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Role of B-Spline Function in Structures under Various Loadings

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Abstract: This paper provides a thorough review of B-Spline function for computing the solution to various problems subjected under dynamic loading system. The variety of complication that the real environment may possess can be easily computed by applying B-Spline function in the context. This method is really advantageous in the real environment problem as this method is easy to use and implement.
Key words: Structural dynamics, Boundary value problem, Natural Frequency, B-spline polynomial function.

I. INTRODUCTION

The analysis of multi degree problem involves several steps and it sometime cumbersome to analyze the whole condition on one go. Past few years several solutions has been developed to approximate the overall condition of the real scenario, but the fact is that the results are approximate at the same time unable to provide solution on much easy and in the few steps. Hence there is a need of more appropriate solution than the available. In this particular context the need to analyze present available solution was necessary that's the prime aim of this article.

II. B-SPLINE ON BOUNDARY VALUE PROBLEMS

In 1997 Siddiqui et al. [1] have solved Linear, twelfth-order boundary-value problems, using polynomial splines of degree 12. The absolute errors in the function values and all derivatives were seen to be small at points remote from the boundaries. Chaniotis et al. [2] have presented a methodology of high order accuracy that constructs in a systematic way functions which can be used for the accurate interpolation and differentiation of scattered data. The functions are based on linear combination of polynomials (herein B-splines are used). The technique is applied to one-dimensional datasets but can be extended as needed for multidimensional interpolation and differentiation. Cheng et al. [[3]] have shown that the problem with the selection of interpolation parameter values, not with even B-spline curves and surface themselves. They have proven that by providing a new approach to perform quadratic B-spline curve interpolation. Song et al. [4] have presented a derivation of closed-form expression of an arbitrary high order uniform B-spline. This close-form expression is then applied to the stability analysis of a learning feedforward controller (LFFC) using B-spline network (BSN) in frequency domain. Unlike the common recursive definition, the technique they have developed in "piecewise closed form".Caglar et al. [5-8] have presented a series of papers on boundary value problems using different degree of B-spline polynomial function; first they have presented the numerical solution of fifth-order, nonlinear boundary-value problems by considering two-point boundary conditions in 1999. They have tested sixth-degree B-spline method on two problems, one linear and one nonlinear, and it was seen to exhibit first-order convergence. In another paper in 2006 they have solved Homogeneous and non-homogenous singular boundary value problems using the third-degree B-splines. They have tested third-degree B-spline on one homogeneous singular boundary value problem and three non-homogenous singular boundary value problems, and the numerical results as well as the exact solutions have tabulated. Numerical results showed that the presented method approximate the exact solution very well. In 2006 they have considered the third-degree B-spline interpolation and compared that method with finite difference, finite element and finite volume methods which applied to the two-point boundary value problem. They have compared their results with finite difference, finite element and finite volume solutions and conclude that the B-spline interpolation is the better method to interpolate any smooth functions than others. In 2008 they have found that the numerical solution of a fourth-order parabolic partial differential equation. Fifth degree B-spline polynomial function has been considered for the numerical solution of the problems. The results show that the proposed method is an applicable technique and approximates the exact solution very well. In 2009 they have presented the numerical solution of a linear system of second-order boundary value problems by using cubic B-spline polynomial function. The comparison shows that the B-spline method is a more efficient and effective tool and yields better results. In 2010 Hamid et al. [9] have presented the solution of linear two-point boundary value problem of order two using extended cubic B-spline interpolation method. They have introduced one free parameter, λ that control the tension of the solution curve. For some λ, that method produced better results than cubic B-spline interpolation method.

In 2011 Chang et al [10] have introduced the cubic B-spline basis functions then they used the linear combination of cubic B-spline basis to approximate the solution. Finally, they have obtained the numerical solution by solving tri-diagonal equations. Gupta et al [11] have presented a numerical method based on cubic B-spline to solve boundary value problems for a system of singularly perturbed second order ordinary differential equations. The method takes into account the values of cubic B-spline and its derivatives at nodal points together with the equations of the given system and boundary conditions, ensuing into the linear matrix equation. They have selected numerical examples of perturbed systems for different cases of perturbation parameters from the literature, which demonstrate the efficiency of present method and also confirm how the developed algorithm is better than existing numerical methods. In 2012, Rashidinia et al. [12] have presented a survey of B-spline techniques which have been used for numerical solutions of mathematical problems recently. They have discussed the definition of B-splines of various degrees by two different approaches to generate the recurrence relation to drive the formulation of B-splines. They have tested Cubic B-spline on two equations and absolute errors in interpolation are compared with cubic and quantic splines. Some remarks have been included. The cubic spline and more or less similar to the quantic spline. In 2012, Hamid et al. [13] have manipulated quartic B-spline to approximate the solution for second order linear two-point boundary value problem. Quartic B-spline gives out more accurate numerical results compared to the other two for some problems. Shahid et al. [14] have developed method to solve the fourth-order parabolic partial differential equation by using quintic B-spline collocation method. This kind of problem arises in the field of transverse vibration of the uniform flexible beam. Stability analysis of the method has also been proven. Two examples have been considered to illustrate the efficiency of the method developed. It has been observed by them is that the numerical results efficiently approximate the exact solutions.

III. ROLE OF B-SPLINE IN HEAT TRANSFER

Johnson [15] has introduced B-spline polynomial function for One-dimensional convection–diffusion equation with constant coefficients. Their objective was to present the research for comparing the efficiency and accuracy of several collocation schemes. it is concluded that higher-order smoothest quartic B-spline curves are competitive with traditional orthogonal collocation method (OCM) cubic schemes. In 2008 caglaret al. [16] had presented the boundary value problem for the one-dimensional heat equation with a nonlocal initial condition has examined by using the third-degree B-splines functions. The numerical solution of the equations is discussed and illustrated with an example. The results of numerical testing show that the numerical method based on the given techniques produce good results.

IV. CONCLUSIONS

On the analysis of several problems following conclusion can been obtained:

A. The B-Spline function is much useful as it can easily approximate several real environment problems.

B. The B-Spline function can provide accuracy in results if much higher degree function is applied to the problem.

C. The B-Spline function is far better than linear order functions.

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