Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **17 (2010)** 207-227
 http://www.watam.org

ANALYTICAL SOLUTION OF THE NONLINEAR VIBRATIONS FOR ELECTROMECHANICAL INTEGRATED TOROIDAL DRIVE

Xiuhong Hao and Lizhong Xu*

Mechanical engineering institute
Yanshan University, Qinhuangdao 066004, China

Abstract. In this paper, the electromechanical coupled dynamic equations of the drive system are presented. The electromagnetic forces between planet and stator or worm are considered. Using Dyadic function Taylor's series equation, the electromechanical coupled dynamic equations are transformed into a team of the nonlinear dynamic equations. By means of the analytical method, the solutions of the nonlinear free vibration and the nonlinear forced response of the drive system are obtained. The equation of the system stability is also presented. The results show that the nonlinear vibrations are coupled vibrations with different frequencies. The resonance vibration, sub-resonance vibration and ultra-harmonic resonance occur in the drive system. The results are compared with numerical simulation. It shows that the analytical equations are valid for nonlinear vibration analysis of the drive system.

Keywords. toroidal drive, electromechanical integrated, nonlinear vibration

1 Introduction

Toroidal drive can transmit large torque in a very small size and is suitable for technical fields such as aviation and space flight, etc[17]. As electrical and control techniques are utilized in mechanical engineering field widely, generalized composite drives become advancing edge of the mechanical science. The electromagnetic harmonic drive[8] and piezoelectric harmonic one[9] are active drives in which the meshing forces between flexible gear and rigid one are controlled by electromagnetic force or piezoelectric one, and drive and power are integrated. Based on researching toroidal drive[10-11], Author presented a new drive system: electromechanical integrated toroidal drive. In the drive, the toroidal drive, power and control are integrated[12].

The drive consists of four basic elements, Fig.1: (a) the central worm; (b) radially positioned planets; (c) a toroidal shaped stator; and (d) a rotor, which forms the central output shaft upon which the planets are mounted.

*Corresponding author. Lizhong Xu, Mechanical engineering institute, Yanshan University, Qinhuangdao 066004, China. Tel.:+86-0335-8057031;fax+86-0335-8074783. E-mail address: Xlz@ysu.edu.cn