ROBUST CONTROL OF ROBOTIC MANIPULATORS BASED ON $\mu$-SYNTHESIS

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A robotic manipulator is modelled as a cantilever rotating Euler-Bernoulli beam. Two dynamic transfer functions are derived to describe beam tip motion and angular rotation in terms of the desired angular rotation. Torque disturbance, imprecision in the payload mass, unknown properties of the manipulator link are sources of uncertainty. The objective is to achieve a desired angular rotation while the vibration of manipulator tip is suppressed. The control input of the system is an external driving torque. The $\mu$-synthesis control approach is used and an $H_\infty$ optimal robust controller is developed based on the DK-iteration algorithm. Results show that the designed controller guarantees the robust stability and performance of the perturbed system against existing uncertainties. Consequently, disturbance rejection and trajectory tracking performance are achieved while the closed-loop system is stable.

1. Introduction

Robotic manipulators have many applications in various fields such as industrial automation, underwater and space vehicles, manufacturing and material handling and medical surgeries. Equations of motion for the flexible manipulators have been governed in many researches. In the early works, the equations of motion for both rigid and flexible robot manipulators through Lagrangian formulation has been derived [1]. Differential equations describing the planar motion of a rotating thin flexible beam were found [2]. Dynamic equations for a planar manipulator with two flexible links, in contact with a constrained surface, have been studied [3]. Using Hamilton’s principle, equations of motion for a chain of flexible links have been developed through a systematic procedure [4]. Constrained motion of flexible-link manipulators including inertial and geometric nonlinearities was simulated [5].

Many control techniques have been developed based on Euler-Bernoulli beam theory for performance control of the flexible robot manipulators. Modelling, design and control of an Euler-Bernoulli beam type manipulator and point to point position control of a flexible beam using