# Automated Modular Part-flexible Feeding System for Micro Parts

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**Abstract**

In the assembly, efficient part feeding is a decisive factor for a successful automation. Especially in the field of micro assembly handling tools have in general to be adapted to every single part and are flexible only to a certain degree. Therefore, an automated feeding system for the part-flexible feeding of micro parts is presented in this paper.

## 1 Introduction

At the wbk Institute of Production Science of the Karlsruhe Institute of Technology (KIT) a computer-based automated modular feeding system working according to the sliding conveyance has been developed on the basis of piezoelectric vibratory conveyors [1]. A wide range of different micro parts can be conveyed, positioned and, depending on their geometry, partly be rotated around their vertical axis on the conveying panels of the piezoelectric vibratory conveyors by simply adapting magnitude and phase of oscillation without additional devices in any direction. The sliding conveyance offers also the possibility to convey thin and fragile parts such as green metal parts before sintering.

## 2 Design of the automated modular part flexible feeding system

The system consists of a product-neutral pre-separation unit and several specially developed miniaturized piezoelectric vibratory conveyors [2] with their hexagonal conveying panels arranged next to each other (figure 1).

Both the pre-separation unit and each single vibratory conveyor are operated and individually controlled by own piezo actors. For automation purposes the computer-based system is additionally equipped with an image processing device which allows for the detection of type and number as well as position and orientation of the parts on the feeding system.

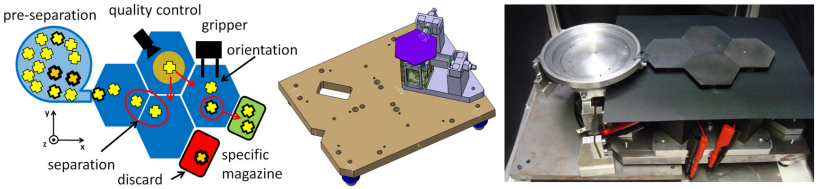


Figure 1: Automated modular part-flexible feeding system for micro parts

During operation a small amount of parts is separated by the pre-separation unit. After that, the pre-separation process is stopped and the final separating takes place on the vibratory conveyor system while the image processing unit detects the part with the smallest distance to one of the neighboring conveyor panels. That part will be separated first by being conveyed onto the adjacent panel. For that purpose, the oscillations of the two neighboring conveyors are temporarily synchronized. Then, the part can be conveyed into a magazine, for instance, or positioned and oriented for a gripping device regardless of the remaining quantity of parts on the other conveyor panels.

## 3 Control technology

The control technology for the system is illustrated schematically in figure 2.

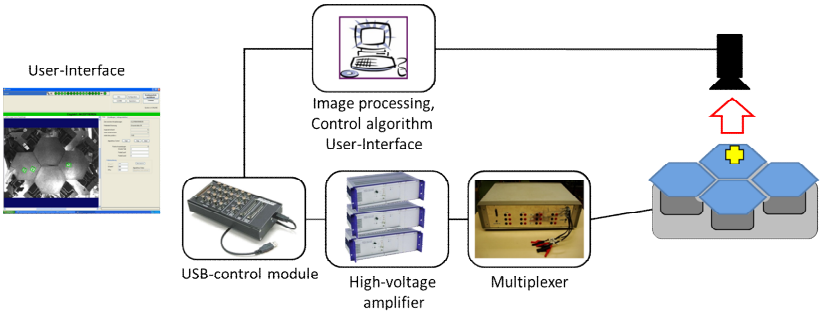


Figure 2: Control technology of the feeding system

Target position and desired orientation of the parts are provided by the user interface. The image processing unit continuously detects type, number, position and orientation of the parts on the conveying system. According to this information the control algorithm generates the appropriate control commands for the activation of

the USB control module that generates the control signals for the piezo amplifiers and outputs the digital switching signals for the multiplexers.

## 4 Commissioning

In the course of the system´s commissioning various exemplarily chosen micro parts could be separated, sorted and positioned in an automated manner. However, the orientation process was only possible to a limited extent. With a maximum position deviation of ±0.3 mm and an orientation within the tolerance of ±30° the cycle time for the separated part in figure 3 was approx. two seconds.

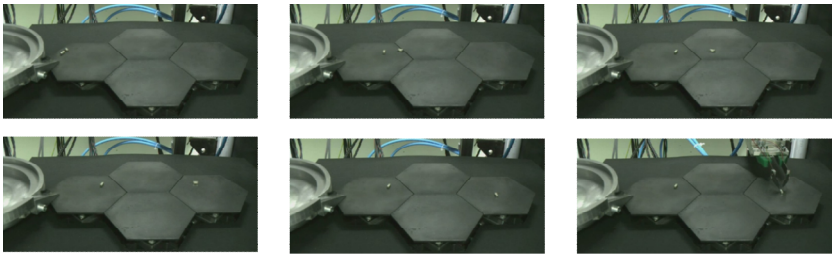

Figure 3: Feeding process of a micro part selected exemplarily

## 5 Summary and outlook

At the wbk Institute of Production Science an automated part-flexible modular feeding system has been developed on the basis of piezoelectric vibratory conveyors. Various exemplarily chosen micro parts could be separated, positioned and partly also be oriented in an automated way.

As to the cycle times, in positioning and orientation accuracy there is still a great potential for optimization that shall be tapped in further studies e.g. by part-specific conveying parameters or the development of an algorithm for the choice of the optimal separation strategy.

**References:**

[1] Fleischer, J.; Leberle, U.: Automated supply of microparts based on the micro slide conveying principle. CIRP Annals - Manufacturing Technology 2011, Budapest, Hungary, P. 13-16

[2] Fleischer, J.; Leberle, U.: Miniaturized piezoelectric vibratory conveyor for the flexible handling of very different small parts. EUSPEN 12th International Conference of the European Society for Precision Engineering & Nanotechnology 2012, Stockholm, Sweden, P. 59-62