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DYNAMIC MODELLING AND CHARACTERISATION OF A TWO-LINK FLEXIBLE ROBOT MANIPULATOR

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ABSTRACT
This paper presents an investigation into the dynamic modelling and characterisation of a two-link flexible robot manipulator incorporating a payload. A planar two-link flexible manipulator incorporating structural damping, hub inertia and payload that moves in the horizontal plane is considered. A dynamic model of the system is developed using a combined Euler-Lagrange and assumed mode methods. Simulation is performed to assess the dynamic model and system responses at the hub and end-point of both links are presented and analysed in time and frequency domains. Moreover, effects of payload on the dynamic characteristics of the flexible manipulator are studied and discussed.

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

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 manoeuvrable and transportable, have less overall cost and higher payload to robot weight ratio. These type 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 (Dwivedy and Eberhard, 2006). However, control of flexible manipulators to maintain accurate positioning is an extremely challenging.

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 (Martins et al., 2003). The complexity of the problem increases dramatically for a two-link flexible manipulator where several other factors such as coupling between both links have to be considered. 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. The dynamic behaviour of the manipulator is significantly affected by payload variations (Tokhi et al., 2001). If the advantages associated with lightness are not to be sacrificed, accurate models and efficient controllers have to be developed.

The main goal on the modelling of a two-link flexible manipulator is to achieve an accurate model representing the actual system behaviour. It is important to recognise the flexible nature and dynamic characteristics of the system and construct a suitable mathematical framework. Modelling of a single-link flexible manipulator has been widely established. Various approaches have been developed which can mainly be divided into two categories: the numerical analysis approach and the assumed mode method (AMM).