ICPE SA INSTITUTUL DE CERCETARI ELECTROTEHNICE
313 Splaiul Unirii, 030138 Bucuresti, ROMANIA
Tel.:+40 21 5893300; Fax:+40 21 5893434; e-mail:icpe.sa@icpe.ro; http://www.icpe.ro

The considered topic is dealt with in 5 schedule sections, including two different aspects, i.e. building up mathematic models for dynamic disturbed processes and for the specific phenomena of the electromagnetic fields.

The general method concerning the dynamic processes is successively developed for the systems with progressive complexity. The simplest model is described by

$$\sum_{i=0}^{n} a_i y(i) = \sum_{j=0}^{m} b_j x(j), \tag{1}$$

with $a_i, b_j =$ const, $x(i), y(j)$ designating ordinary derivatives of the input $x(t)$, and the output $y(t)$ respectively (not disturbed by the noise acting within the physical system).

With the problems of practical interest an availible signal is a disturbed output,whereby the disturbance is induced by a variety of quite unknown causes.

Within this research phase, a novel method, i.e. the *exponential decomposition* was developed, in order to deliver an approximate representation of the process segment by means of the finite series

$$f(t) = \sum_{i=0}^{m} A_i e^{\alpha_i t}, \tag{2}$$

where $A_i, \alpha_i =$ complex numbers. In this way, an efficient generalization of the classical Fourier sum is achieved. The essential advantage of (2) consists in the fact that the spectrun $\{\alpha_i\}$ of the process $f(t)$, is a characteristic of the $f(t)$. As a result, a strong suppression of the noise may be accomplished if the respective spectrum of the test signal, i.e. the system input is given. A similar performance cannot be obtained with the uniform spectrum involved by the Fourier sum, the last one being a non characteristic datum of a process.

Further, if the considered process may be described by (1) with the time variable a_i, b_j then one approximates, the last ones by polynominals of *t*. The polynominal constants have to be determined. In this case the noise filtration is performed by means of a *polynominal – exponential decomposition*. This original method is developed, by a generalization of an operator technique conceived by the authors for the model with the constant parameters a_i, b_j.

The accomplished research also included the difficult model with distributed parameters. This one is described by the eq.

$$\left(\sum_{k=0}^{N}\sum_{j=0}^{k} a_{ijk} D_{ijk}\right)\varphi(t,x,y) = \left(\sum_{k=0}^{N'}\sum_{j=0}^{k} b_{ijk} D_{ijk}\right)\psi(t,x,y), \tag{3}$$

where D_{ij} means the partial derivative operator

$$D_{ijk} = \frac{\partial^k}{\partial t^i \partial_y^{k-i-j}}. \tag{3a}$$

The coefficients $a_{ijk}, b_{ijk} =$ const have to be determined when multivariable (i.e. depending on the space variables (x, y) disturbances are acting within the system. This problem was solved by approximating a function $f(t, x, y)$ by

$$f_{mpq} = \sum_{i=1}^{m} A_i \exp(\alpha_i t) g(x, y), \tag{4}$$

where $g(x, y)$ is the product $h_1(x) \cdot h_2(y)$, with h_1, h_2 taken as finite sums of exponential function. A noise filtration procedure may be developed, in order to deliver the numerical values of a_{ijk}, b_{ijk}.

The resulting identification methods have a simpler structure and do not require any knowledge of statistical properties of the noise compared to the classical ones. At the same time, any short incipient segment of the system output may be used, because the transient system response may be included in the disturbance. The circumstance enables to drastically shorten the measurment time of the system, achieving the *real time* identification. Thereby drift errors are avoided, and also self adaptive systems are build up easily. At the same time, one can determine the parameter model of the system to be identified without the necessity of applying some methods of non-linear programming of the iterative process convergence.

A second research direction, developed by the considered research, consists in the mathematical models more suitable for numerical computation, starting from the eq.s describing the electromagnetic field. Instead of the classical eq.s with partial derivatives, one considers an approximate model of the form

$$\sum_{i=1}^{m} a_i(x) \frac{d\varphi^i}{dx^i} = \sum_{j=0}^{m-1} b_j(x) \frac{d^j \varphi_n}{dx^j}, \tag{5}$$

where $\varphi =$ the potential, $\varphi_n = \dfrac{d\varphi}{dn} =$ the normal derivative of the potential. The relation (5) holds along the domain boundary, the coefficients a_i, b_j depending on the respective geometry. This model leads to a novel field computation enabling the treatment of the boundary by portions. Consequently, the result system matrix will be a sparse one. The significant simplifications of the computational procedure allow the solving of very complicated field configurations. This model leads to the elaboration of a method which can be applied to boundary portions, fact that enables the computation by means of system sparse matrices. There results the possibility of solving the complex field configurations.