

An Adaptive Memristor-Programming Neurodynamic Approach to Nonsmooth Nonconvex Optimization Problems

Mengxin Wang, Yunshu Xie, and Sitian Qin 

Abstract—This article introduces an adaptive memristor-programming neurodynamic approach (AMPNA) to tackle optimization problems that are nonconvex and nonsmooth with inequality and equality constraints. In the circumstance that requiring neither estimating penalty parameters, nor the coerciveness of inequality constraints, the state of the AMPNA can go into the feasible region from any initial points within a finite amount of time and ultimately converge to the critical point set of the aforementioned optimization problems. Differ from the existing neurodynamic approach (NA), AMPNA has superiority in using memristor. On the one hand, with regard to power consumption, AMPNA makes the most of memristor's unconventional characteristics to execute within the flux-charge realm. Compared with conventional NA executing within the voltage-current realm, AMPNA executes within the flux-charge realm and consumes power only in the analog transient. Once the analog transient is complete, all voltages, currents and powers in the AMPNA disappear. On the other hand, in terms of result storage, since the memristor has the ability to calculate and save information at the same physical location, the AMPNA no longer needs additional memories, and can implement the calculation scheme by the principle of in-memory computation. Therefore, the AMPNA presented in this article has significant advantages in reducing power consumption and storage space. Finally, AMPNA's optimization capacity and exceptional performance are confirmed through numerical simulations.

Index Terms—Adaptive penalty parameter, flux-charge realm, memristor-programming neurodynamic approach (MPNA), nonsmooth nonconvex optimization, smoothing method.

I. INTRODUCTION

IN THE past few years, optimization problems have drawn wide attention due to the increasing employments in the fields of industry control, such as robot control [1], signal processing [2], and image restoration [3]. It should be pointed out that in some practical applications (such as real-time distribution logistics optimization [4]), it is essential to

solve optimization problems in real time. Fortunately, circuit-based neurodynamic approach (NA) is capable of real-time computing. Its working principle is using electronic circuit components to obtain real-time continuous solution to optimization problem. Tank and Hopfield [5], in 1986, first propounded an NA to solve linear programming problems. With the pioneering work of Hopfield, more different types of NAs have been introduced to deal with various optimization problems (see [6], [7], [8], and references therein). For example, an NA with penalty parameters for nonlinear optimization was proposed in [6]. Liu et al. [9] presented a NA for dealing with pseudononconvex optimization subject to linear equality constraints.

Nevertheless, electronic circuit elements used in the above NAs are usually resistors, where instantaneous value of resistance is fixed. In this way, power consumption is increased extensively. Fortunately, memristor, an electronic circuit element, was discovered as a contraction of memory and resistor [10]. Differ from the resistor, the instantaneous resistance of the memristor is not constant but instead relies on its past state and the current or voltage applied to it [11]. Moreover, memristors have advantages in expansibility, small size on-chip region and low energy usage. Based on the superiorities of memristors, many researchers introduce memristors into the NA to take place of resistors, which is called memristor-programming NA (MPNA) [12]. MPNA, differ from the traditional NA executing within the voltage-current realm, executes within the flux-charge realm, which has superiorities in power consumption and result storage [13]. Regarding power consumption, MPNA consumes power merely within the analog transient phase, that is, within the steady state, it is closed, resulting in zero power consumption. However, the power of the traditional NA manipulating within the voltage-current realm is not decreased even within the steady state. In terms of result storage, MPNA executes according to the fundamentals of in-memory computation, and the memristor stores the results in a nonvolatile way, while the traditional NA needs extra space in computational results storage [14]. On account of the aforementioned advantages, MPNA gets widely attention.

Until now, there have been some novel results [15], [16], [17], [18]. For example, the stabilization of time-delayed fractional-order MPNAs was considered in [16]. Wang et al. [17] investigated the global stabilization of reaction-diffusion NA based on fuzzy memristor. It is

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Neurodynamic Programming

K Morrison



Neurodynamic Programming:

Neurodynamic Programming Book Review: Unveiling the Magic of Language

In an electronic era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its ability to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Neurodynamic Programming**," published by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we will delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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Neurodynamic Programming Introduction

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