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Angle detection in mobile use:

Magnetic angle sensors for use in rescue operations

In position and angle measuring technology, magnetic methods are often the first choice today. Sensors which, for example, use the Hall effect, supply absolute measured values, also work under harsh environmental conditions and are suitable for countless applications in mechanical and process plant engineering, as well as for mobile applications due to the relatively low costs when compared to other measuring methods. And they can even contribute to saving human life, as the following application example shows.

The company Metz Aerials in Karlsruhe, Germany, is considered the world's leader for rescues from high places. A typical example from the broad product range of hydraulic platforms and aerial ladders is the fully automatic L32A hydraulic aerial ladder with a usable height of 32 m and a special basket arm (Figure 1). This basket arm, i.e. the last segment of the aerial ladder, can be angled down by up to 75 degrees, which also enables roof windows and backset roof balconies to be reached well. However, to ensure smooth use during rescue work the tilt angle of the basket arm must be exactly detected. Only then is it guaranteed that the rescue basket is always positioned horizontally.

Compensating mechanical tolerances in rotary joint

"The requirements which must be met by the sensor used directly in the rotary joint of the basket arm are extremely demanding," explained Jürgen Huditz (Figure 2), Electrical Engineering and Control at Metz. "Of course, properties like durability, a broad temperature range and EMC compatibility are obligatory in mobile use. However, with our tilt-down basket arm, this was further complicated by the fact that the sensor was also to supply reliable measured values with mechanical tolerances in the rotary joint." This is one of the reasons why we chose magnetic angle sensors of the RFC4800 series (Figure 3) from the standard product range of the sensor specialist Novotechnik. Their simple integratability results from the magnetic operating principle (Figure 4):

A position-sending magnet is mounted on the rotating shaft of the basket arm joint for contactless angle detection. Depending on the angle of rotation, the orientation of the magnetic field changes, and with it the signals of the approximately 15 mm high sensor element. This signal change is then already converted into an output signal proportional to the angle of rotation within the sensor IC, which is then made available to the primary controller. In principle, angles of rotation can be detected up to a full 360° or even over several rotations. In the application described, the angular range of the sensor was set to 90 degrees for an output signal from 0.25 to 4.75 V. Here the sensor operates with a 12-bit resolution. The (independent) linearity is +/- 0.3 %, enabling precise angle detection.

Magnetic operating principle simplifies integration

As the sensor element and the position-sending magnet are designed as separate modules, installation is simplified. That's because the sensor can be positioned at a distance of up to 1.5 mm or even 4 mm from the position sensor depending on the strength of the magnet. A marking shows the correct orientation relative to the sensor. Its housing consists of high-quality, temperature-resistant plastic. Fastening lugs with oblong holes enable simple attachment and convenient mechanical adjustment. As a result, no special adjustment devices are required for installation. The sensor is completely encapsulated, making it impervious to soiling. The requirements for the protection type IP67 are met. Cables or single wires cast into the housing are provided for the electrical connection.

The designers at Metz Aerials appreciate these advantages during installation. As neither a shaft nor a mount are necessary, and the measuring distance is variable, installation tolerances on the basket arm joint are no problem at all (Figure 5). Even if the play increases due to joint wear, initially no impairment of the sensor function results. "In addition, the sensor can easily be replaced if service is necessary," added Huditz. "However, this occurs only very seldom; for over two years now the L32A aerial ladders, and have therefore proven their reliability in worldwide use - with them the angle sensors."

Better safe than sorry

The expression "Better safe than sorry!" means that we should only place our trust in what we've checked. "We took this into account before we decided in favor of the magnetic angle sensor," continued Huditz. "Although the magnetic angle sensor has already proven itself in many mobile applications, the data specified by the manufacturer were verified at our plant."

This means the sensor had to withstand several rapid temperature changes between approx. - 25 °C and + 100 °C under actual operating conditions." In further tests it was checked whether signal deviations result with an axial or radial offset between the sensor and the magnet, and whether the output signal changes if changes in the supply voltage (between 9 and 34 V) occur. "The test results convinced us. Further positive factors were the excellent support and consultation provided by Novotechnik," said Huditz in summary.

Reliable in mobile and industrial sector

Of course, the sensor can also utilize its durability and reliability in many other applications. In addition to mobile applications, it is also suitable for a broad range of uses in the industrial sector, especially in a harsh environment, e.g. for outdoor automation solutions. After all, the magnetic angle sensor can withstand oscillations and vibrations up to 2,000 Hz and impacts up to 100 g (6 ms, (in accordance with IEC 60068-2-6) and is also available as an integrated solution in the RSC variant, i.e. the sensor and position-sending magnet are housed in one housing here (Figure 6). Regardless of the design, the magnetic rotary transducer operates without mechanical wear. In a Hall sensor only the position-sending magnet moves. In many cases, it is therefore also a practice-oriented, interestingly priced alternative to the potentiometer, which is always subject to wear due to the principle involved.

Figure 1: L32A fully automatic hydraulic aerial ladders with a usable height of 32 m: The basket arm, i.e. the last segment of the aerial ladder, can be angled down by up to 75 degrees, which also enables roof windows and backset roof balconies to be reached well. (Photo: Metz)

Figure 2: Jürgen Huditz, Electrical Engineering and Control at Metz. "Of course, properties like durability, a broad temperature range and EMC compatibility are obligatory in mobile use. This was further complicated by the fact that the sensor was also to supply reliable measured values with mechanical tolerances in the rotary joint." (Photo: Metz)

Figure 3: A magnetic angle sensor in which the sensor and position encoder are designed as separate components (RFC 4800). The position-sending magnet is simply mounted on the rotating shaft. (Photo: Novotechnik)

Figure 4: A magnet is mounted on the rotating axis for contactless angle detection. Depending on the angle of rotation, the orientation of the magnetic field changes, and with it the signal voltage of the sensor element. (Photo: Novotechnik)

Figure 5: The magnetic angle sensor is mounted directly in the basket arm joint. Tolerances during installation or due to wear are non-critical. (Photo: Metz)

Figure 6: With the RSC design, sensors and position-sending magnets are contained in one housing. (Photo: Novotechnik)

About Novotechnik

For over 60 years Novotechnik, with headquarters in Ostfildern in the Swabian region of Germany has been a pioneer in the further development of measuring technology. Meanwhile over 200 employees work in Germany alone. The results are high-performance position and angle sensors without which production, control and measuring technology or cars are simply no longer imaginable. The broad product range consists of position and angle sensors with different operating principles, special solutions for the automotive sector and measuring transducers and measuring devices. This covers virtually every imaginable task and solutions are custom-tailored for special application needs.

About Metz Aerials GmbH & Co. KG

Since 1998 Metz Aerials GmbH & Co. KG has been the competence centre for hydraulic platforms in the Rosenbauer Group. At the Karlsruhe site approximately 280 employees produce aerial ladders and hydraulic platforms for fire brigades the world over. Constant further development and optimization of products ensure that Metz Aerials is recognized worldwide as a leading company in the field of rescues from high places. A large number of qualified service stations in Germany and abroad guarantee fast, service with close customer proximity. As a result, the aerial ladder technology from Karlsruhe has rescued many thousands of human lives around the globe over many decades.

Text: Stefan Sester, Engineer, Product Division Manager of Rotary Sensors at Novotechnik (Figure 7), and Ellen-Christine Reiff, M.A., Stutensee Editorial Office (Figure 8)

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