

RESEARCH NEWS

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Hannover Messe 2016: Human-Machine Interfaces

Stepless control devices with flexible pressure sensors

Silicone is so soft and flexible that it is easily deformed by the pressure of a finger. Researchers at Fraunhofer have recently created sensors made from this flexible material, making it easier to steplessly control devices. At the Hannover Messe, they are presenting a glove that can measure pressure and a steering wheel that lets the driver control music, light and ventilation at the touch of a finger (Hall 2, Stand C16/C22).

Multifunction steering wheels are standard in most automobiles today, and these days drivers can easily manipulate the cruise control and stereo without taking their hands off the wheel. However, the buttons are rather inflexible and the driver can often only switch something “on” and “off” or can only choose the “next” or “previous” song. “That is because they are made of rigid materials like hard plastic, metal or ceramics,” explains Dr. Holger Böse, technical and scientific manager of the Center Smart Materials (CeSMa) at the Fraunhofer Institute for Silicate Research ISC in Würzburg, Germany. In his work, Böse focuses on smart materials with mechanical features that can be controlled either electrically or magnetically.

These novel sensors invented at ISC can send out electrical impulses to control things. They have therefore been designed like an electrical capacitor – two electrode layers consisting of a conductive silicone above and below and one insulating film layer in between. However, if you press on the capacitor nothing happens at first. “The electrical capacitance – the electrical charge divided by the voltage applied – is the decisive factor. However, in a conventional capacitor structure the pressure effect is so small that it can barely be measured let alone be used for control purposes,” Böse explains. In order for the pressure to have an effect, the researchers applied additional layers of silicone on the film. Thus, for example, two more films press from above and below to put additional pressure on the film in the middle. The two films are not smooth but have a special pattern that was added by the researchers. Through their special capacitor design, the researchers were able to use a physical property of silicone, which so far has only been observed when stretching a silicone film coated with layers of electrodes – its geometry changes; the surface becomes larger and the silicone layer becomes thinner. The result is that the electrical capacitance increases. “We transferred it from tensile forces to compression forces,” explains Böse.

Editorial Notes

Beate Koch | Fraunhofer-Gesellschaft, Munich | Communication | Phone +49 89 1205-1333 | presse@zv.fraunhofer.de

Marie-Luise Righi | Fraunhofer Institute for Silicate Research ISC | Phone +49 931 4100-150 |

Neunerplatz 2 | 97082 Würzburg | www.isc.fraunhofer.de | marie-luise.righi@isc.fraunhofer.de

How the compression force acts strongly depends on how the pattern is applied to the film and how the electrodes are attached. The sensor's electrical capacitance is different in each case. The researchers can use these differences and adapt the design of the sensors individually to different geometries and sensitivities. The scientists apply industrial intermediate silicone products or use their own formula. "Our chemical department can develop customized silicone for the sensors based on the customers' needs. We can vary the chemical composition and technical shape of the sensors depending on the properties required," says Böse.

Sponsored by the Bavarian Ministry of Economics

The pressure sensors were developed within a funding program of the Bavarian Ministry of Economics to develop „smart materials“ and bring them into application. The project is now in its seventh year and will end in 2016. "At conferences, the response of the automotive industry for the new technology was very positive," Böse relates. "Now we have to get the technology out of the lab and adapt it to various applications. In a couple of years there could be various concrete products."

Because the sensors are soft and flexible, they can be integrated into all kinds of environments. "The applications are almost infinite," says Böse. For example in cars, control elements can be applied to steering wheels, central consoles, window openers or in seats. They can replace old rigid buttons or be put somewhere else, such as in the car's ceiling or in the door panels.

Fair exhibits on HMI and Sensor + Test

At the Hannover Messe 2016 (Hall 2, Stand C16/C22) and the Sensor+Test (Hall 5, Stand 5-248) in Nuremberg, the researchers are presenting demonstrations of the steering wheel and the glove. Visitors to the trade fair can press on the sensors and see on a screen how the electrical capacitance and the pressure change. They can manipulate music, light, and ventilation while inspecting the steering wheel and measure the gripping force with the glove. "We would be able to monitor the exertion of a worker when lifting heavy items. If we integrate these sensors into the gripping tools of robots, we could determine the amount of pressure the robots apply," describes Dr. Holger Böse from the Fraunhofer Institute for Silicate Research ISC. Depending on the amount of pressure, processes can be controlled by pressing the sensors on the steering wheel. The sensors can be mounted nearly anywhere in the vehicle.

Electrical capacitance

An electrical capacitor consists of two electrically conductive plates, electrodes and an intermediate insulating layer. By connecting the two plates to an electric voltage source, a negative charge flows on one plate and a positive charge on the other. The electrical capacitance is the charge that flows onto the respective plate divided by the applied voltage. Therefore, it is the indicator for the size of the electrical capacitor. The unit of electrical capacitance is the farad, named after the English natural scientist Michael Faraday. Scientists usually measure changes in their pressure sensors in pico or nano farad. By properly calibrating the measuring devices, the electrical capacitance can be converted into pascal or newton per square meter to calculate the compressive forces.

Weblink

Fraunhofer ISC – Center Smart Materials CeSMa: <http://www.cesma.de/en.html>



Measuring pressure with flexible pressure sensors ...
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... or controlling music, light and ventilation in cars.
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