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Modelling and Vibration Suppression of A Two-Link Flexible Robot Manipulator

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ABSTRACT

This paper presents a dynamic modelling of a two-link flexible manipulator model. An explicit, complete, and accurate nonlinear dynamic model of the system is developed using assumed mode method. The Lagrangian approach is used to derive the dynamic model of the structure. To study the effectiveness of the controller, a PID control is developed. PID controller will implement to the system of a two-link Flexible Manipulator.

Keywords *:*
Assumed mode, modelling, PID, two-link flexible manipulator

1. INTRODUCTION

Robot manipulators are constructed very massively to make them precise and stiff. The arms of these can be considered rigid, which allows a simple control joints. The drawback of their heavy construction is, that the robots need very powerful actuators and their operating speed is strongly limited by their own inertia. Lightweight robots are developed to overcome these drawbacks and allow high speed movements with the same or even better precision. These are commonly used in space applications, because the take-off weight of space shuttles is strongly limited. In order to improve higher productivity, it is required to reduce the weight of the arms and/or to increase their speed of operation. For these purposes it is very desirable to build flexible robotic manipulators. Morever, flexible manipulators are lighter, faster and less expensive than rigid ones.

Each flexible link can be modeled as distributed parameter system where the motion is described by a coupled system of ordinary and partial differential equations (PDE). Various approaches have been developed which can mainly be divided into two categories: the numerical analysis approach and the assumed mode method (AMM). The numerical analysis methods that are utilised include finite difference (FD) and finite element (FE) methods.

The FD and FE approaches have been used in obtaining the dynamic characterisation of a single-link flexible manipulator system incorporating damping, hub inertia and payload [1,2].

Subudhi and Morries [3] have used a combined Euler-Lagrange formulation and AMM approach to model the planar motion of a manipulator consisting of two flexible links and joints. The conventional Lagrangian modeling of flexible link robots does not fully incorporate the bending mechanism of flexible link as it allows free link elongation in addition to link deflection. De Luca and Siciliano [4] have utilized the AMM to derive a dynamic model of multilink flexible robot arms limiting to the case of planar manipulators with no torsional effects. The equations of motion which can be arranged in a computationally efficient closed form that is also linear with respect to a suitable set of constant mechanical parameters have been obtained [5].