11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Bionic optimisation considering scattering of fixed and free parameters

Simon Gekeler, Tatjana Popova, Frank Schweickert, Rolf Steinbuch

Reutlingen University, Alteburgstr. 150, 72762 Reutlingen Germany
rolf.steinbuch@reutlingen-university.de

Key Words: *Bionic optimisation, scatter, fixed parameters, robustness.*

Bionic optimisation includes stochastic approaches by its very definition [1, 2]. Unfortunately, stochastic thinking is not always applied to the data entering the optimisation process itself. We know that the variable optimisation parameters, as well as the fixed design data which define the problem, show some scatter. Consequently, we have to take into account the varying optimisation parameters and the scatter of the fixed data during the optimisation process. Therefore it is essential to make realistic estimates about the scattering and the corresponding distribution of all the input to the optimisation history.

This range or scatter may be small, if we think of measures like lengths, which are the result of manufacturing processes by high precision tooling machinery. Other data like material strengths, friction coefficients, contact areas or forces transmitted by screws are known with far less precision. A common and often-applied method of handling this uncertainty is to use the weakest value, hoping that this is a conservative assumption.

Especially if there are many components or parts interacting, this choosing of weak parameters does not always lead to proposals that correspond to realistic predictions of the structure’s response. For example, links which are too weak may indicate a load distribution which does not affect the parts of an assembly which are really endangered. In consequence, the scatter of all the system parameters that are not known to a very exact value should be taken into account.

Using this approach means that the total number of parameters will necessarily increase. The chance to find good proposals decreases, as the high dimensional space of the non-fixed data has the potential to hide good or acceptable proposals, due to the curse of the dimension. So we might not find a sufficiently good design for the optimisation project within an acceptable time.

To come up with acceptable times for the optimisation, accelerating strategies have to be found. Most of them are based on the fact that in stochastic processes not all parameters have the same impact on the object. So reducing the number of parameters to be handled may help to reach regions quickly where good values of the objective may be expected.

Other strategies use statistical predictions to estimate the best values of the objective in the early stages. From such estimates we might derive decisions whether a region is promising. Unfortunately, these predictions again need a large number of runs to yield reliable data.

Checking the robustness of a proposed design again requires many repetitions of the evaluation of the objective [3, 4]. Once more, stochastic approaches may help to come up with accelerated indications of the sufficient reliability of the optimum design. In some cases deterministic studies may be even more efficient.

All these proposals may help to carry out optimisation and robustness studies substantially faster. Nevertheless bionic optimisation in the presence of many local optima remains a time and computing power consuming approach. Furthermore, all deterministic upgrading of stochastic processes has the potential to introduce reductions to the validity of the probabilistic prerequisites. It may produce non-valid statements as the preconditions of probability, e.g. the independence of the random variables may be disturbed. Now a critical review of all results becomes even more important, so more repetitions may be necessary. Nevertheless accelerated bionic optimisation may be a tool to find promising proposals at acceptable times and costs.

REFERENCES

[1] R. Steinbuch, Bionic optimisation of the earthquake resistance of high buildings by tuned mass dampers, *Journal of Bionic Engineering*, Vol. 8, 2011, pp. 335-344.

[2] Gekeler, S., Steinbuch, R., Widmann, C.: On the efficiency of bionic optimisation procedures in *Computer Aided Optimum Design in Engineering XII*, WIT Press 2012

[3] Doltsinis, I.: *Stochastic Methods in Engineering*, WIT Press 2012.

[4] Du, X., and Chen, W., 2004, “Sequential Optimization and Reliability Assessment Method for Efficient Probabilistic Design,” ASME J. Mech. Des. 126 (2) pp. 225–233.