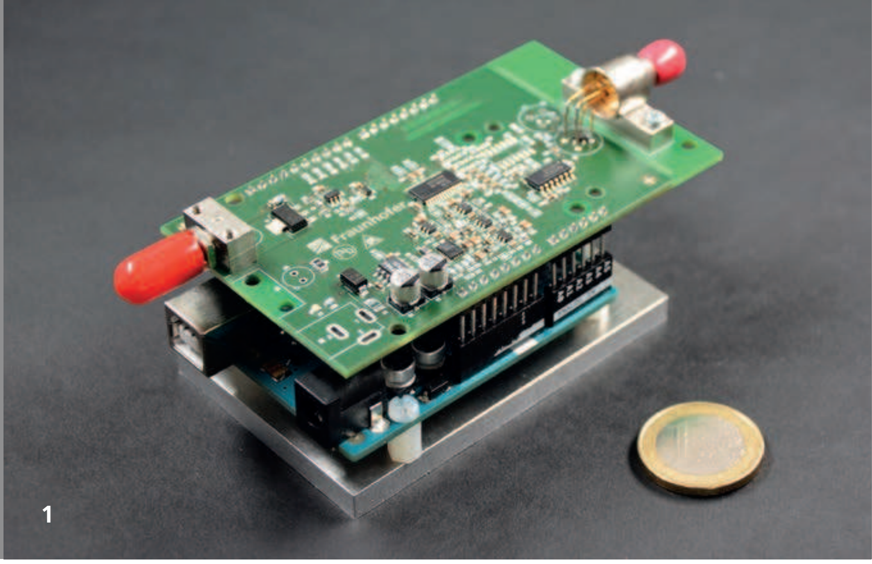

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ROBUST READ-OUT UNIT FOR OPTICAL SPECTRAL SENSORS

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Spectral sensors detect environmental parameters, such as temperature, humidity, gas concentration, mechanical strain, or stress, on the basis of a specific change in their spectral properties. The sensors are often based on detection of wavelength shifts or evaluation of ratiometric changes in two peak signals. These optical sensors offer unique characteristics, such as high sensitivity, electrical passivity, and applicability under extreme conditions (temperature, humidity, electromagnetic fields, etc.). The many different sensor types range from single-point sensors and multiplexed optical fiber versions to two-dimensional sensors. Although many of the sensors have been developed to the application stage, market introduction is often still hampered by read-out systems that lack the necessary miniaturization and robustness for field application as well as the required cost-effectiveness.

This situation motivated Fraunhofer IKTS to develop the wavelength-sensitive photocurrent-based detection system for optical signals shown in Figure 1. The core element is a commercially available wavelength-sensitive photodiode (WSPD) that includes two p-n junctions with different spectral sensitivities. The photocurrents of the two junctions are compared electronically on the circuit board shown above. This approach combines the simplicity of an intensity measurement setup with the robustness of spectral readout. The circuitry was tested to detect wavelength shifts in optical signals and revealed a resolution of 0.08 nm in a first development iteration. Hence, subnanometer resolution is possible without the need for a heavy, vibration-damped, and air-conditioned optical spectrometer. The circuit board is completed by a temperature monitor, a stable power supply, and a light source (LED) with an LED driver.

Both the light source and the detection element are designed for fiber coupling so as to allow for maximum versatility of the final optical sensor system.

It is important to note that the resolution of the system is achieved only if the spectral behavior of the optical signal is precisely known. However, this is the case for most of the optical sensors in use, so the versatility of a spectrometer is not needed.

The goals of the next development iteration are to further miniaturize the overall circuit board and increase the spectral resolution. However, already with the current system, harnessing of the dormant potential of spectral sensor technology in process monitoring, chemical analysis, biosensing, and many other field applications can be envisaged.

1 *Sampling unit for optical wavelength shifts below 0.1 nm.*

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