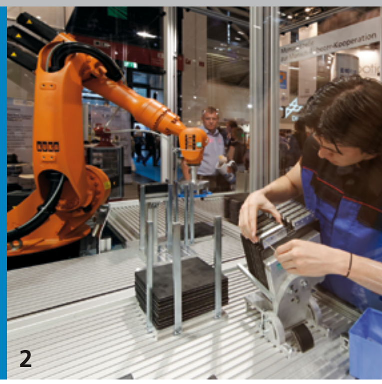
Fraunhofer IPA

FRAUNHOFER INSTITUTE FOR MANUFACTURING ENGINEERING AND AUTOMATION IPA



1 *Assistive robot integrated into a manual work environment.*
2 *Assistive robot system for battery assembly.*

ASSISTIVE ROBOTS FOR ASSEMBLY OPERATIONS

Why assistive robots?

Assistive robots are robots that share the same workspace with humans and enable the partial automation of assembly steps where full automation is not economically viable. Reasons for this may be unstructured work environments where work was previously carried out manually; high demands on flexibility; undefined parts, such as non-rigid components; or simply not enough space. Ideally, an assistive robot is used to enable a division of labor in which the strengths of humans and their cognitive abilities are exploited to cope with unstructured environments and flexibility needs, whereas robots contribute their power, precision and stamina. Thus, the complexity of an automation solution can be reduced – and likewise engineering, investment and maintenance costs – to such a degree that the combination of humans and robots becomes economically viable.

Features of an assistive robot

In order to safely and effectively interact with humans in their work environment, assistive robots must meet a series of requirements:

Safety
Human safety must be guaranteed at all stages of interaction with an assistive robot. This requires a safety concept approved by the relevant authorities. The concept must both conform to current standards and guidelines and be adaptable to specific applications, for instance to the process requirements and the appropriate tool design.

Ease of use
The goal is to enable users to adapt the assistive robot to changing tasks, for instance to an altered component geometry. This requires a simple user interface that allows to have predefined functions combined

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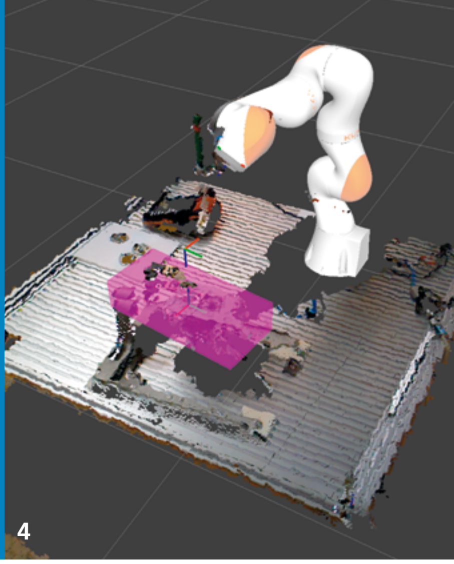

into program sequences and easily parameterized, e.g. by clicking the rivet hole in the component's CAD model or by manually guiding the robot to a position where an image is recorded.

Robust process execution

The aim is to use assistive robots in assembly workstations where operations are currently done manually. It requires robots that can handle the variations in positioning and component tolerances given in manual workstations. To this end, Fraunhofer IPA has developed a sensor-based assembly system following the principle of 'approximate localization – accurate localization – force-controlled assembly'. It uses a 3D-camera installed above the workstation to roughly localize a fixture or component with an accuracy of +/- 1 cm. On the basis of the approximate localization results, the robot heads towards the estimated assembly position. The final position is determined with an accuracy of better than 1 mm, using a stereo camera integrated in the robotic tool. The actual assembly process is force-controlled to detect, for example, variations in part tolerance or the jamming of components. This enables the robot to respond appropriately, e.g. by repeating the process or by informing the user.

What we offer you

In 2002, Fraunhofer IPA was able to implement the first shared workspace for humans and robots as part of the 'team@work' project. More recently, innovative technologies for assistive robots have been developed in publicly funded projects, such as SMErobotics, PRACE and LIAA, and demonstrated in industrial applications. The experience gained in these projects helped to design and implement prototype solutions of assistive robots for industrial use.

We can support you from the design to the final inspection of an assistive robot system on your factory floor. Our activities include the development of a safety and interaction concept, the associated layout, the tool design, and the selection of suitable sensors to cope with tolerance variations. We can customize our operating environment "Assembly Assistant" to meet your needs and implement image processing and control algorithms for robust process execution. Please contact us!

3 *Programming on a touchscreen by dragging and dropping program modules.*

4 *Approximate localization of a fixture using a fixed 3D-camera.*

5 *Accurate localization using a stereo camera integrated into the tool.*