Research Grants for PhD students from the China Scholarship Council

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**Description of the research work proposed for a PhD:**

**Title:** Non-asymptotic algebraic identification of fractional order time delay systems

**Keywords:** Time delay system, Fractional calculus, Parameter identification, Non-asymptotic algebraic approach, Distribution theory, Persistent excitation

**Subject:**

I. Context

I-1. Fractional order time delay systems

Fractional calculus was introduced in many fields of science and engineering long time ago. It was first developed by mathematicians in the middle of the nineteenth century. During the past decades, fractional calculus has gained great interest in several applications [1]. For instance, fractional order systems and controllers have been applied to improve performance and robustness properties in control design.

Modelling of real physical systems having long memory transients and infinite dimensional structures using fractional order dynamic models has significantly attracted interest over the last few years. For this reason, many identification techniques both in the frequency domain and time domain have been developed to model these fractional order systems. However, in many processes time delays are also present and estimation of time delays along with continuous time fractional order model parameters have not been addressed anywhere [2].

I-2. Algebraic approach

The real time delay identification is one of the most crucial open problems in the field of delay systems, and several on line estimation methods have been suggested in the literature for the identification of delay. While the most popular technique of Padé approximation is limited by the range of validity of the approximation, most of the other approaches generally suffer from poor speed performance.

Recently, a fast estimation method for simultaneous parameters and delays identification of continuous dynamical systems has been proposed [3,4]. This method was initially introduced by Fliess and Sira-Ramirez for linear identification. Then, it has also been extended to numerical differentiation [5,6,7]. This method is algebraic, thus non-asymptotic (in other words, it allows for a finite-time convergence), and robust against corrupting noises without
knowing their statistical properties. Thanks to these advantages, it has been applied in many fields, such as signal processing, control, robotic, etc. [8,9].

The objective of this thesis is to extend the algebraic approach for fractional order time delay systems, whose time delay, parameters, and state variables will be estimated.

II. Work plan

- Study existing references on the algebraic approach;
- Study existing references on fractional order time delay systems;
- Extend the algebraic approach for fractional order time delay systems.

References:


