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Author: Ms. Xi Luo
University of Nottingham, China, China, rosy.xi.luo@gmail.com

Dr. Dunant Halim
University of Nottingham China, China, dunant.halim@nottingham.edu.cn
Prof. Pavel M. Trivailo
RMIT University, Australia, Australia, trivailo@rmit.edu.au

INTEGRATED VIBRATION AND VISUAL SENSING FOR A VISION-BASED END-EFFECTOR CONTROL OF A MULTI-LINK FLEXIBLE ROBOTIC MANIPULATOR

Abstract

Flexible lightweight robotic manipulators have a number of advantages over traditionally bulky industrial manipulators. Yet a considerable number of robotic manipulators still lack of feedback control to achieve a satisfactory operating performance in dynamic and unstructured environments. The use of vision-based end-effector provides the required sensing for feedback control to achieve an accurate object positioning. However, the manipulator's motion involves significant structural vibrations which are detrimental to the quality of the vision-based sensing. In addition, vision-based control techniques generally face constraints for real-time control due to rather low calculation speed to process camera images. The present paper aims to propose a method that integrates vibration and visual information for a vision-based end-effector control so to obtain more stable images for accurate object positioning. The flexible robotic manipulator model is developed based on a non-linear dynamic model utilizing the co-rotational finite element method incorporated with smart piezoelectric actuators/sensors. This modeling method uses multiple co-ordinate (co-rotational) systems which rotates and translates with each element, so that the geometric non-linearity present in rotating manipulator system can be dealt with efficiently. To improve the accuracy of end-effector positioning, model predictive based control will be used to fuse information from dynamic vibration and visual sensors. Some experimental results demonstrate that it is possible to enhance the positioning accuracy of multi-link flexible manipulator by the proposed integrated sensing control method.