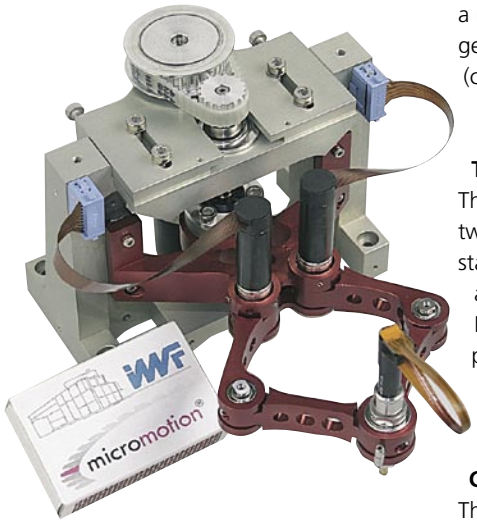
dSPACE Prototyping System: PARVUS – The Little Giant

The trend to miniaturization that started with electronics has now reached the world of mechanical engineering, where it can also help to save on energy and materials. A joint endeavor of the Institute of Machine Tools and Production Technology (Technical University of Braunschweig, Germany) and Micromotion GmbH produced a control system for PARVUS, a miniature robot that works just as precisely as conventional assembly robots, though these are often several times larger and more expensive. A dSPACE prototyping system was used in the project.



PARVUS the miniature robot – shown here with a matchbox to give an impression of size – positions workpieces at a repeat accuracy of under 10 µm.

PARVUS the Miniature Robot

In designing PARVUS (Latin for "small"), they used a range of components from microsystem technology, among them micromotors and microgears. The result is a robot the size of a postcard that positions and assembles as accurately as its bigger brothers. Potential fields of use for the robot are the semiconductor industry (circuit board component placement) and optics (processing and adjusting lenses and mirrors).

Two Arms Instead of One

The special feature of PARVUS is the parallel structure of its arms. That means it has two arms coupled with one another at the hand axis. This construction ensures good stability and allows very precise, reproducible positioning. Controlling two coupled arms is more complex than controlling a single, independent arm, however. In PARVUS, the complex motion sequences are controlled with the aid of a dSPACE prototyping system based on a DS1103 PPC Controller Board. Using this equipment, the first prototype positions at a repeat accuracy of under 10 micrometers (µm). Theoretically, even a precision of under 1 µm is possible.

Controlling with dSPACE Equipment

The advantages of the dSPACE system are the hardware's high performance and the ease with which it can be operated via ControlDesk, the experiment software. A further advantage is the ability to use MATLAB®/Simulink® to develop the robot control. Linear or circular interpolation is used to control the motion sequence of the robot arms. PARVUS has a total of 4 micromotors, which send position signals via encoder to the dSPACE prototyping system. This in turn calculates the actuating values and returns them to the motors to keep the motion on course. The kinematic equations between the robot's arms and its working space are calculated in real time. To ensure the arm movement is sufficiently fast, the sample time is 0.1 milliseconds.

The robot's heart: the micro-harmonic drive (left) with tiny microgear (right).