The fish’s fin: Bionic concepts in automation

At the Hanover Trade Fair 2010, Festo presented some highlights from the Bionic Learning Network. The shown bionic concepts were inspired by nature. With the BionicTripod 2.0 and Modular Lightweight Handling, the company introduced solutions for a wide variety of handling tasks. It could be used with the CAN-connectable CMXR robot controller.

Due to its lightweight design, BionicTripod is efficient in terms of energy consumption in sorting and displacement operation. The bionic principle of the fish’s tail fin finds repeated use as a so-called 3D Fin Ray structure adapted to three-dimensional space. This structure makes for an energy-efficient lightweight design. The tripod is rotated at 90° from the conventional configuration and can thus be described as a horizontally arranged tripod. The integrated adaptive gripper, the so-called FinGripper, and a kind of ball joint based on the function of the human wrist provide maximum flexibility for picking up objects from a working surface and depositing them at different levels.

The adaptive FinGripper constitutes the interface between the object and the actuator system. It consists of a pneumatic actuator in the form of a bellows and three gripping fingers, which are designed as an adaptive structure with Fin Ray effect. The resulting pliability and flexibility make the gripper ideal for tasks in human-machine interaction, e.g. in agriculture for sorting fruit and vegetables, or in sorting materials for recycling in industrial applications. A “third hand” that can pass a screwdriver, a wrench or a component for installation is also an ideal helper for all kinds of assembly tasks.

EGC electric linear axis units and EMMS electric drive ensure precise control and displacement of the tripod structure. The entire system is controlled by CMXR robotic control software. In the hand axis – by analogy with the function of the human wrist – three actuators are arranged around a ball joint in such a way that three further degrees of freedom are attained, thereby allowing deflection by up to 30°.

With Modular Lightweight Handling a light-design articulated-arm kinematic system can be built up. Weighing only 4 kg, and with a payload of up to 800 g and six degrees of freedom, it is ideally suited as a learning system. Thanks to its simple, cost-efficient design, it can be used in pick-and-place applications, in the automation of laboratory processes or as a “third hand” in the field of service robotics. Its low weight allows the use of kinematics without a protective cage, thus paving the way for interactive human-machine cooperation.

Modular Lightweight Handling is as changeable as a chameleon. From single-axis to six-axis kinematics, all variants can be modified or even subsequently retrofitted with a minimum of effort. This yields a variety of possible configurations. The principle of a modular, lightweight construction kit is continued at the front end, for example with the gripping tool interface. Modular Lightweight Handling autonomously selects two- and three-finger grippers, parallel and angle grippers, vacuum grippers and Bernoulli grippers from its storage unit. Adaptive gripper fingers based on the Fin Ray Effect also allow complex, irregularly shaped products to be grasped.

Through the use of actuators with precision gearing, Modular Lightweight Handling can position objects precisely. Due to decentralized control units in the joints, all the motors operate at low voltage and are addressed by a CMXR robot control unit via a CAN-based network. (hz)