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# A Neurodynamic model for solving invex optimization problems

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**Abstract**

In this paper, a neural network model is constructed to solve general invex programming problems. Based on the Saddle point theorem, the equilibrium point of the proposed neural network is proved to be equivalent to the optimal solution of the invex programming problem. By employing Lyapunov function approach, it is also shown that this model is globally convergent and stable in the sense of Lyapunov at each equilibrium points. The simulation result shows that the proposed neural network is efficient.

**Keywords:** Invex function, Neural network, Nonconvex optimization, Global optimality conditions
**Mathematics Subject Classification [2010]:** 90C26, 90C30

## 1 Introduction and Preliminaries

Most of the theory and computational procedures in mathematical programming have been developed in which the various functions are convex. This is a severe limitation in practical applications and much effort has been devoted to removing this limitation. Usually, generalized convex functions have been introduced in order to weaken as much as possible the convexity requirements for results related to optimization theory, to optimal control problems, to variational inequalities, etc. A very broad generalization of convexity, now known as invexity, was introduced by Hanson [3].

**Definition 1.1.** Assume $X \subseteq \mathbb{R}^n$ is an open set.The differentiable function $f : X \to \mathbb{R}$ is invex function if there exists some function $\eta : X \times X \to \mathbb{R}^n$ such that for each $\boldsymbol{x}_1,\ \boldsymbol{x}_2 \in X$,

$$f(\boldsymbol{x}_2) \geq f(\boldsymbol{x}_1) + \nabla f(\boldsymbol{x})^{\mathrm{T}} \eta(\boldsymbol{x}_1, \boldsymbol{x}_2).$$

Consider the following optimization problem:

$$\begin{aligned} &\min\ f(\boldsymbol{x}) \\ &\text{s.t. } G(\boldsymbol{x}) \leq \boldsymbol{0}, \end{aligned} \tag{1}$$

where $G(\boldsymbol{x}) = [g_1(\boldsymbol{x}), g_2(\boldsymbol{x}), ..., g_m(\boldsymbol{x})]$, $f$ and $g_i$, $i = 1, ..., m$ are continuously differentiable functions. If $f$ and $g_i$, $i = 1, ..., m$ be invex, then problem (1) is called invex programming problem.

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