Tutorial Proposal
IEEE 20th International Conference on Industrial Informatics (INDIN 2022)

Tutorial Title: An Active Disturbance Rejection Method: The Equivalent Input Disturbance Approach and Its Applications

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1. KEYWORDS

Active disturbance rejection, equivalent input disturbance (EID), disturbance estimation, disturbance rejection, robust control, state observer, system design

2. AIMS AND LEARNING OBJECTIVES

This tutorial aims at explaining what is called the equivalent-input-disturbance (EID) approach from theory to application. It is an active disturbance-rejection method and features improving control performance. The target audiences include academic researchers and industrial engineers. After attending this tutorial, audiences will be able to

1) understand the basic concept of equivalent input disturbance and the mechanism of disturbance estimation and rejection;
2) understand the structure of an EID estimator and analyze the robustness and performance of an EID-based control system; and
3) design an EID-based control system to achieve satisfactory disturbance-rejection performance.

3. SHORT SUMMARY OF CONTENTS

Industrial systems usually contain disturbances that degrade control performance. Thus, disturbance rejection is one of the most important objectives in control-system design. Several elegant methods, which have two degrees of freedom, have been devised and used in control engineering practice. Since one degree of freedom is directly used for disturbance rejecting, this kind of method has the potential to achieve high disturbance-rejection performance. The EID approach is one of the methods. It uses a state observer and an EID estimator to actively estimate and compensate for the effect of disturbances on system output. It does not require the inverse dynamics of a plant, a system state, a model of exogenous disturbances, or the differentiation of measured outputs. Thus, it is simple to implement and is effective in rejecting various kinds of disturbances.

In this tutorial, three speakers are going to explain the method from the basic idea to the recently developed theoretical results and advanced applications. First, the background and the way of

thinking about active disturbance rejection, and the definition of an EID are explained. Next, the configuration of an EID-based control system is described. Techniques of system design are discussed in detail. Then, the analysis of system stability and control performance is discussed. Finally, Application examples of the EID approach in different industrial fields are demonstrated.

4. TARGET AUDIENCE

Engineers, researchers, and graduate students in the fields of electrical engineering, mechanical engineering, high-precision engineering, process control, etc.

5. DURATION

(< 90 min.) 70 min

6. SHORT BIOGRAPHY OF SPEAKER (max. ½ page)

Jinhua She received his Ph.D. degree from Tokyo Institute of Technology, Tokyo, Japan, in 1993 in control engineering. In 1993, he joined the School of Engineering, Tokyo University of Technology, where he is currently a professor at the Department of Mechanical Engineering. His research interests include the application of control theory, repetitive control, process control, Internet-based engineering education, and assistive robotics.

Dr. She's research interests include the applications of control theory, repetitive control, active disturbance rejection, process control, mobile-based engineering education, and assistive robotics. He has published more than 300 journal papers. His work has been cited 10831 times, and his h-index is 41 and i10-index is 144 (Google Scholar, January 8, 2021). He received the IFAC (International Federation of Automatic Control) Control Engineering Practice Paper Prize in 1999 (jointly with M. Wu and M. Nakano), and had been included in the list of Thomson Reuters' Highly Cited Researchers in 2012-2015.

Dr. She served as the Delegate of Cluster 4 of Technical Committees (containing 6 TCs) in IES and the Chair of IEEE IES Technical Committee on Human Factors, and is an AdCom member from 2022 to 2024. He is an Associate Editor of IEEE Transactions on Industrial Electronics, IEEE/ASME Transactions on Mechatronics, IEEE Journal of Emerging and Selected Topics in Industrial Electronics, etc.

Lan Zhou received the B.S. degree from Hunan Normal University, Changsha, China, in 1998, and the M.S. degree and the Ph.D. degree from Central South University, Changsha, China, in 2006 and 2011, respectively. From 2008 to 2010, she was a Joint Cultivation Doctoral Candidate of Japan and China. She is currently a Professor of Control Theory and Control Engineering at the School of Information and Electrical Engineering, Hunan University of Science and Technology, Xiangtan, China. Her current research interests include robust control, repetitive control, nonlinear control, and application for mechatronic systems.

Youwu Du received the B.S. and the M.S. degrees in engineering from Central South University, Changsha, China, in 2007 and 2010, respectively, and the ph.D. degree in engineering from China University of Geosciences, Wuhan, China, in 2020. In 2012, he joined the School of Physics and

Electronic Information, Anhui Normal University, Wuhu, China. He was a Visiting Scholar with the Graduate School of Industrial Technology, Advanced Institute of Industrial Technology, Tokyo, Japan, from 2018 to 2019. In 2021, he moved to the School of Electrical & Information Engineering, Jiangsu University of Technology, Changzhou, China. His research interests include disturbance estimation and rejection, application of control theory, time-delay system, and robust control. Dr. Du is a member of IEEE and a member of the Automation Association of China.