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RBFNN CONTROL OF A TWO-LINK FLEXIBLE MANIPULATOR INCORPORATING PAYLOAD

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Abstract

This paper presents the dynamic modeling and control of a two-link flexible robot manipulator. A dynamic model of the system is developed using a combined Euler-Lagrange and assumed mode methods. The most problems of a two-link flexible manipulator are vibration of flexible link and unpredictable payload additional. Previous researchers have discussed control methods for this system, few presented the effect of a payload profile. Simulation is performed to assess the dynamic model and system responses at the hub and end-point of both links are presented and analyzed in time domains and show the advantages using radial basis function neural network (RBFNN) controller for solving flexible link vibration, achieve high-precision position tracking, and payload effect robustness. The results achieved by the proposed controller are compared with conventional PID to substantiate and verify the advantages the proposed scheme and its promising potential in control of a two-link flexible manipulator. It is shown that smaller overshoot, quickly steady state response and tracking performance of the proposed controller is good profile and better than PID controllers.

Keywords: Modeling, RBFNN, two-link flexible manipulator.

Abstrak

Paper ini menyajikan model dinamik dan kendali robot lengan fleksibel dua link. Model dinamik menggunakan teknik Lagrangian dan assumed mode method (AMM). Permasalahan yang sering terjadi dalam robot lengan fleksibel dua link adalah getaran sebagai effect gerakan lengan fleksibel dan penambahan beban yang tidak diprediksi. Penelitian sebelumnya banyak membahas model kendali untuk system ini tetapi sedikit membahas sistem kendali terhadap effect penambahan beban. Simulasi ini untuk menguji model dinamik, sistem response pada hub dan titik ujung dari setiap link dalam fungsi waktu serta menampilkan keuntungan menggunakan RBFNN kontroler untuk mengatasi masalah getaran pada gerakan lengan fleksibel, tracking posisi yang akurat dan effect penambahan beban. Hasil RBFNN controller akan diverikasi dengan membandingkan hasil PID kontroler. Hasil menggunakan metode RBFNN menunjukkan overshoot yang lebih kecil, cepat mencapai steady state dan performa yang lebih baik dibandingkan dengan menggunakan PID controller.

Kata kunci: Model, RBFNN, robot lengan fleksibel dua link.

1. INTRODUCTION

Flexible manipulators have several advantages over rigid robots: they require less material, are lighter in weight, consume less power, require smaller actuators, are more maneuverable and transportable, have less overall cost and higher payload to robot weight ratio [1]. These types of robots are used in a wide spectrum of applications starting from simple pick and place operations of an industrial robot to micro-surgery, maintenance of nuclear plants and space robotics [2].

Due to the flexible nature of the system, the dynamics are highly non-linear and complex. Problems arise due to lack of sensing, vibration due to system flexibility, imprecise positional accuracy and the difficulty in obtaining accurate model for the system [3]. Moreover, the complexity of this problem increases when the flexible manipulator carries a payload.

Practically, a robot is required to perform a single or sequential task such as to pick up a payload, move to a specified location or along a pre-planned trajectory and place the payload.

4. CONCLUSSION

The development of dynamic model and a RBFNN controller of a two-link flexible manipulator incorporating structural damping, hub inertia and payload have been presented. The model has been developed using a combined AMM and Euler-Lagrange approach. The RBFNN controller is efficient and easy to curry on. The RBFNN controller used has better then PID controller, as it can assume very different type of trajectory with training the controller for it. Simulations of the dynamic model have been carried out in the time where the system responses including angular positions, modal displacements and end-point acceleration are studied. The results show that the performance of the control system is improved greatly with the proposed controller, greatly decreasing the tip deflection of the second link and also enhancing the steady state accuracy for both links. Simulation results have shown that significant vibration occurs during movement of the system. It is found that the payload significantly affected the system behaviour in time response.

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