Power Flow Investigation Using Cubic Spline Function a Case Study

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ABSTRACT

This article presents an approach using cubic spline function to study Load Flow with a view to acquiring a reliable convergence in the Bus System. The solution of the power flow is one of the extreme problems in Electrical Power Systems. The prime objective of power flow analysis is to find the magnitude and phase angle of voltage at each bus. Conventional methods for solving the load flow problems are iterative in nature, and are computed using the Newton-Raphson, Gauss-Seidel and Fast Decoupled method. To build this method, this paper used cubic spline function. This approach can be considered as a ‘two stage’ iterative method. To accredit the proposed method load flow study is carried out in IEEE-30 bus systems.

KEYWORDS

1. INTRODUCTION

1.1. Method/Analysis

Methodology is presented as an improved method based on Cubic Spline functions for solving nonlinear equations. Further exploring the application of this function, it is proposed for load flow analysis in power transmission network.

1.2. Findings

The proposed methodology will help power distribution system planners to validate the planning model developed. Proposed method can replace the traditional way of load flow analysis which require sequential numbering pattern on nodes.

1.3. Novelty/Improvement

Load flow study technique developed is carried out on IEEE 30 Bus Test System scheme for validation. The result obtained by the proposed method is same compared to other methods. The number of iterations and time consumption is less compared to all other methods shown in this research paper.

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Load flow studies are used to maintain the electrical power transfer from generators to consumers through the grid system, this scheme is secure, reliable and economic. The description of elementary design of the load-flow Problem is mentioned (Guile and Paterson, 1977; Stevenson, 1982). Conventional methods for solving the load flow problems are iterative in nature, and are computed using the Newton-Raphson or Gauss-Seidel method. By the use of optimally ordered Gaussian elimination and special programming techniques, the ac load flow problem can be solved efficiently by Newton’s method (Tinney & Hart, 1967). The Load Flow solution procedures and formulations can be precise or approximate, with values adjusted or unadjusted, intended for either on-line or off-line application, and designed for either single-case or multiple-case applications (Dharamjit & Tanti, 2012). Significant research has already been done using advanced computer platforms for the load flow study of bulky power systems. The proposed method for analyzing nonlinear functions has been submitted with a latest Quadrature Rule based on Cubic Spline Functions (Hasan, Srivastava & Ahmad, 2014). In order to take these commendable research toward the method is used to developed load flow analysis method in this research. This approach can be considered as a two stage iterative method. The proposed method takes less iteration and time compared to other conventional methods for load flow study.

With the arrival of hi-tech digital computers, a load-flow solution was acquired via network analyzers. The widespread conventional Gauss-Siedle iterative method necessitates more computer storage through Y-matrix formation. Even though the method is acceptable on different bus systems but the key weakness is their converging time. Attempts to overcome this shortage led to the growth of Z-matrix approaches, where converge more dependably, but negate several of the benefits of Y-matrix iterative approach, especially storage and speediness when applied to bulky systems. The other conventional approaches like Newton-Raphson method was revealed to have dominant convergence properties, but was computationally complex and hence expensive. The main breakthrough in power system network calculation was made in the mid-1960s. Optimally ordered triangular factorization of sparse matrices, hints at a dominant general-purpose load flow method which has been implemented by number of industries (Tinney and Walker, 1967). Various popular techniques in Optimum Load flow, covering both Conventional as well as intelligent methodologies are available (Amaranth and Ramana, 2011). The first applied digital solution method was performed by Bhowmik, Rajan and Bose 2012. Currently, with the inducement of expanding problematic dimensions, online applications, system optimization, and innovative approaches are evolving, and are anticipated to throw up innovative and varied applications. Platform like IEEE-6 bus system for steady state analysis using PSAT (Power System Analysis Toolbox), an open source toolbox which is compatible with MATLAB that makes possible in re-using existing code and merging different software packages into new and less costly applications (Nitve and Naik, 2014).

An approach was presented using a compensation method for weakly meshed networks. This method started from a network structure analysis to find the interconnection points. It broke those interconnection points using the compensation method so that the meshed system structure could be changed to simple tree-type radial system. This method was also suitable for the system with 43 multiple voltage control buses. Structure analysis of the system is quite complex (Luo & Semlyen, 1990).

Sometimes a heuristic method is used to decide the break points, where meshed network is converted into radial network by means of selecting and opening number of breakpoints. So, the adaptability of this method is not so encouraging. Load conditions at the break points have great influence on the power flow solutions and heavy loading loops and weak power sources (dispersed generation) in meshed systems may cause difficulties for the speed and accuracy of convergence.

A method is presented for solving radial and meshed distribution networks. This method had the advantages of accurate solution for a realistic distribution system with composite loads and without any problem of convergence. Disadvantages associated are difficulty in numbering the nodes and branches and no node in the network is the junction of more than three branches (Goswami & Basu,
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