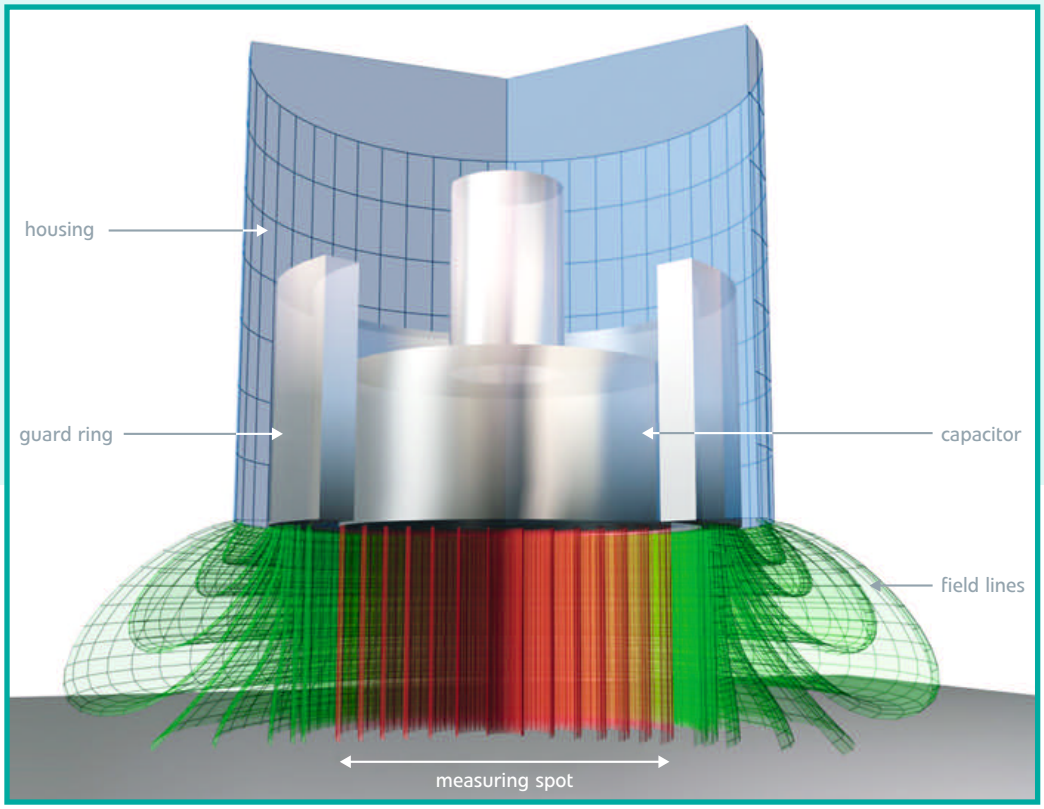
Modern sensors and measurement systems are helping to make medical interventions more secure, automate research, and to design more ergonomic medical devices.

Sensors in Medical Technology



1 Measuring principle of capacitive sensors: If a constant alternating current is flowing through, the amplitude of the alternating voltage is proportional to the distance between sensor and target

