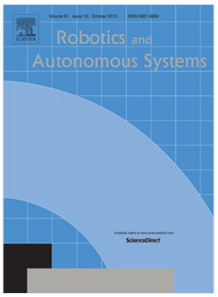
Accepted Manuscript



A model-based scooping grasp for the autonomous picking of unknown objects with a two-fingered gripper

François Lévesque, Bruno Sauvet, Philippe Cardou, Clément Gosselin

PII: S0921-8890(17)30889-8
DOI: https://doi.org/10.1016/j.robot.2018.04.003
Reference: ROBOT 3015

To appear in: *Robotics and Autonomous Systems*

Received date : 12 December 2017
Revised date : 21 March 2018
Accepted date : 11 April 2018

Please cite this article as: F. Lévesque, B. Sauvet, P. Cardou, C. Gosselin, A model-based scooping grasp for the autonomous picking of unknown objects with a two-fingered gripper, *Robotics and Autonomous Systems* (2018), https://doi.org/10.1016/j.robot.2018.04.003

A Model-Based Scooping Grasp for the Autonomous Picking of Unknown Objects with a Two-Fingered Gripper

François Lévesque, Bruno Sauvet, Philippe Cardou, and Clément Gosselin

Département de génie mécanique, Université Laval, 1065 Avenue de la Médecine, Québec, QC, G1V0A6, Canada. e-mail: bruno.sauvet@gmail.com; philippe.cardou@gmc.ulaval.ca; gosselin@gmc.ulaval.ca.

Abstract

Grasping objects used in daily activities is not an easy task for a robot: the diversity of shapes and volumes of objects renders specific grasping methods inefficient. In this paper, we propose a novel model-based scooping grasp for the picking of thin objects lying on a flat surface, which are typically elusive to common grippers and grasping strategies. A robotic work cell composed of a serial arm, a commercially available gripper and a 3D camera overlooking the workspace is used to demonstrate and test the algorithm. Since a commercial gripper is used, the robot is capable of grasping a large variety of objects, in addition to the targeted thin objects. An experiment based on a test set of 80 objects results in an overall grasp success rate of 84%, which demonstrates the potential of the novel scooping grasp to extend the capabilities of existing grippers.

Keywords: grasping, unknown objects, underactuated gripper, scooping, lateral grasping

1. Introduction

Some tasks such as lifting heavy payloads or repeating the same operation thousands of times are difficult for humans but easy to program on robotic manipulators. Conversely, other tasks are effortless for humans, but remain difficult for robotic manipulators. Reliably grasping unknown objects is one such task. Various methods of grasping have been reviewed in [1, 2, 3]. The grasping problem can be classified according to whether the object is known [4], familiar [5] or unknown [6, 7]. The solutions to these problems can also be classified according to their nature: the empirical approach [8, 9], based on the replication of the behaviour of the human hand, and the analytical approach [10, 11], based on the mechanical properties of the grasping action.

As described in Section 2, various research groups have succeeded in developing autonomous systems for the grasping of objects. Some works use machine learning or deep learning, either to identify objects or to synthesize grasps. Others use recognition with elementary forms or faces, or work with known objects. Approaches based on learning require large amounts of data and may not perform well in unusual situations (or objects). On the other hand, techniques based on the recognition of elementary shapes may not be well adapted to objects with complex shapes. Most existing methods are designed for non-flat objects and only a few tackle the problem of grasping thin objects.

Hence, the objective of this work is to develop a robotic cell for grasping a wide diversity of unknown objects used in the everyday life, including flat thin objects. Moreover, the robotic cell is tested on a large number of objects to ensure its reliability. In order to succeed in this task, three steps are essential, namely : *i*) recognize and locate the objects in the workspace, *ii*) choose the most appropriate grasping method and *iii*) find a robust feasible grasp (i.e. find a grasping configuration).

In this paper, we propose a model-based scooping grasp that is capable of picking thin objects on a flat surface, in order to extend the variety of unknown objects that can be autonomously grasped by a robot in a work cell. Two different grasping methods are implemented, — namely a conventional overhead grasp and the novel scooping grasp — in order to demonstrate the effectiveness of the proposed method at increasing the variety of objects that can be grasped. In the scooping grasp, one finger of an underactuated gripper slips under the object. Thus, the gripper pinches the object from one of its sides much like a human hand grasps a sheet of paper on a flat surface. The proposed scooping maneuver