The Evolution and Future of Gripping for Human Robot Collaboration

Human robot collaboration (HRC) requires intelligent and safe gripping. In the following article SCHUNK illustrates what is important for HRC-capable actuators, which minimum standards must be fulfilled and what is already possible in the field of HRC gripping today. Additionally, SCHUNK sets a new benchmark for HRC grippers of the future with the Co-act Gripper JL1.

When SCHUNK presented the world's first certified safety gripping system approximately two years ago, it was to be expected that the competence leader for clamping technology and gripping systems would soon build upon this success. At the time, Ralf Steinmann, Director Business Unit Gripping Systems at SCHUNK, had already defined the barrier-free collaboration of human and robot as a target for the future. Just 24 months later, the SCHUNK development engineers reached, and have surpassed this target. SCHUNK Co-act Grippers have the potential to catapult the gripper into a new dimension.

Graduated safety concepts

The machining areas of humans and robots are growing closer to each other, for instance when operators step into the automated system to remove defective components, load part storage conveyors, or to eliminate malfunctions. The SCHUNK safety gripping systems EGN and EZN in combination with the SCHUNK ECM controller and the SCHUNK ECS safety module, enable SLS, SOS and STO functionalities. This, in combination with safety mats, door switches, light curtains or 3D cameras with area monitoring, makes it possible to define graded protection zones without completely interrupting the production process. Emergency shutdown operations are only necessary when human/machine distance gets too close. Instead, the grippers go into either a safely limited speed or a safe operating stop, depending on which protection zone is activated. In safe operating stop, the grippers are continuously supplied with power, so that gripped parts are held safely even without mechanical gripping force. As soon as the safety zone is released, they directly switch back to regular operating mode without any delay or having to restart the system.

Where full automation of production or assembly lines is only economically possible in certain conditions, or if humans are necessary to the process, sub-processes will be separated and divided up between man and robot more distinctly in the future. In such situations, autonomous cobots (meaning robots that are used in the worker's immediate environment) can handle tasks that are ergonomically awkward or particularly monotonous. Through assisting with intelligent lifting or positioning for instance, the cobots reduce the physical exertion on humans and ensure high process efficiency. Compared with full automation, the space requirements for man and robot are being reduced, and with hand-in-hand work the process can be more flexible. According to the specialists at SCHUNK, the number of robot-assisted systems, particularly in assembly applications, will therefore rapidly increase in the future.

SCHUNK Co-Act Grippers facilitate interaction and communication

The closer humans and robots work together, the higher the safety requirements become. Whilst in the lowest stage, i.e. in completely separate machining areas, a risk assessment in accordance with DIN EN ISO 12100 is sufficient, along with a certification of the machine safety in accordance with DIN EN ISO 13849 for functional safety. With direct human robot collaboration, the principles of protection outlined in DIN EN ISO 10218-1/-2 and DIN EN ISO/TS 15066 must additionally be taken into consideration.

Even at a basic level, SCHUNK Co-act Grippers will satisfy the three most critical requirements of safe human-robot collaboration in the future: They never lose grip of an object, they always detect contact with humans and they will never cause injury when gripping. With the aid of various sensors, the gripping process can be adjusted in real time. Various sensors are used to record, evaluate and communicate situational, ambient and operational conditions. Thus, in the future, SCHUNK Co-act grippers will be able to transmit all relevant data about processes and surroundings to the control and production systems. The focus will be on the intelligent flow of materials, process optimization and continuous documentation. The modules of the SCHUNK Co-act series are designed to be manufacturer-independent and can be used on all relevant HRC robots.

The SCHUNK Co-act Gripper JL1 illustrates the direction that development is heading in. This is the first intelligent HRC gripper, which directly interacts and communicates with humans. SCHUNK consciously chose the initials of the brand ambassador Jens Lehmann for the technology carrier. The world class goalkeeper stands for safe, precise gripping and holding like no one else. Five features are characteristic for the JL1:

- A safe drive, which facilities a wide gripping force range and simultaneously ensures functional safety. It is therefore continuously ensured that gripped parts are held reliably if a process is interrupted.
- Environmental sensors which record the environment of the gripper.
- A software that evaluates and processes the signals from the sensors.
- A limitation of the gripping force, which is deployed immediately after unintentional contact with a human.
- A smooth external contour without sharp, angular or cutting edges.

Sensoric aura for environmental monitoring

The JL1 gripper demonstrates what is important for HRC applications: A soft covering, flowing form, protection from loss of workpiece and communication interface over an LED panel integrated into the gripper. With the help of specifically designed gripping techniques and force-measuring jaws in its fingers, the gripper can adjust its behavior in real time depending on whether it is gripping a workpiece or a human hand – and given the magnitude of its gripping force, this is by no means an insignificant accomplishment. Mechanically, the gripper facilitates both a parallel and also an angular grip, meaning it is able to reliably handle a wide variety of objects. Adjusted to suit the respective application, plant planners and users will have a complex interplay between various sensors and safety mechanisms at their disposal. Force-measuring jaws and visual monitoring by using cameras will be incorporated as well as surfaces made of tactile and capacitive sensors or current-based force control. Similar to humans, the Co-act Gripper JL1, also uses several senses at the same size in order to evaluate a situation. A special software bundles the various information from the individual sensor sources and derives the correct information from them. Furthermore, via OPC UA interface, the gripper is able to communicate with both robots and the higher-level system control. In doing so, it creates the prerequisite to develop processes envisioned by Industry 4.0. At the same time, the gripper acts as a direct means of communication between the plant controller and the operator: using LEDs and a corresponding color coding system, it provides information as to whether the system is ready for operation or if the correct workpiece is gripped. Depending on the application, the components can be identified using defined machining areas, RFID or visual codes. An integrated touchscreen also enables direct communication with the gripper as well as teaching or switching to various operating modes.

Bundling HRC competence in the SCHUNK Co-act team

Based on the technology carrier, the next steps for SCHUNK is to put the finishing touches on the development of the individual standard modules of the SCHUNK Co-act Gripping family. While the standard program is being developed, SCHUNK is already able to deliver HRC customized for the respective application as a solution to the customer. SCHUNK formed the interdisciplinary Co-Act team, with specialists trained in the fields of design, product management, assembly and distribution. The team of HRC specialists ensures a unique concentration of competence in the field of gripping, regardless of the HRC robots deployed. It enables swift and needs-based technical implementation as well as active support for the required risk assessment.