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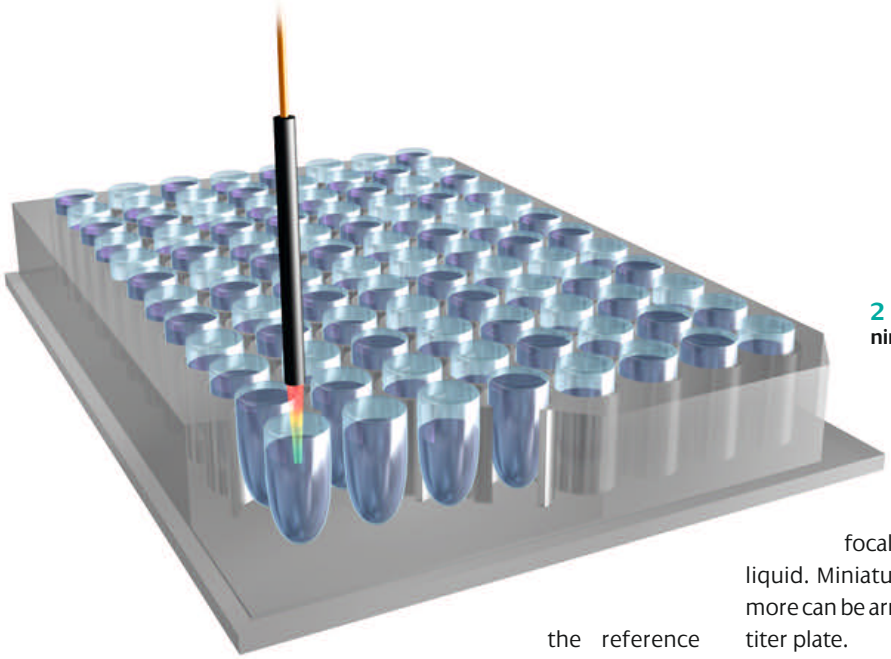
Let's start with capacitive displacement sensors. During capacitive measurements, the sensor and target act as electrodes for the electrical capacitor (Figure 1). If a constant alternating current is flowing through, the amplitude of the alternating voltage is proportional to the distance between sensor and target. Capacitive sensors are very stable and provide nanometer-accuracies and resolution, which is why these sensors are used in high precision applications. For example, they are used in surgical procedures, where a perfect line of vision to the operating table is required. Here, the surgeon is often supported by a surgical microscope. The microscope optics are attached to the long arms of a stand. The pivot joints require continuous adjustments to keep the microscope area of vision stable for the surgeon. This is where the capaNCDT capacitive sensor is used. The system measures the distance to the reference area, which reflects the arm movement in the pivot joint. If

Fine positioning



2 Confocal chromatic sensor scanning the fill level of microtiters

the reference displacement is too large, the control mechanism will move the arm back to its original position. Key benefits of this solution include its compact design and easy integration of the system into an existing design. It also provides the surgeon with a clear picture throughout the entire procedure.

In certain cases, sensors even make it possible to switch from manual to automated procedures, for example, in medical laboratories. In this scenario active agents are manually filled into microtiter containers for batch testing. It is essential, but also challenging, to measure each agent precisely.

Filling level measurement

During automated filling, the fill volume is controlled automatically. However, small batches that are often used in medicine are pipetted manually. Typically, random samples are measured, but this is not sufficient for 100 percent quality control. Confocal displacement measurement is an excellent solution for such applications. During confocal chromatic measurements lenses are used to separate white light into different spectra, which is then focused perpendicular to the object (**Figure 2**). A spectrometer is used to transmit the reflected light to the CCD array: each position in the CCD array now corresponds to one wavelength, i.e. the distance between target and sensor. This technology facilitates measurements to nanometer resolutions. The confocalDT sensors successively scan the microtiters in the plate, and the system measures the distance from sensor to liquid to micrometer accuracies. Standard confocal sensors can be tilted which means they work reliably even if the meniscus of a liquid is large. confocalDT sensors can be used for measurements on any liquid. Miniature sensors with a diameter of four millimeters or more can be arranged in rows to scan the entire width of the microtiter plate.

3 Internal structure of a draw-wire sensor: Beside sensors with steel wires, there is also a choice of synthetic wire versions or sensors with plastic connectors that prevent any interference with X-ray or MRI scans

wireSENSOR draw-wire sensors ensure optimum patient positioning of operating tables. The sensor wire is wound around the drum (**Figure 3**) on one side and attached to the moving object on the other side. An encoder translates the movement created by the extension of the wire into an electronic signal. An operating table is modular in design and provides many adjustment options for the optimum positioning of the patient during an operation: table height, horizontal position and multiple angle features, e.g. for head, torso and legs. Measuring technology is required to read the positions of the various adjustable elements. Due to their compact footprint, high precision and long service life, draw-wire sensors from Micro-Epsilon are the ideal choice. Typically, up to five draw-wire sensors are mounted to an operating table. As well as standard sensors with steel wires, there is also a choice of synthetic wire versions or sensors with plastic connectors that prevent any interference with X-ray or MRI scans.

In addition to draw-wire sensors, capacitive and confocal measuring systems for displacement and distance measurements, Micro-Epsilon offers optical micrometers, temperature and colour sensors, laser sensors, and magneto-inductive measurement systems for medical technology, pharmaceuticals and biotech industries.

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