APPLICATION OF MULTIVERSION PROGRAMMING METHODOLOGY TO CONTINUOUSLY DIFFERENTIABLE FUNCTIONS OF SEVERAL VARIABLES

Kotenok A.V.
Siberian State Aerospace University named after Academician Reshetnev M.F.
Krasnoyarsk, Russia

In modern nonlinear programming the universal methods allowing solving arbitrary problems have not been elaborated yet. It is conditioned by the fact that real problems of minimization usually differ very much from each other both intrinsically and dimensionally. The basic idea of my research is the elaboration of a system connecting all optimization methods into a single one, so that the advantages of both first- and second-order methods speed and direct search methods universality remained. It is obvious that all the optimization algorithms are of the same specification – they get a function and initial point at the entry, ant at the output – return the found optimal point. This property allows us to combine them into one *multiversion system.*

The main idea of the *multiversion programming* is in the introduction of software redundancy due to using several various program modules equivalent on the functional purpose (got the name of *multiversions*), working in time parallel and getting the same data at the entry. The multiversion outputs are conformed by means of a particular multiversion voting algorithm. As a result, all the program module versions operate as an organic whole and return one coherent result irrespective of failures and errors of certain modules. Because of its high efficiency the given method has got a wide spread occurrence and development.

Having applied the multiversion programming ideology to the problem of several variables function optimization, we get the system, in which different optimization methods act as multiversions.

Methods of comparison of multiversions against each other:

- by the function value;
- by the search direction at the last step;

The influence of random search algorithms on the general result:

- the general search speed increases;
- there is no search process circling;

The influence of various voting methods on the efficiency of several variables functions optimization multiversion system:

- the overall majority voting method is invalid;
- the coherent majority voting method shows authentically high results;
- the coherent majority ill-defined voting method shows the best results;
- the weighted voting algorithms often end in results' mismatch when using random search methods;
- the median voting results in the optimization process "circling".

As the carried out experiments showed, the multiversion system of several variables functions optimization doesn't loose its efficiency compared to the best of all methods separately, while in some cases with a complex surface character, functions show even more rapid convergence speed.

It allows using the offered elaboration as a universal method of any several variables continuously differentiable functions optimization while solving academic and practical problems.

The work was submitted to international scientific conference «Innovation technologies», Thailand, February, 20-28, 2008, came to the editorial office 10.01.2008.

CAPACITY ELECTROMECHANICAL SYSTEMS

Lyapunov D.Yu.
Tomsk Polytechnic University

Nowadays capacity electromechanical systems are widely used in such applications as microactuators for high-accuracy drives, accelerometers for automotive control and safety, etc. It is due to the development of thin-film technologies. The theory of capacity devices as a whole has also received a development. A new branch of science – film electromechanics – has appeared [1]. The systems under consideration have small sizes – at least some microns in one direction. It is caused by their rather high value of power capacity at given sizes. This fact determines rather perspective branch of systems' application – transducers of microtransferences.

This paper deals with a mathematical model of the step-type capacity motor with a rolling rotor. The system is represented in figure 1.

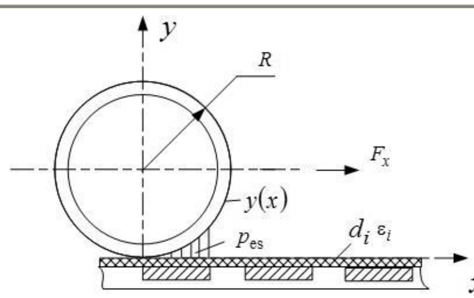

Figure 1. The model of the capacity electromechanical system

R – the radius of the rotor, d_i – the thickness of the thin dielectric film on the stator surface, ε_i – permittivity of the dielectric, p_{es} – electrostatic pressure applied to an element of the rotor surface

The stator surface contains electrodes and is covered by dielectric thin film. The rotor represents metal hollow thin-walled cylinder.

Electrostatic pressure is defined as:

$$p_{es} = \frac{\varepsilon_0 E^2}{2}. \quad (1)$$

The determinative factor of capacity devices operation is mutual capacitance, i.e. the capacitance between a rotor and a stator. With the purpose of its increase the choice of a design of the motor with a rolling rotor [2] was made. Between the rotor and the stator electrodes the potential differences are applied by turns, and the rotor rolls along the stator's surface under action of the force created by the interaction of electric charges.

The following assumptions were made: 1) the stator and rotor surfaces have no any defects, i.e. the stator surface is a plane and the rotor surface is a cylindrical surface; 2) electric losses (losses in the dielectric) and mechanical losses (losses on friction) are not taken into account; 3) the phenomenon of charge accumulation on the border gas – solid dielectric is not taken into account; 4) the external factors change influence on the system's operation is negligible, i.e. temperature, pressure and humidity practically do not vary.

Thus, it is supposed, that any energy change of the system under consideration is converted into mechanical work.

Let's acquaint the reference frame *xoy*. Assume, that abscissa *x* is the generalized coordinate. Hence, the force exerted to the rotor in a direction of *x* will be directly proportional to the generalized coordinate partial derivative of the system's energy [3], in compliance with the following expression:

$$F_x = -\left.\frac{\partial W}{\partial x}\right|_{U=\text{const}} = -\frac{U^2}{2}\frac{\partial C}{\partial x}, \quad (2)$$

where W – energy of an electric field, C – mutual capacitance.

Thus, the more mutual capacitance change, the more force will be exerted to the rotor at $U = \text{const}$.

In its turn, mutual capacitance is defined by the following expression:

$$C(x) = \frac{\varepsilon_0 S(x)}{y(x) + d_i/\varepsilon_i} \quad (3)$$

and is also the function of *x*. Here $y(x)$ is the function describing distance between the rotor surface and the stator one.

$$y(x) = R - \sqrt{R^2 - x^2},$$

and the expression in the denominator is the function describing the change of a work gap.

The developed mathematical model allows to estimate one of the basic geometrical parameters of the capacitor electromechanical system of the offered design (the width of the stator electrode) and it will be possible to apply this model to estimate parameters of any other design of the systems under consideration.

References:

1. Dyatlov V.L., Konyashkin V.V., Potapov B.S., Fadeev S.I. Film electromechanics. – Novosibirsk: Science, 1991. – 247 p.
2. Bekishev R.F., Semenova L.N., Lyapunov D.Y. Capacitance wobble micromotors // The News of Tomsk polytechnic university, №1, 2004.
3. Kaplyancky A.Y. Introduction to the general theory of electric machines. – Moscow: the State power publishing house, 1941. – 96 p.

The work was submitted to III international scientific conference «Basic Research», Dominican Republic, April, 10-20, 2008, came to the editorial office 14.02.2008.