講演会

日時： 2017 年 6 月 7 日 (水) 13:00〜15:00

講演１： 13:00〜14:00

Sliding Mode Controllers and Sliding Mode Control for Multi-input Nonlinear Uncertain Systems

Elisabetta Punta 博士 (イタリア CNR-IEIIT)

講演２： 14:00〜15:00

Randomized Algorithms and Uncertain Systems: Aeronautical Applications

Elisa Capello 博士 (イタリア トリノ工科大学 / CNR-IEIIT)

場所： 大阪大学 吹田キャンパス 情報科学研究科 C 棟 1 階 C101 室 (住所：吹田市山田丘 1–5)

講演１： 13:00〜14:00

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講師： Elisabetta Punta 博士 (イタリア CNR-IEIIT)

概要： The history and evolution of sliding mode control will be introduced and discussed. The first order sliding mode methods and the second order sliding mode control algorithms, together with their specific features will be presented. The main concept of sliding mode, including discontinuous control, Filippov's definition of solution, sliding surface, Utkin's definition of the equivalent control, chattering phenomenon and uncertainty will be introduced, discussed and analysed. The precision featured by the different sliding mode controllers will be considered. The extension of the sliding mode methodology to the control of multi-input nonlinear uncertain systems will be also discussed, together with the crucial role played by the matrix multiplying the control inputs vector in the dynamic equation of the sliding output. When the control matrix is perfectly known and invertible it is possible to transform a multi-input sliding mode control problem in an almost decoupled set of single-input problems. In general, the properties of the control matrix allow to find conditions to design the Lyapunov function, which guarantees that the sliding motion on the sliding manifold can be attained. The simplex sliding mode control method applied to multi-input nonlinear control systems under uncertainties will be introduced. According to such sliding mode control method, the control vector is constrained to belong to a finite set of (fixed or varying) vectors, with an appropriate switching logic to guarantee the specified sliding condition. Bounded uncertainties acting on the nominal nonlinear system are allowed. Experimental results will be presented to illustrate the properties of the main sliding mode algorithms and strategies.

略歴： Elisabetta Punta (MSc, Electronic Engineering, 1993, and PhD, Electronic Engineering and Computer Science, 1998, Genoa University, Italy) is a researcher of the National Research Council of Italy (CNR) at the Institute CNR-IEIIT. From 1994 to 2003, she was research fellow at Genoa University. She participated and directed several research projects. She is a member of the Italian Research Unit of the Joint International Lab COOPS, CNR Italy and JST Japan, 2015-2017. Dr. Punta is Senior Member IEEE, member of the IEEE-CSS Technical Committee on Variable Structure and Sliding Mode Control, member of the IPC of the IEEE International VSS Workshop, member of the CEB of the IEEE-CSS, Subject Editor for International Journal of Adaptive Control and Signal Processing and Associate Editor for IMA Journal of Mathematical Control and Information. She is author of more than 90 works published in international journals, books, and proceedings of international conferences. Her research interests include Variable Structure Systems, Sliding Mode Control Theory, Higher Order Sliding Mode Control, Sliding Mode Observers, Nonlinear Control, Nonlinear Observers, Mechanical Systems, Time Delay Systems, Energy Production Systems, Telecommunication Systems, Control and Optimization Methods for Freeways, and Complex Systems.

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概要： Uncertainty has always been a critical issue in control systems. In recent years, a growing interest in probabilistic and randomized methods for the analysis and design of these systems can be observed. Uncertainty modeling is especially crucial in the model development for mini-UAVs since their aerodynamics data are more difficult to be set and they are generally more sensitive to wind gust disturbance than full-size aircraft. In addition, low cost onboard sensors produce significant sensor data errors and measurement noise. Classical robustness tools, which are basically available only for linear uncertainty structures, are not directly applicable, and alternative simulation-based techniques are especially appealing. In particular, a class of low-complexity algorithms, based on sequential probabilistic validation techniques, is analyzed. For aeronautical systems, the fundamental challenges are associated with developing controllers that are robust to uncertainties and are flexible enough to quickly respond to dynamic changes. The main contribution, presented in this lecture, is to demonstrate that the proposed sequential algorithm provides a randomized controller which stabilizes the uncertain system and that this algorithm does not suffer from computational complexity drawbacks. Moreover, the presented algorithm also incorporates a robustness validation test, involving stability of interval matrices. The “ a posteriori ” analysis is also considered, that includes the computation of the real and complex stability radii, based on the theory of worst case deterministic and probabilistic analysis. Throughout this talk, an overview on Monte Carlo randomized algorithms is also presented. In particular, the notion of sample complexity, demonstrating its key role in feedback analysis, is introduced and related probabilistic bounds (for example, Chernoff bound) are studied.

略歴： Elisa Capello received her PhD (March 2011) from Politecnico di Torino and now she is in the Flight Mechanics group of the Mechanical and Aerospace Engineering Department of Politecnico di Torino as Assistant Professor. She is a research associate of the National Research Council of Italy (CNR) at the Institute of Electronics, Computer and Telecommunication Engineering (CNR-IEIIT) from 2012 and she is currently involved in a Joint Lab Project with the Department of Information and Physical Sciences, Osaka University/JST CREST. Her domains of expertise are flight mechanics, aircraft (manned and unmanned) control system, Matlab programming. She worked in some Italian projects supported by the Piedmont region and by the Italian Antarctica Research Project. She serves as regular reviewer for scientific journals, published by Springer, Emerald, ASCE, etc.. She worked on the assessment of load control system activation logics to react effectively to sudden or quasi-static external load source, in the JTI Clean Sky project supported by EU research funds and on the development of a 6 dof simulator for rendezvous e docking maneuvers. She is an international FAI judge for helicopter championships.

企画： 大阪大学 大学院情報科学研究科 情報数理学専攻
藤崎泰正
(JST-CREST EMS 領域 内田チーム 藤崎グループ / 国際ジョイントラボ COOPS)

共催： IEEE Control Systems Society Kansai Chapter

担当： 藤崎泰正 (教員室 TEL: 06-6879-7868, Email: fujisaki@ist.osaka-u.ac.jp)