M5 PRIMITIVE SHAPE FITTING IN POINT CLOUDS FOR ENABLING AUTONOMOUS UNDERWATER GRASPING

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Abstract

Autonomous grasping of unknown objects by a robot is a highly challenging skill that is receiving increasing attention in the last years, and is still more challenging in underwater environments, with highly unstructured scenarios, limited availability of sensors and adverse conditions that affect the robot perception and control systems. This paper describes an approach for autonomous grasping on underwater primitive shaped objects from floating vehicles, in particular cylinder shaped objects like an amphora. Various sources of stereo information are used to gather 3D information in order to recognise the object and plan feasible grasp on it using a RANSAC primitive shape recognition algorithm.

Keywords – autonomous grasping, underwater, point cloud, RANSAC, shape fitting.

INTRODUCTION

Exploration of the oceans is attracting the interest of many companies and institutions. Remote Operated Vehicles (ROVs) are currently the most used machines but the trend is to advance towards Autonomous Underwater Vehicles (AUVs). The approach holds lots of challenges, being one of the biggest the autonomous grasping and manipulation tasks. Within this context the most recent project focused on increasing autonomy is the project TRIDENT [1], where Prats presents in [2] a framework to grasp objects with limited user interaction which is further developed here. In this paper we present a method able to perform grasp tasks autonomously in the constrained, yet realistic, problem of grasping objects like an amphora.

3D RECONSTRUCTION AND SEGMENTATION

Grasping objects generally requires at least some partial 3D structure. In this case it can be gathered either using laser stripe reconstruction [2] or a stereo camera (real or virtual in the UWSim [3]). In the proposed experiments a stereo camera is attached to a vehicle and captures a pair of images from which a 3D reconstruction with respect to a fixed frame is performed. These images are processed with PCL [4] to continuously obtain a point cloud, which is then processed using downsampling and filtering algorithms.

With this relevant point cloud a RANSAC algorithm, described in [5], is used twice to separate the object from the background as can be seen in Figure 1. First, the background plane is detected with a plane fitting algorithm. In the next step, other RANSAC algorithm is used to obtain the cylinder parameters associated to the real amphora. These algorithms are parameterized to enable fitting quality and performance control. The result of this sequence is a set of inliers that represent the detected amphora points, a point in the obtained cylinder model axis as well as its direction and cylinder radius.

GRASP SPECIFICATION

Using the cylinder model obtained a grasp is then computed. To avoid errors the grasp point is computed using the most significant points of the cylinder inliers, using the middle point of the cylinder axis as a starting grasp point. Then taking into account the amphora radius and desired approach distance and angle, the grasping end-effector frame is computed with respect to a world fixed frame, with this free variables allowing computing different grasp frames around the cylinder centre axis.

After that, it is necessary to select a feasible grasp among the available ones. This can be done by computing the inverse kinematics of the whole arm kinematic chain and calculating its reachability. Our approach is to adopt a classical iterative inverse jacobian method.

FUTURE WORK AND EXPERIMENTS

This approach will be tested in water tank conditions to perform a fully autonomous grasp with a lightweight ARM5E arm, given the aforementioned constraints of the problem.

Here has been described a new framework that can be further developed to recognise other primitive shapes such as spheres, cuboids or even more complex models that can be approximated with a set of primitive shapes, as shown in [6], in order to tackle the problem of completely unknown objects .

ACKNOWLEDGMENTS

This research was partly supported by Spanish Ministry of Research and Innovation DPI2011-27977-C03 (TRITON Project), by the European Commission's Seventh Framework Programme FP7/2007-2013 under Grant agreement 248497 (TRIDENT Project), by Foundation Caixa Castelló-Bancaixa PI.1B2011-17, and by Generalitat Valenciana ACOMP/2012/252.

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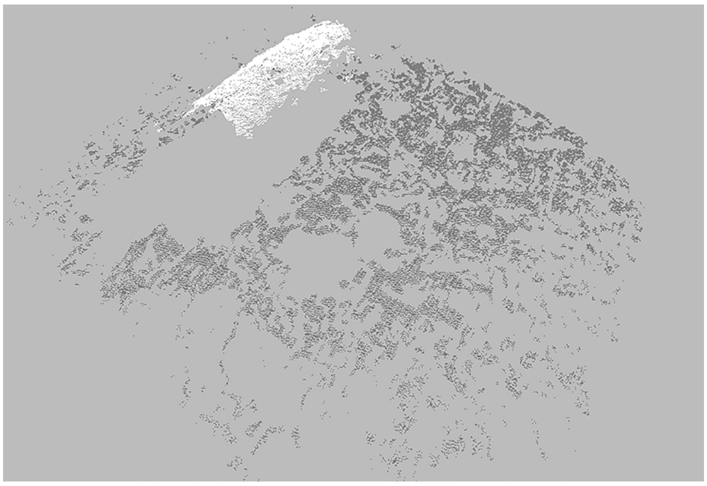

Fig. 1 Object from background segmentation.

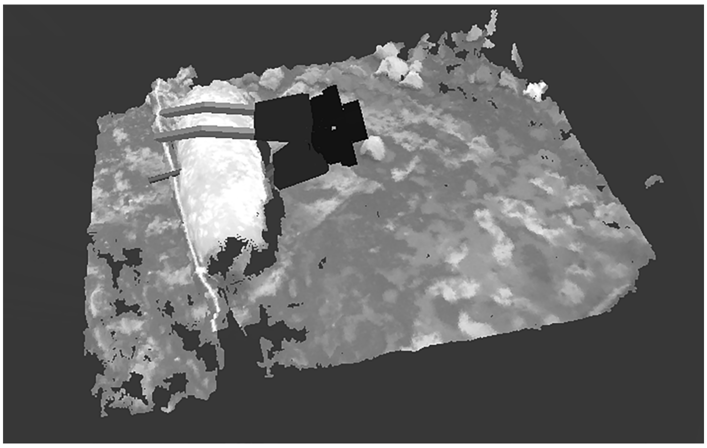

Fig. 2 Grasp Specification shown in UWSim.