

FLEXIBLE HOLDING FIXTURES AND MACHINE CALIBRATION

**Fraunhofer Institute for
Manufacturing Technology
and Advanced Materials IFAM
– Adhesive Bonding Technology
and Surfaces –**

Wiener Strasse 12
28359 Bremen | Germany

Institute Director
Prof. Dr. Bernd Mayer

Contact
Automation and
Production Technology
Research Center CFK NORD
Ottenbecker Damm 12
21684 Stade | Germany

Dipl.-Ing. Urs Roemer
Phone +49 4141 787 07-226
urs.roemer@ifam.fraunhofer.de

Christian Böhlmann, M.Eng.
Phone +49 4141 787 07-262
christian.boehlmann@ifam.fraunhofer.de

www.ifam.fraunhofer.de
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Robot Calibration

The implementation of adaptive processes with standard industrial robots fails until now because these systems lack of absolute accuracy. This is due to the use of robots whose movements were manually programmed, "teaching", before the operations took place. In this mode, repeatability accuracy is the only important criterion. This has been changed with the industrial robots used in Fraunhofer IFAM for the assembly and machining of large structures. Our innovative use of calibration routines enables these robots to reach spatial coordinates on target and with a high degree of accuracy without the need for an operator to intervene and take corrective action. This calibration process adjusts the robot's model parameters to the reality of the robot cell's measurements and builds the basis for its absolute accuracy when used in an "Industry 4.0" manufacturing environment.

Flexible Holding Fixtures

Conventional fixtures used for the assembly of light-weight structures are typically expensive since they are custom-made, can only be used for a specific geometry and must be regularly and extensively measured. By contrast, the automated part manipulation developed by Fraunhofer IFAM enables precise and stress-free holding of almost every part of 2 to 6 m in length and up to 6 m height. This is made possible by a flexible arrangement of currently 10 hexapods, 24 linear units and modular rack elements. Vacuum grippers with force and torque 6D sensors gently adjust the pose and shape of the part, as required by the tolerance management in the assembly process. Even complex joining motions can be easily implemented with cooperating hexapods. The guidance and monitoring of these fast and iterative adjustment processes is done by an optical measuring device.

Advantages of Robot Calibration

- | Allows the use of standard industrial robots with lower investment costs for adaptive manufacturing processes
- | Manually teaching the robot is no longer necessary
- | One-time calibration of the robot's cell for its entire lifespan
- | Manufacturer-independent calibration through an open communication interface
- | User-friendly application with integration of commercially-available offline programming software
- | Ideal integration into fully automated process chains
- | Interfaces to diverse optical measuring devices available

Advantages of Flexible Holding Fixtures

- | Adaptive part manipulation for all assembly and machining processes
- | Iterative adjustment of shape and pose also possible for large parts
- | Innovative integration of optical measuring systems for automated part and machine measurement
- | Process reliable control through integration of 6D force and torque sensors
- | Vacuum gripper for the assembly of diverse part geometries
- | Robot field with up to 10 hexapods with high stiffness and positioning accuracy
- | Additional use of up to 24 linear actuators possible

Performance Spectrum

Form and Pose Adjustment

- Flexible holding fixture
- Stress-controlled assembly
- Positioning and shaping of large parts
- Development of part measurement strategies

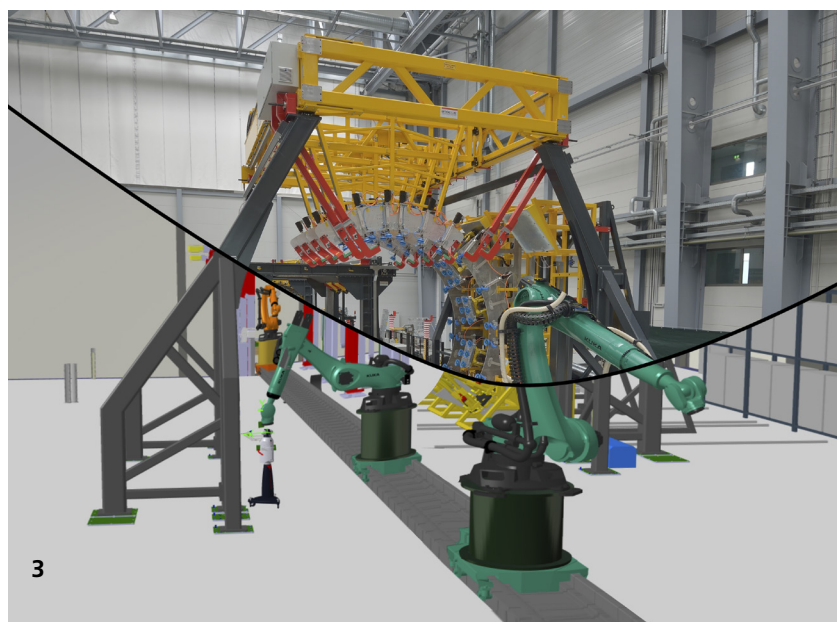
System Calibration

- Measurement of tool-center-point and sensor position
- Calibration of linear axes and robots
- Development and testing of machine measurement strategies

Software Strategies

- Communication networks and architecture
- Software structures and paradigms
- Adaptive machine simulation
- Integration of customer-specific cell layout during offline programming

In cooperation with the Institute for Production Management and Technology of Hamburg University of Technology:
PD Dr.-Ing. habil. Jörg Wollnack
(Research field: opto-mechatronics)



- 1 Flexible holding fixture for large structure assembly.
- 2 Manufacturer-independent robot calibration.
- 3 Virtual production environment.