SYSTEM IDENTIFICATION WITH USING OF MATLAB

Stanislav Kocúr

Department of Control and Information Systems,
Faculty of Electrical Engineering, University of Žilina

Identification of unknown continuous or discrete time systems is a very wide and important part of system control theory. Qualitative indicators of system control directly depends on system identification because system control is only as good as good is created model of system. So this article deals with system identification problem. At first identification problem is described, then there is simple classification of identification methods. Rest of paper is devoted to required theory and one practical example of discrete time FIR system parameters identification with using of recursive least squares method in Matlab.

Effective system control with using of continuous-time or discrete-time control technology assumes accomplishment of two basic preconditions. The first is needed to know controlled system as good as possible. This means making of suitable mathematical model for this system. The second step is voting or creating of adequate control algorithm, or setting of control law parameters of fixed structure, which is predetermined. The synthesis depends on attributes and structure of mathematical model both of these cases.

One of ways how to make model of unknown system is using of adaptive filtration. Filter with recursive optimal adaptation is used in example. Recursive Wiener adaptive filter uses a recursive calculation of correlation matrix approximation. In term of function, this filter type is equivalent of Wiener filter. It enables to reduce a computation complexity markedly.

Approximations of correlation matrix with recursive method are calculated according to

$$r_{yy}(n) = \alpha\, r_{yy}(n-1) + y(n)y^T(n)\,, \qquad r_{yx}(n) = \alpha\, r_{yx}(n-1) + y(n)x(n)\,. \tag{1}$$

Recursive term for calculation of new vector of digital filter coefficients is

$$h(n) = h(n-1) + r_{yy}^{-1}(n)y(n)e(n)\,, \tag{2}$$

so the algorithm doesn't need an exact calculation of cross-correlation vector $r_{yx}(n)$.

Recursive term for vector correcting from former step of processing needs an inversion of autocorrelation matrix estimation. Inversion has to run in every step. Here is a method how to correct an inverted matrix recursively. Correction is possible without precision loss during calculation. The term that enables such correction is as follows:

$$r_{yy}^{-1}(n) = \frac{1}{\alpha}\left(r_{yy}^{-1}(n-1) - \frac{r_{yy}^{-1}(n-1)y(n)y^T(n)r_{yy}^{-1}(n-1)}{\alpha + y^T(n)r_{yy}^{-1}(n-1)y(n)} \right). \tag{3}$$

Such calculation is considerably easier than inversion, because of recover of inverted matrix clams only recovered vector of watched signal $y(n)$.