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ICOM'08

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Design and Implementation of Fuzzy Control for Two Link Flexible Manipulator

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ABSTRACT

The increase demand on robotic applications has magnified and highlighted the importance of studying different aspects concerning robots. A recent trend is to use flexible manipulator in order to reduce weight and increase the payload carrying capacity at the same time. The studied manipulator is a single flexible link manipulator implemented and controlled by Feliu *et al* [1]. An intelligent controller is designed based on fuzzy logic control technique to reduce the resulting vibration at the tip of the link. Simulations and experimental studies will be conducted to evaluate the effectiveness of the proposed controller.

1. INTRODUCTION

The light weight links of flexible manipulators improve some characteristics of the manipulator such as minimizing the energy needed to run the manipulator, increasing its payload, and enhancing its reachability due to the use of long links. In addition, the increasing demand for precise high speed operation has made the flexible manipulators attractive (Yigit, 1992) [2]. The performance of the flexible manipulators are severely limited by the oscillatory response which persists for a period of time after the move is completed (DeLuca and Di Giovanni, 2001) [3], thus delaying any subsequent operation. The main objective is to reduce the oscillations and the delay time.

The implementation of the control is being held on a two-flexible-link Quanser robot. The control method used by Quanser is PID, while the proposed control method is based on Fuzzy logic. This paper presents a comparison between the two methods as well as their hybrid.

For nearly a decade, control engineers and roboticists alike have been investigating the problem of controlling robotic mechanisms that have very flexible links. Such mechanisms are important in space structure applications, where large, lightweight robots are to be utilized in a variety of tasks, including deployment, spacecraft servicing, space-station maintenance, and so on. Flexibility is not designed into the mechanism; it is usually an undesirable characteristic that results from trading off mass and length requirements in optimizing effectiveness and "deploy-ability" of the robot. These requirements and limitations of mass and rigidity give rise to many interesting issues from a control perspective.

2. LITERATURE REVIEW

2.1 Single flexible link manipulator

(Lut, Shafiq and Yahagitt 1996) presented a new method for the vibration control of one-link flexible robotic arms using robust model matching control strategy. To reduce the order of the compensator the rigid-body mode and the first flexible mode were considered as nominal model. The other flexible modes were considered as unmodeled dynamics. The method was suitable to robustly control the nominal model in the presence of unmodeled flexible dynamics and achieved the desired model matching simultaneously. Moreover, the sufficient condition for stabilizing the nominal model in the presence the unmodeled flexible dynamics was derived. The payload at the end of the arm was modeled as concentrated mass. Finally, computer simulation results were presented to demonstrate the effectiveness of the proposed method [4].

(H. Yang H. Krishnan M. H. Ang, Jr. 1998) implemented a nonlinear variable structure controller (VSC). The damping of vibration was achieved by relocating the poles of controllable pair (Q, P). The closed-loop system was robust and stable not only in the reaching phase but also in the sliding mode. The system dynamics expressed in the new state variables enabled them to consider VSC design and vibration suppression separately. A modified sliding surface was introduced to damp out vibration in