

Search Methods for Parameter Identification

“Parameter identification models rely on the principality that either the components or physical phenomena are correlated with a nominal condition”.

The main prerequisite of “***parameter identification***” is to accomplish a productive control plan and respond to the changes in the operating conditions in a successful manner. The identification of material parameters of constitutive models is usually carried out on the basis of experiments, where an analytical solution of the underlying initial boundary-value problem is derivable. In the case of finite deformations, these are the uniaxial tension test, biaxial tension test, shear experiments and tension-torsion tests if isotropy and incompressibility are assumed. However, there is a series of experiments, which are not describable by an analytical solution. In these cases, the boundary value problem has to be solved numerically. Here, we use the finite element method, especially the finite element code ANSYS. The identification of the material parameters is usually done by means of a “***least-square function***” which minimizes the difference between the experimental data and the numerical simulation.

Although LSF is the most considerate method to accept in this field, there are other methods as well which have shown their presence in the field of parameter identification. They are as follows,

1. Linearized Maximum Likelihood,
2. Extended Kalman Filter,
3. The Calculus of State Variables Sensibilities,
4. The Subspace Method,
5. The Minimization of Euclidian Distance.

Years passed by and life changed in a drastic manner as a result of this many approaches to parameter identification has evolved. One of the major methods which one can ever think of when it comes to methods for parameter identification would be the “***LSF – Least Square Function***”.

These procedures have the advantage of a lower number of evaluations of the boundary value problem but, as a serious disadvantage, the necessity of (a) time-consuming analytical

derivations, (b) implementation for any new constitutive model and (c) additional computations during the identification. Thus, this procedure is not possible in the context of commercial finite element codes. Therefore, we propose another concept which applies a gradient-free direct search method. This has the advantage of very fast implementation and, furthermore, being independent of the underlying constitutive model.

The history of the *least squares methods* began in 1795 when the inventor of this approach, **Karl Friedrich Gauss**, formulated its basic concept and used it practically for astronomical computations. He suggested that the most appropriate values for the unknown but desired parameters are the most probable values. He defined that "the most probable value of the unknown quantities will be that one for which the sum of the squares of the differences between the actually observed and computed values multiplied by numbers that measure the degree of precision is a minimum."

Since that time the method of least squares has been applied to the solution of many technical problems. Its properties were analyzed many times, numerical procedures were proposed for individual applications and the method itself was modified according to the specific requirements.

Exactly the same endeavour may be observed in the field of parameter estimation of controlled systems. The problem of identifying a dynamic process has received considerable attention in recent years. The various techniques developed for input-output data collection and evaluation range from the simplest form of deterministic procedures to elegant numerical and statistical methods based on the results of optimal estimation theory. It may be stressed that in the field of parameter estimation the least squares technique has reached a significant level of popularity and perfection.

Conclusion:

Least square methods have been evolving for nearly 200 years and they have been applied to the solution of a wide variety of technical problems. In the past 20 years, these methods have been successfully applied to estimating parameter values of controlled systems. In particular, new variations such as the instrumental variable method, generalized least squares, extended least squares and square root filtering have developed to make the least squares principle more useful in practice especially for recursive, online applications using digital computers

References:

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