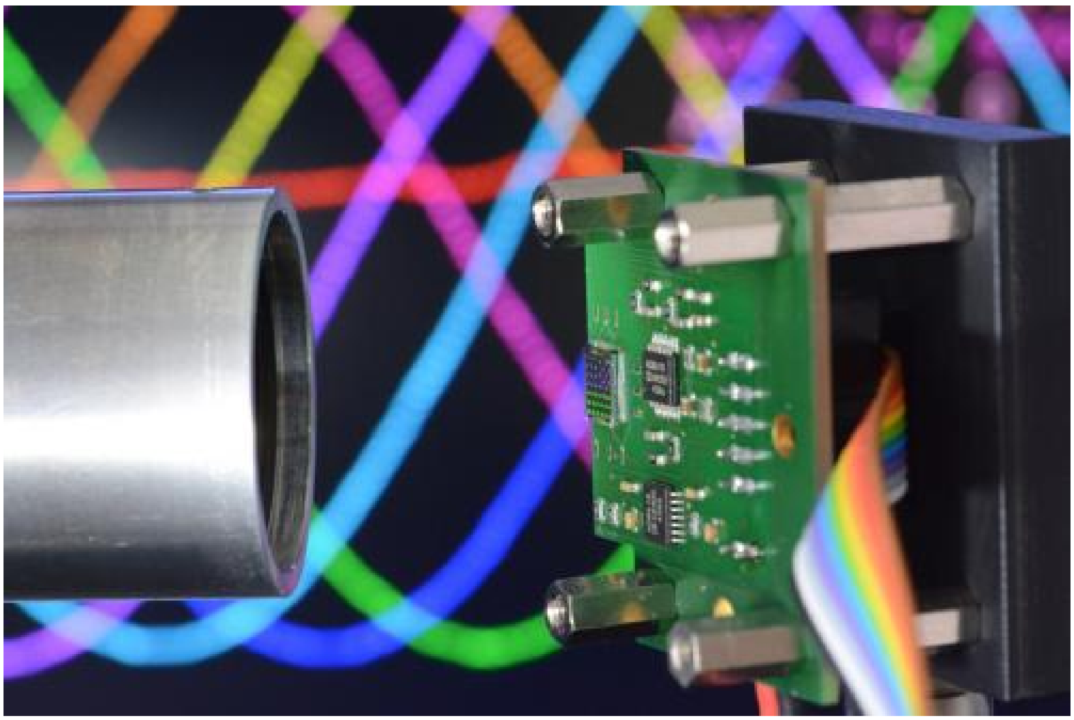
Getting the right spin

May 14 2014



The polarization sensor that measures the angle of rotation mounted on the test board. On the left: A shaft with integrated polarizing film. Credit: Fraunhofer IIS

Rotary sensors can help determine the position of a moveable body in relation to an axis. They are essential to the smooth running of car engines in the automotive industry, for example. Fraunhofer researchers have developed a new kind of sensor that combines precision measurement with flexible handling, allowing it to be customized to specific measurement tasks. The scientists will be presenting their prototype at the Sensor + Test trade show in Nürnberg from June 3 to 5.

In factories, goods and products are transported from one processing station to the next via conveyor belt. For the transfer from one belt to the next to run smoothly, it must take place precisely at a specific position, which means knowing the relative position of objects on the conveyor belts as they move towards each other. This can be determined from the angle of rotation, which refers to the position of a moveable body to an axis. Rotation angles are also important within the automotive industry, where they provide information for engine feedback systems, for example, in which the rotational speed of the drive shaft must be precisely set. The angle of rotation is measured using special sensors. There are currently two types of such rotation angle sensors on the market, working according to either magnetic or optical measuring principles. Magnetic sensors are very durable and dirt resistant, giving them an advantage in harsh environments. They are, however not as precise as optical sensors. These in turn are not very flexible to use since they must be precisely mounted in a fixed position on the object being measured.

Researchers at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen have now developed a new rotational angle sensor that combines the advantages of both solutions into one. "While our sensor also relies on optical measurement, its functional principle is completely different to other products currently available on the market," says Dr. Norbert Weber, group manager at the IIS. The researchers' development utilizes the polarization effect. Under normal conditions, light oscillates in all possible directions, meaning it is not polarized in its original state. With the help of special polarizing films, it is possible to steer these oscillations in a defined uniform direction, either horizontally or vertically. A good example of how polarizing films work is to be found in 3D glasses, which generate depth information because the viewer looks through lenses fitted with different polarizing filters for each eye.

The researchers attach just such a polarization film to the test object – the drive shaft, for example – and direct a light beam at it. Polarized light is produced on the reverse side of the film. Should the drive shaft now rotate, the polarization vector rotates with it, thus serving as a kind of direction indicator.

Sensor can be fitted flexibly

The read-out module is then mounted in such a way that it is located in the beam of light. Several wire grids – small microstructures – are arranged in a matrix on the sensor chip. These lattices can be produced as part of the normal CMOS chip manufacturing process without any additional effort. The angular position of the shaft is calculated when the polarized light strikes the lattices. "In order to obtain a definite measurement of the angular position of a shaft, we need at least three grids that are each structured in different directions. Depending on the measuring task we can also add further grids, thus adapting the chip to suit the specific requirements of customers while increasing measurement accuracy, "explains Weber. With this design, the Erlanger researchers are not able to attain 100 percent of the precision of conventional optical sensors, but their sensor is significantly more robust and can be positioned relatively flexibly. "The chip does not even have to sit directly on the optical axis – the only thing that matters is that it is located within the light beam," says Weber. Another advantage is that even if the shaft wobbles slightly, the result will not be affected as long as the beam is wide enough. At the SENSOR + TEST 2014 trade fair, researchers from Erlangen will present their solution on an exhibit which demonstrates rotation angle measurement on a hollow shaft. The measurement results are then displayed as a graph on the monitor.

Provided by Fraunhofer-Gesellschaft