

## Practical Consideration for Identification of Decentralised Control Systems

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**Abstract** – In practice, there is a great number of complex systems (not only by physical size, but also by the nature of models that describe systems) which need to be controlled. The identification of the original multivariable system is a difficult problem. Therefore, the idea is to decompose the original problem into a series of simpler subproblems. The ideas, in system identification, are borrowed from the methods for multivariable controller design: hierarchical and decentralized controllers. In this paper, the concept of decentralization has used. The original multivariable system is decomposed into a series of simpler subsystems with single input and single output. Then, the identification algorithms are proposed for the case when stochastic disturbance have non-Gaussian distribution. The algorithms of stochastic approximation and extended least squared are considered. Based on simulation, convergence speed and accuracy of estimation are compared. The concept of algorithms with extended memory is discussed.

**Key words:** large-scale systems, outliers, robust estimation, stochastic approximation, least squares

### I. INTRODUCTION

The central problem in modern theory and application of systems is complexity. Instead of centralised control systems, which have high performances, concepts such as subsystems, interconnections, distributed computing, and parallel processing are introduced. Within the control theory of complex systems, there are two important approaches. The first approach is based on the principle of decentralisation, which allows the decentralisation of multivariable systems into a collection of SISO (single-input single-output) systems or collection of MIMO (multi-input multi-output) systems with lower order than original MIMO system [1-2]. A huge number of references is devoted to this category of problems. Reference [3] considers the stability problem of the stochastic decentralised control systems. Decentralised system consists of a collection of

MIMO subsystems, and controllers are stochastic minimum variance controllers.

The second approach in the control of complex systems is hierarchic control systems [4-5]. This theory is based on decomposition-coordination. The reference [6] is dedicated to the identification of hierarchical stochastic systems.

In this paper, the identification of stochastic decentralised systems is discussed. MIMO system is decomposed into a collection of SISO systems. Since in the real conditions outliers are inevitable [7], it is assumed that stochastic disturbance is non-Gaussian, and its distribution belongs to the class of approximately normal distributions. This approach enables the application of Huber theory in the synthesis method of robust recursive algorithm for system identification. Algorithms of stochastic approximation and least squares are discussed. The application of robust algorithms in the field of adaptive control systems is presented in [9-10].

In this paper, recursive identification of decentralised system is discussed. Based on simulation results, it can be concluded that the convergence speed of stochastic approximation (SA) algorithm is significantly lower than the convergence speed of least squares. The next step is to apply the concept of algorithms with extended memory to significantly increase convergence speed of the SA algorithm while preserving the simplicity of the algorithm. The convergence of decentralised algorithm is presented in [11].

### II. PROBLEM FORMULATION

Consider the collection of  $N$  SISO subsystems

$$S_i : A_i(q^{-1})y_i(k) = B_i(q^{-1})u_i(k) + C_i(q^{-1})e_i(k) + \sum_{j=1, j \neq i}^N B_{ij}(q^{-1})u_j(k) - \sum_{j=1, j \neq i}^N A_{ij}(q^{-1})y_j(k), \quad i \in \mathcal{N} \quad (1)$$





