Semiconductors Bring Robots Closer to Humans

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Robots have long been workhorses in the production lines of modern factories. Manufacturers worldwide benefit from them in terms of increased productivity and cost optimization. Against the background of Industry 4.0 and the Smart Factory, the latest generation of industrial robots is revolutionizing traditional production processes. This generation is used as collaborative robots, otherwise known as cobots. They work alongside people, support them in the respective manufacturing processes and enhance the quality of finished products thanks to their highly precise and safe working methods.

New robot type: compact, agile and safe

Technological advances in the fields of sensor technology, the rapid analysis of vast amounts of data, artificial intelligence and power electronics have made the new generation of robots possible. And the robotics market is undergoing radical change. In addition to the well-known "top dogs", many relatively small start-up companies have appeared on the market, and the trend continues. Their focus is to develop special algorithms as a basis for new robot concepts. They do not want to spend so much time with the mechanical design and required electronics hardware.

Within a few weeks, these specialized start-up robotics companies are able for example to set up development platforms, on the basis of which robots are developed for use in a wide range of fields. Unlike the earlier robot generations, these do not require complex programming for the respective target application. Instead, they can be easily and flexibly reprogrammed and can adapt their motion sequences – sometimes even independently – to new conditions.

The new generation of robots provides a broad application field for modern semiconductor products. The spectrum ranges from motor control, high-performance position and object detection, efficient and compact drives, power supplies and chargers. It also includes the implementation of virtual safety gates to security functions with secure authentication and calibration. Without security, functional safety is not possible in networked production environments. In addition, IP protection, especially for start-up companies whose know-how is based on the algorithms, is essential.

Out of the cage

If you want to liberate robots from their cages, you have to ensure that people do not come within a critical range of a robot that is working at high speed and high precision. This could result in people being injured either through their own fault or by malfunctions. Designing robots with the corresponding degree of sensitivity is only possible with sophisticated sensor technology.

Basically, it is important to make the area between the person and robot safer, and also between the robots themselves. This is about making the protection zones more flexible, i.e. having much smaller protection zones move along dynamically with a moving robot arm, for example. A zone concept is used when implementing the virtual fences. By way of example, only a warning signal is triggered when someone approaches the first warning level, whilst the robot continues to operate at full speed. On approaching further, the speed is then reduced with the corresponding warning. Only in the immediate danger area does the robot stop.

Appropriate protection mechanisms require extremely precise object recognition. Redundant sampling ensures maximum functional safety. It is also helpful to capture the direction of movement, for example whether a person approaches and then moves away again, or whether they enter the danger area. Intelligent detection of the actual danger situation prevents unnecessary downtime or slowing down of the robot's work, and accordingly, production losses and costs.

No safety without security

Only in terms of security (data security) are secure systems also functionally safe – an aspect that is increasingly important in the context of Industry 4.0 and IoT. Cryptographic encryption can be used to avoid modification of the robot's software-code by non-authorized users and therefore ensures that the robot only performs the functions that it is supposed to. In particular, robots used as part of manufacturing processes are to be secured against manipulation, but on the other hand should permit wired or remote software updates. This also requires secure authentication of users and newly added components.

Calibration is necessary for the correct functioning of the robot. If, for example, a hacker manipulates the calibrations, the robot could then exceed the specified limits of movement. This is where security and safety converge – without efficient security protection, there is no functional safety. This is an important requirement for future systems, which is addressed by dedicated security controllers or microcontrollers with features such as the HSM (Hardware Security Module). Since the security functions are implemented in the hardware, users require little detailed knowledge of encryption technologies. In addition, the impact on existing software implementations is extremely low!

Mobile for longer
Efficient and compact power supplies and charging functions play an essential role in mobile robots. On the basis of the latest CoolMOS, SiC and GaN technologies, Infineon expects an increase in power density by a factor of 2 to 5 compared to conventional battery chargers, with a shorter charging time for mobile robots. Wireless charging is also possible. The energy can be used even more efficiently if the batteries are recharged via the braking process.

This is made possible by modern power semiconductors and the improved use of batteries in uninterruptible power supplies, for example for buffering energy. Due to the increasing use of battery-powered AGVs in Industry 4.0 factories, the automated guided vehicles could dramatically reduce the outlay and cost of the additional UPS batteries needed in manufacturing. Because the batteries of an AGV located at the charging station, if networked, could be used to some extent for the emergency power supply of the factory's internal supply network.

Simplified wiring
A conventional industrial robot is usually based on a central motor-control and numerous drives in the axes. This requires a considerable amount of wiring for a typical robot arm with thick motor cables (3 or more phases) per motor, plus an additional communication bus for control purposes and reading out sensor data.

Thanks to modern semiconductors and the integration of powerline-like modulation, together with motor-control electronics, this outlay can be significantly reduced, thus also weight and costs. In laboratory experiments, Infineon has succeeded in reducing the number of cables in a robot arm from almost 30 down to only 2 or 3.
At the same time, transmission speeds for signal communication of well over 100 Mbps have been achieved. Less wiring also means fewer interfaces in harsh manufacturing environments, which in turn increases reliability. An initial prototype of such a motor control, for which Infineon integrates the necessary components, is in preparation.

From controllers and power electronics to sensors and chips for safety and security functions: Infineon offers a comprehensive range of components that can be used to implement efficient electronics for the new generation of robots. Additionally, we not only manufacture a comprehensive semiconductor portfolio for robots but also use various generations of robots in our production lines.
Many concepts that are currently being discussed in connection with Industry 4.0 are already in use here. It is only logical that the knowledge acquired in robotics will then be incorporated into the further development of our semiconductor offering.

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