Automated Gripper Jaw Design and Grasp Planning for Sets of 3D Objects

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An algorithm for automatically generating a common jaw design and planning grasps for a given set of polyhedral objects is presented. The algorithm is suitable for a parallel-jaw gripper equipped with three cylindrical fingers. The common jaw design eliminates the need for custom made grippers and tool changing. The proposed jaw configuration and planning approach reduces the search associated with locating the finger contacts from six degrees-of-freedom to one degree-of-freedom. Closed-form algorithms for checking force closure and for predicting jamming are developed. Three quality metrics are introduced to improve the quality of the planned grasps. The first is a measure of the sensitivity of the grasp to errors between the actual and planned finger locations. The second is a measure of the efficiency of the grasp in terms of the contact forces. The third is a measure of the dependence of force closure on friction. These quality metrics are not restricted to cylindrical fingers and can be applied to n finger grasps. Running on a standard PC, the algorithm generated a solution in less than five minutes for a set of five objects with a total of 456 triangular facets.

1. INTRODUCTION

This paper is motivated by two problems faced by the manufacturing industry today. The first involves the time needed to bring new products to market. To satisfy customer demand many companies must change their products frequently and bring them to market quickly. Assuming the parts used with these products are handled at some point during production using robotic grippers, the time required to adapt these grippers to the new part shapes will delay the introduction of these products. Typically, parallel-jaw grippers with custom jaws are used in industry, requiring the design and manufacture of a new set of jaws to complete the adaptation. The second problem is the custom jaws tend to be part specific. Each gripper becomes dedicated to one part and automated tool changing is required for handling sets of different parts. The time spent on tool changing increases

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