Bifurcation analysis of a microcantilever in AFM system

Neng-Sheng Pai\textsuperscript{a}, Cheng-Chi Wang\textsuperscript{b,}\textsuperscript{*}, David T.W. Lin\textsuperscript{b}

\textsuperscript{a}Department of Electrical Engineering, National Chin-Yi University of Technology, Taichung 411, Taiwan
\textsuperscript{b}Graduate Institute of Mechatronic System Engineering, National University of Tainan, Tainan 700, Taiwan

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Abstract

The atomic force microscope system (AFM) has become a popular and useful instrument to measure the intermolecular forces with atomic resolution that can be applied in electronics, biological analysis, materials, semiconductors, etc. This paper studies the bifurcation phenomenon and complex nonlinear dynamic behavior of the probe tip between the sample and microcantilever of an atomic force microscope using the differential transformation method. The dynamic behavior of the probe tip is characterized with reference to bifurcation diagrams, phase portraits, power spectra, Poincaré maps, and maximum Lyapunov exponent plots produced using the time-series data obtained from differential transformation method. The results indicate that the probe tip behavior is significantly dependent on the magnitude of the vibrational amplitude. Specifically, the probe tip motion changes from T-periodic to 3T-periodic, then from 6T-periodic to multi-periodic, and finally to chaotic motion with windows of periodic motion as the vibrational amplitude is increased from 0 to 5.0. Furthermore, it is demonstrated that the differential transformation method is in good agreement for the considered system.

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1. Introduction

Recently, many significant researches have been studied to design, analyze, and implement micro- and nanosystems. The atomic force microscope (AFM) provides a