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Careful selection and specification unlocks the potential of smart sensors in industrial motion control

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The term ‘smart sensor’ has been much used in recent years to describe a new breed of sensor that helps facilitate the manufacturing sector’s shift to Industry 4.0 ideology. While many might think that smart sensors are little more than conventional switching sensors or measured process parameters, in reality, they are far more. For instance, the latest smart sensors are able to share information with the controller, typically via technologies such as IO-Link. They can also receive commands and parameter information from the controller and thus adapt to new requirements on a continuous basis. Two-way data flow helps facilitate what can be defined as a true Industry 4.0 environment. The upshot for manufacturers is considerable gains in efficiency, alongside greater flexibility and better planning with regard to maintenance.

This very thinking applies to all kinds of smart sensors, including those used for pneumatic and hydraulic cylinders. The latest sensors for applications of this ilk feature intelligent functionality and make up one of three parts of what is commonly termed ‘smart pneumatics’, namely sensors, processors and communications protocols.

Smart sensors on cylinders offer fast, accurate, high-resolution and contactless sensing of the piston's position. Of particular note, direct detection of the piston magnet is achieved without the requirement for separate position encoders or additional mechanics.

Cylinders with intelligence

Among the latest sensors are those such as the new P8S CPS sensors from Parker Hannifin, which continuously supply data via analogue signals, IO-Link process data or flexible switching point (an LED indicates the output state). The continuous transfer of position data serves to upgrade the functionality of pneumatic cylinders, making them more intelligent and, as a result, more versatile. With this in mind, it is possible to solve engineering challenges in areas such as quality monitoring and process control, particularly in consumer goods markets like packaging.

Included among the principal benefits of continuous position sensing is the ability to monitor quality, deliver process control and support optimisation, especially in tensioning applications like paper or film processing, where quality, repeatability and speed are vital to profitable operations. Here, the remote reading of data from position sensors permits process deviations to be seen fast and acted upon, therefore retaining process optimisation and promoting predictive maintenance strategies.

Numerous other applications will also benefit, including materials handling, consumer packaging, small component assembly, machine building, and even tasks in the renewable energy industry, such as the positional control of solar panels as they track the sun. Offering the appropriate resistance to shock, vibration, moisture, chemicals and water ingress, continuous position sensing can be deployed reliably in demanding operating environments over extended time periods.

Two-way communications

The key to 'smart' functionality is two-way data flow. Using traditional discrete or analogue signals, the monitoring of sensor data is simply one-way communication, which may be sufficient to allow the remote monitoring of automated processes, for instance. However, in order to adopt Industry 4.0 strategies, two-way communication is required, meaning connection to a network such as Profinet or IO-Link. With regard to CPS sensors on pneumatic cylinders, implementation would include not only monitoring, but automatic configuration at start up and/or during replacement as part of maintenance routines.

Indeed, the shift to predictive, rather than preventative or reactive maintenance is one of industry's principal current trends, and it's an area where smart sensors can add significant value. After all, if smart sensors can warn users of an impending issue or failure before it occurs, then maintenance personnel can schedule repairs accordingly and avoid any costly downtime, typically when production throughput is either low or can be stopped.

This ethos can be applied across all fluid-power systems (pneumatic, electro-pneumatic, hydraulic, electro-hydraulic). Ultimately, every process has a 'heartbeat', so the question to ask is: has that heartbeat changed over a certain period of time? Maybe it has become slower or faster, for instance. This is where smart sensor technologies really begin to pay dividends.

Specification and selection of smart sensors

The potential application benefits of smart sensors are significant and clear as already explained. However, to maximise the gains, engineers need to consider several factors.

Firstly, the sensor needs to be able to fit securely on the cylinder body. External profiles may include linear slides, T-slots and dovetails. The sensor body of course needs to correspond to the profile, and the use of adaptors or some form of gripper may be needed to secure the sensor in place. Alternatively, a combination screw combining an Allen key head and slotted screw can provide a convenient, simple, and fast method of locating and securing the sensor. Alternatively, retaining ribs on the side of the sensor are a feature that can hold the device in the desired position even before the screw is tightened. By using this approach, sensors can be quickly and accurately secured in the cylinder slot with just a single quarter turn of the fixing screw.

Rugged design is perhaps an obvious requirement for a smart sensor that will likely spend its working life in an environment that may see wide variations in temperature, vibration, and even exposure to aggressive fluids or chemicals. Smart sensors may be offered with specific IP ratings to denote suitability for use where different degrees of exposure to moisture are an issue. In addition, automated applications in which the smart sensor might be used may be operating 24 hours per day, seven days per week. As well as making operation more demanding, this also means that sensor failure leading directly to downtime, can be extremely costly in terms of lost production. So, as well as having a long service life in the toughest use scenarios, smart sensors must be quick to change or swap-out in order to keep any downtime – scheduled or unscheduled – to an absolute minimum. This type of operation must be able to be completed without the requirement to the remove cylinder end caps or any other 'strip down' of the assembly.

During installation and at points in the sensor's operating life, adjustment and configuration of operating parameters will be necessary. For systems designers, how they wish to do this is an important consideration. Typical approaches are either via the IO Link, or some kind of portable 'teach pad.'

From an electrical standpoint, the ready availability of a supply voltage for the sensor is an absolute requirement. And finally, knowing that the sensor is working is of course important, and therefore a visual cue of an active state or output in the form of an LED can be of value to operators.

Summary
Smart sensors are increasingly important and relevant as Industry 4.0 and the Industrial Internet of Things begins to gain real momentum. Where there is emphasis on process and quality control and where maximising uptime is important, smart sensors can provide the information required to monitor and control processes. The selection and implementation of smart sensors is important to get right if the benefits to be enjoyed are to be optimised.

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