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A HIGH ACCURACY APPROXIMATED SCHEME BASED ON INDIRECT RADIAL BASIS NEURAL NETWORKS

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ABSTRACT

This paper discusses high accuracy approximated scheme applied in the mesh-free methods developed in the past decade. An efficient approximated scheme based indirect basis neural networks for eliminating the drawbacks is proposed due to high accuracy and rapid convergence. Several examples of numerical evaluations are presented for illustrating the properties of the approximated scheme proposed.

It is well known that the most important work for solving problems of science and engineering in numerical methods is to utilize an acquired approximated scheme to approach unknown functions. Mesh less methods are the one of the popular numerical methods developed in the past decade. The cores of the mesh less methods are to construct approximated functions which are meshing independently, or mesh less at all. The approximated functions are based on the moving-least squared (MLS) scheme in the most meshless methods. One of the main known defects of the MLS scheme is of the absence of the Kronecker delta function property. This drawback results difficulty of applying boundary conditions to the system of control equations.

Studies reveal that the approximated functions approached by the MLS scheme shows serious numerical oscillations at the neighbour domain of the peak of the function. Moreover, the locations of the peak of the approximated derivatives drift significantly. Those phenomena mentioned above are fatal to the high accuracy analyses, especial for tracing the high gradient various in a narrow domain, such as stress concentration and creak propagation etc.

In order to avoid numerical oscillation and drift at the peak of the approached functions which exist in the MLS scheme, a newly approximated scheme is proposed. In the proposed scheme, approximated functions are built by integral with multi-quadratic function as function bases. According to the accuracy requirement of the variables, an approximated function can be obtained from the selected derivative with indefinite integral step by step. The indefinite integral constants, which are matched the numbers of the times of the indefinite integral and are considered as new unknown, can be found by boundary conditions in system of control equations. The numerical results show that newly approximated scheme presented in indefinite integral has excellent numerical properties in accuracy and convergence. This procedure can be exhibited as following Equations 1-4 and Figure 1.

$$\frac{\partial^2 f(s)}{\partial s^2} = \sum_{i=1}^{m} w_i g_i(s) \qquad g(s-a_i) = \left((s-a_i)^2 + d_i^2\right)^{\frac{n}{2}} \tag{1}$$

$$\frac{df(s)}{ds} = \int \sum_{i=1}^{m+1} w_i g_i(s) = \sum_{j=1}^{m+1} w_i g_{i1}(s) \qquad f(s) = \int \sum_{j=1}^{m+2} w_i g_i(s) = \sum_{j=1}^{m+2} w_i g_{i2}(s) \tag{2}$$

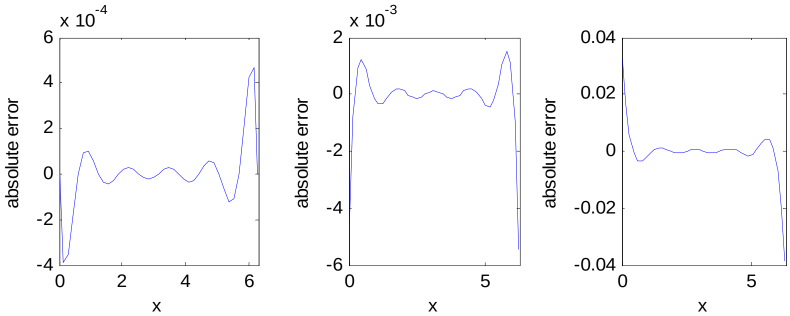

Figure 1 Error distribution of the sine function approached by proposed method

De rerum natura, the approximated scheme proposed is an approximated scheme based on the scatted point’s data. Applying the approximated to the numerical issues, the results illustrate that fewer scatted points can provide higher accuracy and rapidly convergence. Numerical oscillations and derivatives peak location drift phenomenal almost vanished at all. A numerical result on the plate with a central hole is presented as following Figure 2.

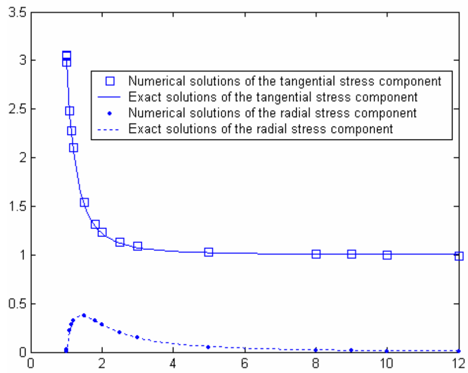

Figure 2 Stress distribution of the plate with a central hole

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