master's Degree students, but it can be fruitfully attended also by doctoral students and by Bachelor's Degree students with a focus on automation as well as by any interested researchers in the field or in an affine one. In fact, the course is conceived in a way that, starting from the main inspiring concepts using direct Matalb/Simulink in the classroom, a wide gamma of applications will be shown.

Program from the 5th until the 9th February 2024

- Monday the 5th of February 2024 from 14:30 am until 18:30 am - A basic concept and notions of the concept of observability of a dynamical system (linear and nonlinear case), concept of the observer and Kalman Filters;

- Tuesday the 6th of February 2024 from 14:30 am until 18:30 am – Exercises using Matlab/Simulink Filters in the classroom concerning analysis, design and software implementation of Linear Kalman Filters and introduction on Extended Kalman Filters;

- Wednesday the 7th of February 2024 from 14:30 am until 18:30 am - Some variations of Kalman Filters and exercises. Introduction on Sliding Mode Control;

- Thursday the 8h of February 2024 from 14:30 am until 18:30 am - Sliding Mode Control more in depth;

- Friday the 9th of February 2024 from 14:30 am until 18:30 am – Some applications in Sliding Mode Control;

Contacts

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The program can be subject to some variations

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Paolo Mercorelli received his PhD from the University Bologna in year 1998. In 1997, during the PhD training he spent one year at the University of California at Santa Barbara working with Prof. Brad Paden. Paolo Mercorelli received an award from the Marie Curie Actions research fellowship program sponsored by The European Commission in year 1998. The Marie-Curie Fellowships are Europe's most competitive and prestigious awards, and are aimed at fostering interdisciplinary research and international collaboration. Thanks to this award, from 1998 to 2002, he was a postdoctoral researcher with ABB (Asea Brown Boveri) Corporate Research, Heidelberg, Germany. From 2002 to 2005, he was a senior researcher with the Institute of Automation and Informatics, Wernigerode, Germany, where Paolo Mercorelli was the leader of the control group. He received eight best international conferences paper awards: IECON 2013, IECON 2014, CoDIT 2014, ICCC 2017, FedCSIS 2019, ACD 2019, ICCC 2020, ICSTCC 2023. He held eight plenary lectures in international conferences. Since 2019, he has continuously been in the list of World's Top 2% most cited scientists, in accordance with the Elsevier Database and featured in Stanford University. https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw/6

Main academic and research activities from 2005 until the present

From 2005 to 2011, Paolo Mercorelli was an Associate Professor of Process Informatics with Ostfalia University of Applied Sciences, Wolfsburg, Germany. In Wolfsburg, he was involved in various projects with the Volkswagen AG Research Center developing different control systems which have been implemented in production series of vehicles as, for instance, the control algorithms for Intelligent Parking Assist System. In 2010 he received the call from the **German University in Cairo** (Egypt) to accept a Full Professorship (Chair) in Mechatronics, which he declined. In 2011 he was a visiting professor at **Villanova University**, Philadelphia, USA, where he was invited to become Professor of Dynamic Systems, which he declined. Since 2012 he has had the position of Full Professor and Head of the Chair of Control and Drive Systems at the **Institute for Production Technology and Systems**, **Leuphana University of Lueneburg**, Lueneburg, Germany. Since 2018 he has obtained an international visiting professor fellowship at the Institute of Automatic Control of **Lodz University of Technology** (Poland) at the Master in "Automatic Control and Robotics". Since 2018 he has obtained a visiting scientist fellowship with the **Institute of Information Theory and Automation (UTIA)** at the Czech Academy of Science of Prague (Czech Republic). He has been involved in different research projects and in particular, in a project concerning DC/DC converters control supported by Panasonic Ltd. Lueneburg.

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