Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 44 (2016) 239 – 244

www.elsevier.com/locate/procedia

6th CIRP Conference on Assembly Technologies and Systems (CATS)

Method for the Automated Dimensioning of Gripper Systems

Johannes Schmalz[a]*, Lucas Giering[a], Matthias Hölzle[a], Niklas Huber[a], Gunther Reinhart[a]

[a]*Institute for Machine Tools and Industrial Management (iwb), Technical University of Munich (TUM), 80333 Munich,Germany*

* Corresponding author. Tel.: +49 89 289 15534; fax: +49 89 289 15555. *E-mail address:* johannes.schmalz@iwb.tum.de

Abstract

Industrial grippers play an important role within automated production and assembly processes. In most cases their selection and dimensioning is done experience-based. This article presents an approach to dimension grippers automatically based on the properties of the handling object, the handling environment, the handling device and the handling process. Special attention is paid to the adaption of the operational elements, which interact with the handling object, like suction cups or jaws.

© 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of the 6th CIRP Conference on Assembly Technologies and Systems (CATS)

Keywords: handling; methodology; tooling

1. Introduction

Being the link between the workpiece and the handling device, grippers play an important role in automated production and assembly processes. To ensure the best possible handling performance, the selection of a feasible gripper and the adaption to the workpiece is crucial. This selection and dimensioning has so far been done manually based on experience and rudimentary methodologies [1]. To meet the requirements of future virtual production and assembly planning and to lower time and cost for the selection and dimensioning of gripper systems there is a need for an automated methodology to address this task [2].

To be able to automate the selection and dimensioning process a holistical examination of the system is required. There are five elements in the system “handling” (the system the gripper is embedded in): Environment, handling device, part, task and gripper. Earlier work analyzing the system showed that particularly the gripping point (“where does the gripper get in contact with the part”) and the gripping force have a tremendous impact on the behavior of the system [3]. Closely linked to these two topics is the dimensioning, which merges the requirements of gripping point and -force towards a feasible gripper.

This paper points out, how to address these topics against the background of an automated selection and dimensioning of gripper systems considering parallel, angular and vacuum grippers. Grippers again can be divided in a gripper body and the operational elements (jaws, suction cups) that interact with the part.

2. Automated search for gripping points

The gripping point is the major factor for the performance of a handling system and hence also for the selection and dimensioning of the gripper. It has a strong influence on a number of factors like, for instance, the gripping force. The gripping force again has a strong influence on which gripper to take and how to dimension the operational elements (jaws or suctions cups) that provide the contact with the part [3].

To automate the search for possible gripping points, means to define a program that extracts possible positions for different grippers based on the provided CAD data, ranks their fitness and processes them for the further selection and dimensioning process.

There are several approaches that address this task [4, 5, 6, 7, and 8]. Main drawback of all the methods is, that each of them only focuses on one kind of gripper, which makes the comparison of different solutions reaching across different

2212-8271 © 2016 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of the 6th CIRP Conference on Assembly Technologies and Systems (CATS)
doi:10.1016/j.procir.2016.02.106

gripper types difficult. The following approach shows possibilities to integrate different kinds of grippers in one process.

2.1. Definition of gripping positions

A gripping position is an umbrella term for a possible holding position of a specific gripper on a specific part. To be able to process the gripping positions further while addressing several gripper types the following classification is proposed:

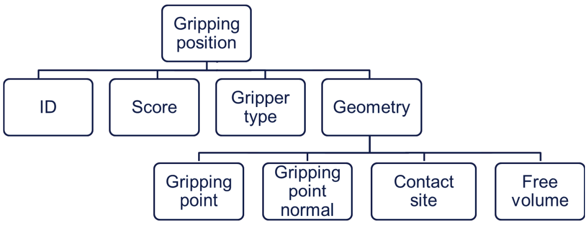

Fig. 1. Gripping position classification

ID: To address each position individually, each is assigned a distinct number

Score: As the program searches for any gripping position on a part there is a need to rank the positions. Ranking criteria are:

1. The distance of the position to the center of gravity
2. Size of the contact site
3. Curvature of the contact site
4. Free volume above the contact site

Grippertype: Applicable kind of gripper for the gripping position

Geometry: General information about the geometry of the gripping position, which consists of:

- The gripping point as origin of the gripping position
- The gripping point normal to describe the orientation of the gripping point
- The contact site which is a defined gathering of several gripping points with similar properties
- The free volume, which defines how much free volume is available for approaching the gripping position.

Central element of the gripping position is the contact site. It is the geometrical element that ensures a proper fixture between gripper and part. A vacuum gripper needs at least one contact site, a parallel or angular gripper at least two. There are three types of contact positions: Contact points, contact lines and contact areas. Vacuum grippers are due to their physical properties only applicable for contact areas.

2.2. Algorithm for the automated identification of gripping positions

In order to receive the data mentioned in section 2.1 the following steps have to be carried out by the algorithm.

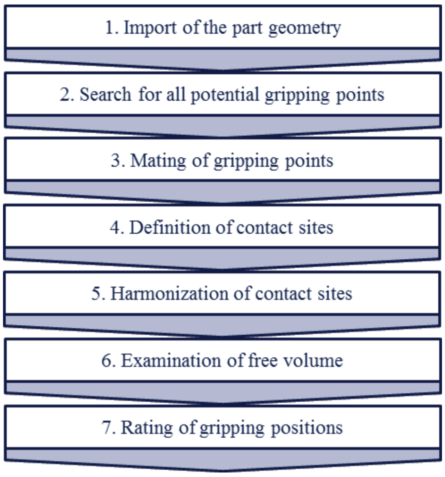

Fig. 2. Flow-chart of the gripping position search algorithm

First of all the CAD data has to be provided. Being widely-used STEP (Standard for the Exchange of Product Model Data) [9] is the preferred format.

In a second step, the algorithm searches for all theoretically possible gripping points. This is performed by rasterizing each surface of the part with a regular grid. This leads to a scatter-plot of the surface. For each intersection of the grid the normal vector of the surface is generated. The resolution of the grid has to be adapted manually based on the wanted accuracy.

In this step, the algorithm checks whether there are partners for the gripping points regarding parallel and angular grippers. This means that the normal vectors have the same orientation but face in the opposite direction. The user is able to define tolerances so that points which are not completely parallel to each other are also taken into consideration.

After the search for possible linked points the algorithm tries to calculate the maximal contact site symmetrically around each gripping point. Therefore the geometry around the point is further analyzed based on the original CAD data, which makes it possible to use the real shape of the contact site instead of the scatter-plot. If the algorithm is not able to build a contact area (but for example a contact point or a contact line) vacuum grippers are excluded from the further process.

For parallel and angular grippers, the algorithm then harmonizes the contact sites. This means it compares the sizes and geometries of the contact sites and tries to define contact sites that mate geometrically in the best possible way to ensure symmetrical jaws later during dimensioning.

In the sixth step, the free volume above the contact sites is determined to be able to dimension the grippers accordingly afterwards. Starting from the gripping points of the contact

Download English Version:

https://daneshyari.com/en/article/1698601

Download Persian Version:

https://daneshyari.com/article/1698601

Daneshyari.com