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R. Behl, P. Maroju, S.S. Motsa

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A family of second derivative free fourth order continuation method for solving nonlinear equations

R.Behl[a] [1], P. Maroju[a] [2], S.S. Motsa[a] [3]

[a]School of Mathematics, Statistics and Computer Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa

Abstract

In this paper, we present a parameter based iterative method free from the second derivative for solving nonlinear equations of type $f(x) = 0$. Ezquerro and Hernandez [6] discussed the convergence analysis of a uniparametric family of an iterative method in Banach space. Based on his idea, we propose a uniparametric family of second derivative free iterative method in $\mathbb{R}$. We discuss the convergence analysis and observe that it possesses a fourth-order convergence for for solving nonlinear equations in $\alpha \in \mathbb{R}$. Several numerical examples are worked out with our proposed methods for parameter $\alpha = 1$, $\alpha = 2$ and the existing fourth-order iterative method proposed in [1–3,16]. Finally, from the comparison, we observe that our method more efficient than existing methods. Finally, we compare basins of attraction of our methods with the second derivative free fourth-order iterative method proposed in [1–3, 16] observe that the proposed scheme is more efficient.

keywords: A continuation method, Nonlinear equations, The Halley's method, The Chebyshev's method, Basins of attraction

1 Introduction

Solving non-linear equations is one of the most important and challenging problems in numerical analysis. Let $f : D \subseteq \mathbb{R} \to \mathbb{R}$ be a nonlinear differentiable on an open interval D. One of the main problems in numerical analysis is to solve the nonlinear equation

$$f(x) = 0. \tag{1}$$

Newton's method is basic and well known iterative method for solving nonlinear (1). The order of convergence of this method is quadratically convergent. The main advantage of this method is that the computation of the second derivative not required. Also, we have many higher order iterative methods for solving nonlinear equations those are the Chebyshev's method, Halley's method and the Super-Halley's method [9, 15]. Chebyshev-Halley's method is well known a parametric iterative method for solving nonlinear equations. The order of convergence of this method is three. In recent years, many variants

[1]ramanbehl87@yahoo.in

[2]Corresponding author: P. Maroju (maroju.prashanth@gmail.com)

[3] sandilemotsa@gmail.com