Title: **Cubic Spline Meshless Method for Numerical Analysis of the Two-Dimensional Navier-Stokes Equations**

Author: **Westover, L. M. & Adeeb, S. M.**

Published in: *Int. J. of Numerical Analysis and Modeling, Series B*, **1:2**, 172–196, (2010)

Review by: Mario Forcinito

In this work, the authors introduce a Galerkin weighted residuals method that uses cubic splines as interpolation and weighting functions for the solution of the steady state, incompressible Navier-Stokes equations. The method does not require a mesh in the usual Finite Element Method sense and has the advantage that the solution is represented by a continuous (C2) functions.

In this type of methods, the formulation of the discrete equations requires a careful analysis of the effects of boundary conditions because, unlike what happens on the finite element method, the interpolating functions on the boundary need to have the value and the first derivative correctly specified for the solution to work.

Two problems were analyzed using the method. The first models the squeezing of a fluid between two flat, parallel plates and the second is the well known square box with a moving lid. Both problems were simulated in two dimensions and the results compared with those produce by a commercial finite element code. The results show that this method performs well at moderate Reynolds number (~ 1000) where the solution is still stable for this method but not achievable for the commercial code.

Although analyses for stability and convergence were not performed, numerical results indicate a remarkable ability of this approach to produce good results with relatively few collocation points. The authors took advantage of the smooth nature of the solution to calculate the error of the approximation by substituting the solution on the original equations.

See Also:

1. Atluri, S. N. and Shen, S., *The Meshless Local Petrov-Galerkin (MLPG) Method: A Simple & Less-costly Alternative to the Finite Element and*

Boundary Element Methods, CMES, **3**:1, pp 11-51, (2002), available on-line at:
`http://www.care.eng.uci.edu/pdf/(02.31).pdf`