International Journal of Innovative Computing, Information and Control
Volume **7**, Number **7(B)**, July **2011**
ICIC International ©2011 ISSN 1349-4198
pp. 4161–4170

BACKSTEPPING METHOD FOR A SINGLE-LINK FLEXIBLE-JOINT MANIPULATOR USING GENETIC ALGORITHM

Ali Reza Sahab[1] and Mohammad Reza Modabbernia[2]

[1]Department of Engineering, Electrical Engineering Group
Islamic Azad University, Lahijan Branch
Shaghayegh Street, Lahijan, Guilan, Iran
sahab@iau-lahijan.ac.ir

[2]Department of Electronics
Chamran Community Collage of Technology
Rasht, Iran
m_modabbernia@afr.ac.ir

Received April 2010; revised August 2010

Abstract. *Flexible manipulators are extensively used in industries. In this paper, backstepping method (BM) is used to control flexible manipulator. BM consists of parameters which accept positive values. The parameters are usually chosen variously. The system responses differently for each value. In this method, some paremeters exist, which, if not defined well, may cause some performance degrade. It is necessary to select proper parameters to obtain a good response because the improper selection of the parameters leads to inappropriate responses or even may lead to instability of the system. Genetic algorithms (GA) are used to compute the optimal parameters for the backstepping controller of single-link flexible-joint manipulator systems. GA can select appropriate and optimal values for the parameters. GA minimize the fitness function, so the optimal values for the parameters will be found. Selected fitness function is defined to minimize the least square error. Fitness function enforces the system error to decay to zero rapidly. Hence, it causes the system to have a short and optimal setting time. Fitness function also makes an optimal controller and causes overshoot to reach to its minimum value. This hybrid leads to optimal backstepping controller (OBM).*
Keywords: Single-link flexible-joint manipulator, Lyapunov function, Backstepping method, Genetic algorithm

1. **Introduction.** Industrial manipulator robots play an important role in the field of flexible automation. A single link manipulator is the most basic one which is operated to perform tasks such as moving payloads or painting objects. To obtain a high performance single link manipulator, position controllers are necessary in order to follow a preselected positional trajectory specified either as point-to-point or continuous path tracking motion with minimal deviation by manipulator.

In recent years of considering flexible manipulator, several papers were published. Most of them considered following items: 1. The necessity of considering flexibility. 2. Flexible manipulator modeling. 3. Simple controller design. 4. Analysis of the flexible manipulator specifications such as controllability. Many investigators worked to control the position of the end-effector of the single-link manipulators. Here in this section, the methods used by different investigators are described very briefly, while the computed torque control [1] inversion based on control schemes [2] for the end-point control of single-link flexible manipulator. Adaptive control schemes [3] for tip position control of single-link manipulators. Used robust control schemes for the single-link manipulator [4]. Lyapunov based