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FINITE-TIME STABLE VERSIONS OF THE CONTINUOUS NEWTON METHOD AND APPLICATIONS TO NEURAL NETWORKS

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Abstract. Control theory has become a focus of research for evaluation and synthesis of numerical algorithms. In this paper, a finite-time version of the continuous Newton method is proposed using finite-time stability theory. Moreover, robustness of the proposed method under computational errors is discussed. It is also shown that the proposed approach can change the singularity structure of the Newton vector field. A finite-time continuous quasi Gauss-Newton's method is also derived. The effectiveness as well as some limitations of the proposed methods in zero finding and optimization problems are illustrated via numerical examples

Keywords. Newton's method; Control theory; Finite-time stability; Zero finding; Neural network.

1 Introduction

Applications of numerical methods in solving nonlinear equations, optimizing functions, differentiating dynamic equations, and so on, have been the focus of research for a long time. The success of these methods depends on various parameters such as initial points, step size, direction, etc. Thus, finding a suitable framework for the design and analysis of such methods is an important goal for researchers and users of numerical analysis techniques. In this regard, control theory has become a focus of research for evaluation and synthesis of numerical algorithms [1-6]. In one of the main recent contributions, Bhaya and Kaszkurewicz [1-2] used some ideas of control theory to systematize a class of approaches to algorithm analysis and design. In their proposed approach, the error dynamics are stabilized using some suitable Lyapunov functions.

As point out in [29], continuous analogies of iterative methods, otherwise known as trajectory-following methods for ODEs, have some advantages. First, it is generally easier to prove convergence theorems for continuous methods; second, if a convergence theorem holds for the Cauchy problem for