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Fractional Order Adaptive Control: the switched order approach

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ABSTRACT: While controlling a real process, the designer rarely knows its parameters accurately. The characteristics of the process can change with time due to a variety of factors. There may also be unforeseen changes in the statistics of the external inputs and disturbances that may be considered as change in the environment in which the system operates. The tools of conventional control theory, even when used efficiently, may be inadequate to achieve satisfactory performance in the entire range over which the characteristics of the system may vary.

In 1957, Drenick and Shahbender introduced the term adaptive system in control theory to represent control systems that monitor their own performance and adjust their parameters in the direction of better performance. A great deal of work and effort was made along the years to propose different kind of stable adaptive control strategies, but due to their nonlinear nature, a common framework for stability analysis was lacking, until the error model approach appeared.

In early 2000s, fractional operators were introduced in adaptive control, and subsequently a series of generalizations of adaptive schemes were made to the fractional order case. Different advantages of fractional adaptive controllers were reported, such as better management of noise, improvements in transient responses, better behavior in the presence of disturbances, among other. Still, the lack of analytical tools to generalize error model approach to fractional cases was a problem, until some results appeared around 2015 and they were partially solved.

Still, the use of fractional adaptive schemes and classic integer order adaptive schemes usually presented a trade-off among system speed of response and control energy used. This problem has led to a new approach, currently under investigation, regarding the use of switched fractional order adaptive schemes, such as the above mentioned trade-off can be improved.

This talk aims to make a summary of the evolution of adaptive control and ending up presenting the motivation to research about switched order adaptive controllers, as well as the more recent results obtained in that line.

Norelys Aguila Camacho received her Automatic Control Engineer title from the Central University in Cuba in 2003, M.Sc. from the Jose Antonio Echeverria Polytechnic Superior Institute of Cuba in 2010 and Ph.D. in Electrical Engineering from the University of Chile in 2014.

From 2003 to 2010 she worked as automatic control specialist in an Engineering Design Company in Cuba, participating in automation projects for the cement industry, thermoelectric, refinery, among others. From 2010 to 2014 she was a PhD student at the University of Chile and a Postdoctoral Researcher at the same institution from 2015 to 2018. Since 2018 she is an Associate Professor at the Department of Electricity, Faculty of Engineering, Universidad Tecnológica Metropolitana, Chile.

Dr. Aguila-Camacho received the Best PhD. Thesis Award in Exact Sciences in 2016, from the Chilean National Academy of Sciences. Her main research interests are in fractional adaptive control and nonlinear control, focused on their applications to improve control energy.