Robotic Untangling of Herbs with Parallel Grippers

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Overview

Fig.1. Herb entanglement.

For a pile composed of herbs, the weight picked up can be controlled by varying the opening aperture width of a parallel gripper. However, the individual strands of herbs get entangled with each other, causing more to be picked up than desired (see Fig.1). Here, it is shown that using a *spread-and-pick* approach the degree of entanglement in a herb pile can be reduced. Compared to the traditional approach of picking from an entanglement-free point in the pile, the proposed approach reduces the variance in picked weight for homogeneous piles of plastic and real herbs by 36.35% and 23.64%, respectively. These results demonstrate that using the proposed *spread-and-pick* approach, the stochasticity of a herb environment can be counterbalanced effectively.

Motivation

Fig.2. Herb picking.

Humans frequently use their fingers to separate things while picking, especially when they have to work with one hand. The proposed *spread-and-pick* approach draws inspiration from this behaviour. Specifically, if the target object is between the two fingers of a parallel gripper, instead of moving inwards (closing) and picking the object, the fingers could be moved outward which will result in displacing other objects entangled or close to the boundary of the target object. The Graspability index* (GI) is a vision-based measure for evaluating the candidate grasping poses for picking individual objects avoiding collision between objects and gripper plates. The *spread-and-pick* approach extends GI to counter herb entanglement.

Methodology

Estimate the collision-free point r^* using GI.

↓

Estimate the entanglement point r' using the vision module.

↓

Adjust gripper's orientation θ as per (1).

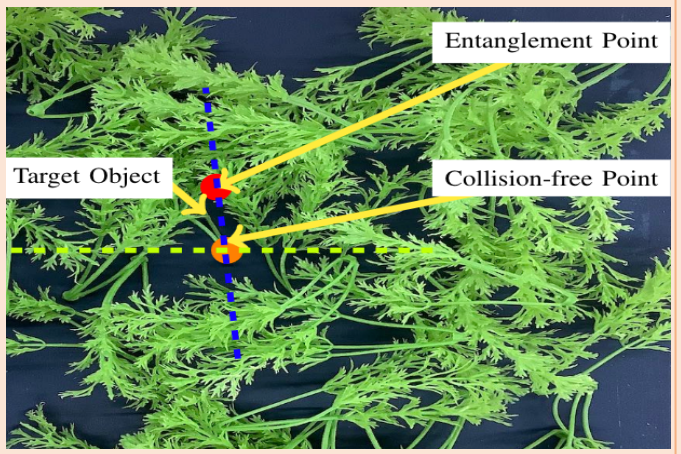

Fig.3. Overview of the proposed *spread-and-pick* approach. Dashed yellow line represent the initial orientation of the x-axis of the gripper. z-axis of the gripper points upwards. Dashed blue line represents the line of entanglement.

(1)

$$\theta = \arccos\left(\frac{\mathbf{r}^{*\top}\mathbf{r}'}{|\mathbf{r}^*||\mathbf{r}'|}\right).$$

Experiments

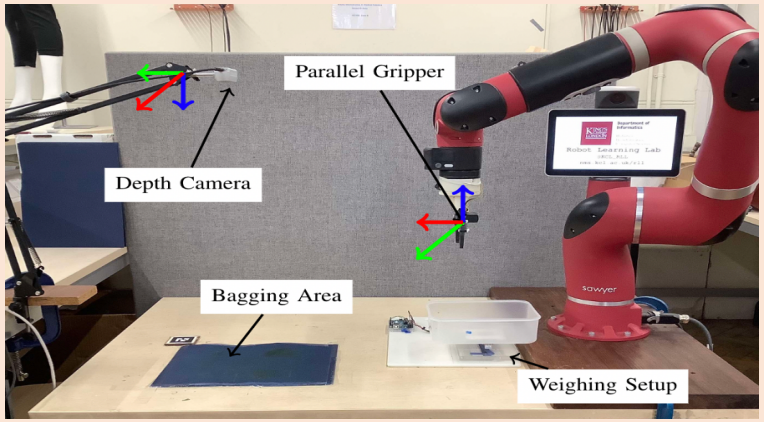

Fig.4. Overview of the experimental setup.

A series of robotic picking operations are conducted for plastic and real herbs following a simple picking methodology (picking from the point as suggested by GI) as well as following the *proposed spread-and-pick* methodology, whereby the pick operation is augmented with an extra detangling step using an extension to the GI.

Results

Picked weight (mean±s.d.) over 10 trials for real herbs.

Gripper Width(mm)	Method	Picked Weight(g)
20	Graspability Index	3.712±3.028
	Spread and Pick	15.646±2.471
30	Graspability Index	8.622±3.480
	Spread and Pick	15.788±2.658
40	Graspability Index	19.192±7.273
	Spread and Pick	18.361±6.934

Picked weight (mean±s.d.) over 20 trials for plastic herbs.

Gripper Width(mm)	Method	Picked Weight(g)
20	Graspability Index	9.844±11.078
	Spread and Pick	8.247±7.635
30	Graspability Index	10.482±9.172
	Spread and Pick	7.501±5.839
40	Graspability Index	13.267±11.953
	Spread and Pick	14.333±8.480

As can be seen, there is a clear reduction in the variance of the picked mass for the *spread-and-pick*. The maximum percentage decrease in the variance for real herbs is 23.64%, for the intermediate gripper width = 30 millimeter.

* Domae, H. Okuda, Y. Taguchi, K. Sumi, and T. Hirai, "Fast graspability evaluation on single depth maps for bin picking with general grippers," Proceedings - IEEE International Conference on Robotics and Automation (ICRA), pp. 1997–2004, 2014.

https://nms.kcl.ac.uk/rll/index.html
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