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Comments on "intelligent optimal control of robotic manipulator using neural networks" ☆

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Abstract

This note points out that the proof of Theorem 3 in Kim, Lewis, and Dawson (Automatica 36(9) 1355) has a mistake. Additionally, it is presented as the correction of the theorem. © 2002 Published by Elsevier Science Ltd.

Keywords: Robotic manipulator; Optimal control; Closed-loop control; Neural networks.

Theorem 3 in Kim, Lewis, and Dawson, 2000 presents an adaptive learning rule for adjustment of weights in an artificial neural network. Eq. (4.8) shown in this theorem has the format

$$\dot{\widehat{\mathbf{W}}} = \mathbf{F}\,\sigma(\mathbf{p})\,\mathbf{B}^{\mathrm{T}}\,\mathbf{P}(\mathbf{q})\,\tilde{\mathbf{z}} - \kappa\,\|\tilde{\mathbf{z}}\|\,\widehat{\mathbf{W}},$$

where $\mathbf{F} \in \mathbb{R}^{m\times m}$, $\sigma(\mathbf{p}) \in \mathbb{R}^{m\times 1}$, $\mathbf{B} \in \mathbb{R}^{2n\times n}$, $\mathbf{P}(\mathbf{q}) \in \mathbb{R}^{2n\times 2n}$, $\tilde{\mathbf{z}} \in \mathbb{R}^{2n\times 1}$, and $\widehat{\mathbf{W}} \in \mathbb{R}^{m\times n}$.

However, notice that there is a mistake when computed $\sigma(\mathbf{p})\,\mathbf{B}^{\mathrm{T}}$ because $\sigma(\mathbf{p}) \in \mathbb{R}^{m\times 1}$ and $\mathbf{B}^{\mathrm{T}} \in \mathbb{R}^{n\times 2n}$. This mistakes is consequence of a mistakes in the proof of the Theorem 3.

In theorem's proof, the time derivative of Lyapunov function shown by authors was manipulated wrongly (see Eq. (4.13)) because the transition of Eqs. (4.11)–(4.13) must be done in this way:

$$\tilde{\mathbf{z}}^{\mathrm{T}}\,\mathbf{P}(\mathbf{q})\,\mathbf{B}\,\widetilde{\mathbf{W}}^{\mathrm{T}}\,\sigma(\mathbf{p}) = tr\{\widetilde{\mathbf{W}}^{\mathrm{T}}\,\sigma(\mathbf{p})\,\tilde{\mathbf{z}}^{\mathrm{T}}\,\mathbf{P}(\mathbf{q})\quad\mathbf{B}\}$$

$$= tr\{\widetilde{\mathbf{W}}^{\mathrm{T}}\,\sigma(\mathbf{p})\,(\mathbf{B}^{\mathrm{T}}\,\mathbf{P}(\mathbf{q})\,\tilde{\mathbf{z}})^{\mathrm{T}}\}.$$

With this, Theorem 3 can be proved in a correct way and the Eq. (4.8) in the cited theorem will have the format

$$\dot{\widehat{\mathbf{W}}} = \mathbf{F}\,\sigma(\mathbf{p})\,(\mathbf{B}^{\mathrm{T}}\,\mathbf{P}(\mathbf{q})\,\tilde{\mathbf{z}})^{\mathrm{T}} - \kappa\,\|\tilde{\mathbf{z}}\|\,\widehat{\mathbf{W}}.$$

References

Kim, Y. H., Lewis, F. L., & Dawson, D. M. (2000). Intelligent optimal control of robotic manipulator using neural networks. *Automatica*, *36*(9), 1355–1364.

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