Utilising existing safety hardware, communications standards and ideas

Two worlds growing together

Figure: K.A. Schmersal

State of technology in Industry 4.0 production: Cooperation between humans and robots without safety fences

What are the implications of production according to the principles of Industry 4.0 for functional safety? Humans and robots will increasingly be working together without intervening safety fences and the safety-related signals are also processed at higher control levels. The prerequisites for this are already in place.

If the experts are right, the future will see cyber-physical systems (CPS) finding their way through production facilities, with individual products made in batch sizes of one on an automated and as efficiently as mass-produced goods. This, in brief, is a core element of Industry 4.0. Many companies have initiated and/or implemented projects accordingly. New business models have emerged (the key concept here is 'platform economy') and the majority of stakeholders in industry and academia believe Industry 4.0 is an ideal method of guaranteeing the future viability of German mechanical engineering and the production industry. What are the implications of production according to the principles of Industry 4.0 for functional safety - i.e. for machine safety and safety-driven control engineering? The answer is complex, and the following covers just two major aspects.

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Collaborative robotics

Many robot manufacturers have presented solutions where (smaller) robots effectively assist the human personnel, enabling cooperation without an intervening safety fence. On the one hand, this addresses the issue of demographic change: older workers can be relieved from repeated physically strenuous activities. It also considers the desire for increasingly customised products which cannot be produced by means of full automation (which is also more inflexible).

Safety without the safety fence

One way or another: One of the key safety-related prerequisites for human robot collaboration (HRC) was put in place by the Schmersal Group more than ten years ago in the form of the safety controller. This gives the robot a defined three-dimensional working area and immediately registers if its leaves this area. In this case, the robot is stopped. At the same time, the Safety Controller monitors the speed towards the limit at all times. This means: The speed can only ever be so fast that the robot can brake at any time without leaving the movement zone allowed. This is how functions such as 'Safe Axle Range' and 'Safe Speed' are achieved. This safety solution is already in use in over 30,000 robots, especially in the automotive industry. It gives the robot a virtual working area and thus enables collaboration between humans and robots without an intervening safety fence.

Research project: Sensor systems recognise human skin

In future, an additional safety measure for direct cooperation between humans and robots alongside tactile systems will be a multi-level sensor system which uses optical sensors and special image processing algorithms to detect human silhouettes and human skin. The Bonn-Rhein-Sieg University of Applied Science's 'beyondSPAI' research project is working on a sensor system of this kind. The Schmersal Group is acting as an industrial partner in support of this project.

Moving away from stand-alone solutions

Another implication of Industry 4.0 ideas on machine safety is increasing networking and the move away from stand-alone solutions at the (safety-related) control technology level. This trend is definitely not new, but will be reinforced by Industry 4.0. One reason for this is the desire to make all machine-related information accessible in one place and to utilise it at higher levels within the company IT system, another is the option of adapting the safety function, which are increasingly controlled by software, to changing requirements. This flexibility is one of the key features of Industry 4.0.

Figure: Schmersal

Range of safety switchgear devices - one bus line: ASi SaW simplifies connections and thus increases transparency and flexibility.


Figure: Schmersal

Schmersal safety systems not only simplify installation, they also improve the prerequisite for preventative maintenance.

Bus systems make installation easier.

The manufacturers of safe machines and systems now have means of networking safety switchgear and establishing alternatives to conventional point-to-point wiring between the safety switchgear device and the safety relay module or safety controller. Safety-related bus systems provide one alternative for simplified connections. The central ranges of safety switchgear are available with built-in ASi-SaW interfaces, this is an international standard developed for applications of this kind and which enables really simple installation, partially because both the energy feed and the operational, i.e. non-safety-related communication is via the ASi line. Another advantage of this system is the additional diagnostics and monitoring information which is generated and provided to users in the IT system or cloud environment via the operational controller. This increases transparency. The safety function can also be adapted better and more flexibly to the application. e.g. by means of individual configuration and parametrisation of the safety switchgear with safety links, step categories and filter times.

Figure: Schmersal

MZM 100 contactless solenoid, version for integration into ASi-SaW networks shown.

Safety integrated or safety separated?

Irrespective of the type of signal transmission, i.e. with or without safe fieldbus system, consistent concepts can be realised based on “safety separated” and “safety integrated” principles. The “safety integrated” concept has the safety-related control functions within a safety area of the operational fail-safe (F-CPU) controller. In ‘safety separated’, the operational controller is separate from the safety-related functions, and the safety controller transmits status and diagnostic information to the ‘normal’ controller. This simplifies trouble-shooting in the event of irregularities and prevents downtimes. This makes it much easier for the operational controller to be adapted to customer requirements without changing the safety functions or their documentation.

Simple, fast wiring with installation systems.

The topic of ‘simple diagnostics’ is also addressed by the safety installation systems developed by Schmersal. They allow quick and easy connection of different electronic safety switchgear devices, such as sensors and interlocks, which can be combined for the relevant application. At a non-safety level, they also enable individual diagnostics for all safety switchgear devices connected. This means that a user can easily tell which switch in the series has triggered a signal. This also helps resolve problems more quickly and thus increases machine availability. Variants are available with a passive distributor module (PDM) or a passive fieldbox (PFB). They allow mixed series connection with up to four different electronic safety switchgear units for each module. Multiple modules can be connected to form larger systems. A third, active variant is available for electromechanical safety switches with contact outputs and for safety sensors with electronic OSSD outputs. Here, a safety input extension from the SRB-E range takes over active electronic signal evaluation.

Predictive maintenance - key element of Industry 4.0

One example of the benefits of passive installation systems which transmit non-secure data via a ‘Serial Diagnostics’ (SD) interface. Safety sensors and interlocks connected in series and fitted with this SD interface can transfer and visualise extensive diagnostics data via the SD gateway and a fieldbus to a controller, e.g. status data or error messages. For example, in the MZM100-SD contactless magnetic safety interlock, this could, for example, be diagnostic data or error messages, such as "Fault or short at a safety output", "Operating voltage too low", or "Defective actuator". This enables quick problem solving. In future, extended diagnostics functions will also allow predictive maintenance, which is another important element of Industry 4.0.

Well prepared for the requirements of the (near) future

The overview shows: Machine and electronic engineers wishing to design functional safety based on the principles of Industry 4.0 do not need to start from scratch. They can select from safety switchgear, safety concepts and communications standards which fulfil core elements of Industry 4.0. Transparency in the information chain, networking both with other safety switchgear devices and with higher-level, non-safety related levels and close cooperation between humans and robots. The opportunities for diagnostics and problem solving have also been considerably improved. At SPS IPC Drives 2017, the Schmersal Group group will be showcasing example safety systems and solutions which meet these requirements. tec.nicum, which is Schmersal’s service division, will also have a presence at the show. The experts at tec.nicum provided objective, manufacturer-neutral advice on which safety concepts are most suited to individual applications.

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