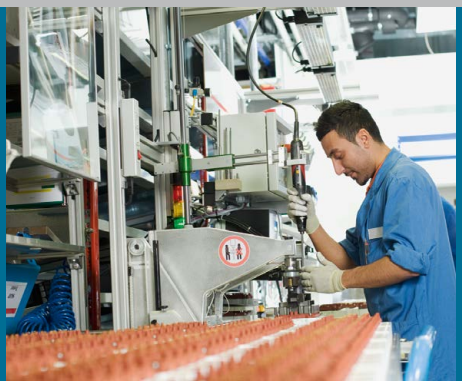
Fraunhofer
IPA

FRAUNHOFER INSTITUTE FOR MANUFACTURING ENGINEERING AND AUTOMATION IPA



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1 *Worker performing an assembly task manually.*
2 *Force-controlled assembly of a complex part by a robot*

LEARNING ROBUST ROBOT PROGRAMS THROUGH DEMONSTRATION

A fast and intuitive method for teaching trainee robots: thanks to Imitation Learning, robots can be programmed simply by demonstrating processes – saving time and without any specialist robotics knowledge.

Hurdles related to assembly automation

A major hurdle faced when automating manual assembly processes is the lack of skilled workers qualified to do the job. Using robots would offer significant advantages, such as making processes more efficient and cost-effective, ensuring consistent quality and relieving workers of monotonous or physically demanding tasks. In order to facilitate or speed up the transition from a purely manual to a partially or fully automated production process, it makes sense to give the most time-consuming parts of the robot program special consideration. It takes a lot of time for robot programmers to teach the robot points where is in contact with its surroundings (e.g. snap connections) in a robust and accurate way.

To simplify programming, Fraunhofer IPA has been working for several years on force-controlled assembly, which promises to be more robust in terms of component tolerances and shifted positions. The pitasc software developed for this purpose at the institute is already successfully facilitating assembly automation.

Thanks to Imitation Learning, it can be used to advantage without the need for specialist robotics or process knowledge!

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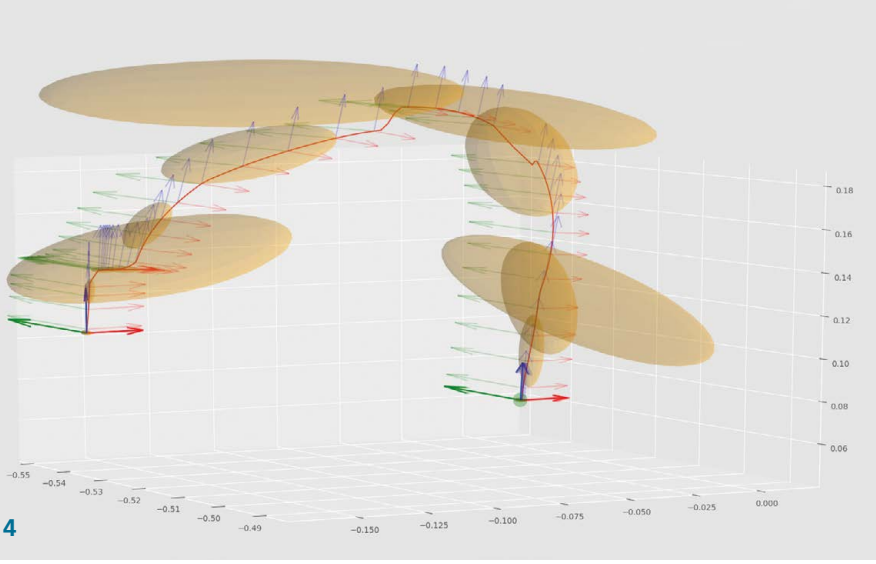

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Human expertise

Since many products are manufactured manually, considerable motoric knowledge about the respective assembly processes is already at hand. For example, workers know the exact amount of force required to insert a part, or which insertion bevel to use to quickly clip in a part.

A highly specialized robot programmer must first painstakingly learn this motoric knowledge before being able to subsequently convert it into a robot program. As a result, robot programmers need diverse mechanical, electrical, programming and manufacturing skills – a time-consuming learning process. This is where our technology comes into play.

Machine learning

Machine learning promises faster robot programming by enabling automated knowledge from humans to be abstracted and correlations to be extracted. Probabilistic methods and sensor technology combined with machine learning help to encode complex motor processes.

We not only record the movement of the parts, but also the contact forces generated. This makes it possible to realize even complex programs, such as a robot gliding over a surface or complex snap fits.

Optimization

In contrast to robots, humans do not always act in exactly the same way, but rather exercise a certain amount of leeway as they carry out their actions. These variations can subsequently not only be taken into account but also be used to optimize the robot program with regard to other criteria, such as the cycle time.

Since the positions and forces used for the component are already known from the manual assembly process, the robot is able to optimize specific parts of the program. Thanks to the human expertise it has learned, it can also adapt to its environment and thus automatically optimize its program during ongoing assembly without damaging any parts.

High product variance

The programs generated in this process are divided into separate program modules, so-called skills, such as a linear movement towards the component or the engagement of a snap fit. These skills can be reused for variants of the same product.

If, for example, an additional lever needs to be inserted, the already existing and optimized skill is still usable and can adapt to the slight change within the space of a few assembly processes.

Because the skills can be parameterized, there is no need to create a whole new program if, for example, the position of the mounting points changes. Instead, the already encoded assembly knowledge can be employed to generate a new program with the modified point positions.

Our services

Are your robot programmers under time pressure? Do you need more manpower? Do you assemble parts in a manual process that are difficult to automate because it involves potentially complex motoric movements? Are you interested in trying out our technology and giving us feedback as an "early adopter"?

Then give us a call. In a personal meeting, we will be happy to assess the advantages of implementing our technology and how it can help you.

3 *Worker demonstrating an assembly process*

4 *Assembly trajectory generated through demonstrations and derived path points displayed with optimization horizon as ellipses based on a plug-in assembly task*