8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

SOFT COMPUTING METHODS IN COMPUTATIONAL GRIDS

***Wacław Kuś [1] and Tadeusz Burczyński [1,2]**

[1] Department for Strength of Materials and Computational Mechanics, Silesian University of Technology, ul. Konarskiego 18a, Gliwice, 44-100, Poland
waclaw.kus@polsl.pl

[2] Cracow University of Technology, Institute of Computer Modelling, Warszawska 24 str., Cracow, 31-155, Poland
tadeusz.burczynski@polsl.pl

Key Words: **c***omputational grids, evolutionary algorithm, artificial immune system, particle swarm optimization, artificial neural networks.*

ABSTRACT

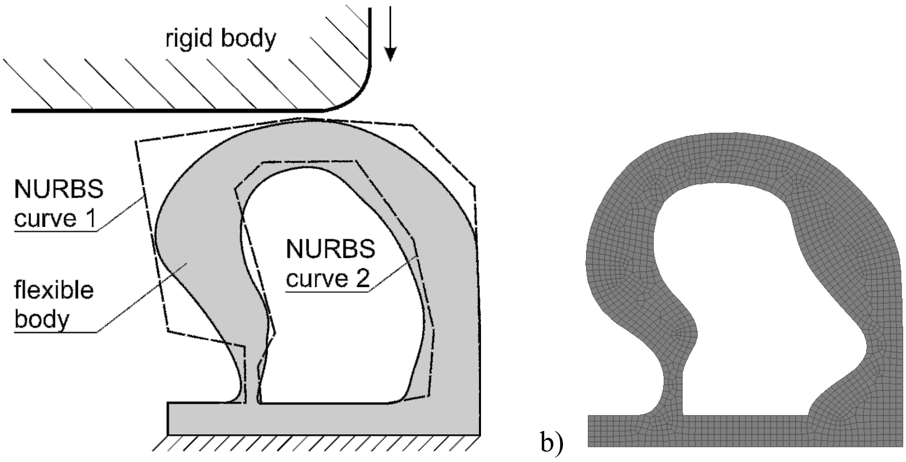
The paper is devoted to soft computing methods in computational grids. The computational grids provide sophisticated and user friendly environment for performing time consuming computations. The grids are build on top of cluster, supercomputers and networks connecting resources. The grid middleware plays important role connecting resources with different hardware, operating systems, queuing systems. The use of grid middleware such as Unicore[5], Alchemi[1], gives oportunity to use distributed heterogenous resources by comunicationg with standarized grid middleware. The soft computing methods applied to optimization and aproximation problems in mechanics are considered. The evolutionary algorithms[4], artificial immune systems[2], particle swarm optimization[3] and artificial neural networks are considered. The parallelization of these algorithms allows efficient utilization of grids resources. The objective function in optimization problems is computed using the finite element method.

The full paper contains examples of optimization and aproximation using parallel soft computing algorithms, speedup measurements and results comparison. The optimization in contact problem is considered as one of the examples. The contact between seal and rigid body is considered. The objective function depends on the contact status – part of the flexible body should be touching rigid one and area of the flexible structure. The fitness function is expressed as:

$$\min_{\mathbf{ch}} F(\mathbf{ch}); \qquad F(\mathbf{ch}) = \int_{\Omega} \mathrm{d}\Omega - w_c \int_{\Gamma_C} \mathrm{d}\Gamma_C \tag{1}$$

where: ch - is a chromosome, Ω - domain of the flexible body, Γ_C - flexible body boundary in contact with rigid body, w_c - scaling coefficient in length units. The constraints on maximum equivalent stresses value are imposed.The scaling coefficient is used to obtain balance between two parts of the fitness function. The shape of the flexible body is defined by the NURBS curve (Fig.1a). The design variables are coordinates of control polygon points of the NURBS curve. The genes contain control polygon points coordinates. The geometry and boundary condition for test problem are shown in Fig. 1a. The flexible

body is constrained on bottom surface. The prescribed displacements of the rigid body are shown by the arrow. The flexible body is described using two NURBS curves, each with 10 moving control points. Total number of genes is 40. The Fig. 1b presents best found shape of the seal.



a) b)

Figure 1. a) Geometry of optimized structure,
b) the best shape obtained using parallel evolutionary algorithm

Acknowledgements

The research is financed from the Polish science budget resources in the years 2005-2008 as the research project.

REFERENCES

[1] L. Akshay, B. Rajkumar, R. Rajiv, V. Srikumar, "Peer-to-Peer Grid Computing and a .NET-based Alchemi Framework, High Performance Computing: Paradigm and Infrastructure", Laurence Yang and Minyi Guo (editors), Wiley Press, New Jersey, USA, (2005).

[2] L. N de Castro and J. Timmis, "Artificial Immune Systems as a Novel Soft Computing Paradigm", *Soft Computing,* vol. 7(8), pp.526-544, (2003).

[3] Kennedy J., Eberhart R. C., Shi Y., *Swarm Intelligence*, Morgan Kaufmann Publishers, (2001).

[4] W. Kuś, "Evolutionary optimization of forging anvils using grid based on Alchemi framework", Proc. 2nd IEEE International Conference on e-Science and Grid Computing eScience 2006, Amsterdam, (2006).

[5] UNICORE Plus Final Report - Uniform Interface to Computing Resources, Joint Project Report for the BMBF Project UNICORE Plus, Grant Number: 01IR001AD, (2003).