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The Role of Fiber Optic Detectors and Sensing Networks

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Introduction

The advancement of optical fibre technology was a significant step forward in global communications technology. The advent of low-attenuation optical fibres in the 1970s enabled high-bandwidth long-distance communications. Since these advancements, the volume of production has increased, and by 2000, optical fibres had already been rapidly installed around the world. The advancement of optical fibre technology also allowed for the development of devices for optical processing entirely in fibre, reducing insertion losses and improving processing quality. The identification of photosensitive optical fibres was one factor that contributed to the full migration of optical fibre technology. Due to their versatility in various sensing applications, Bragg gratings have gained a prominent position in optical fibre sensors in parallel with their interest and use in optical communications. Several markets have embraced the benefits of this technology, including aeronautics, aerospace, civil engineering, and biological or environmental monitoring. Optical fibres offer high-performance sensing solutions for a wide range of applications and environments. Fiber sensors can be designed to take advantage of one or more optical parameters of guided light, such as intensity, phase, polarisation, and wavelength. The optical fibre has dual functionality: it can measure several parameters by changing the properties of light propagating through the fibre, and it can also function as a communications channel, eliminating the need for an additional dedicated communication channel and thus providing an advantage over all other sensing technologies.

Description

Electromagnetically, optical fibre sensors are inactive. This property is critical because it enables the use of optical sensors in situations where other types of sensors cannot be used, such as in high and variable electric field environments where there is a risk of explosion. Furthermore, the silica compound, which is the basic optical fibre transduction material, is resistant to most chemical and biological agents and can thus be used in this type of environment and materials. Another advantage of optical fibre sensors is that they can be small and lightweight. Because the fibre has low optical attenuation, it can transmit signals over long distances (kilometres) between monitoring stations [1-3]. Low attenuation is also required for multiplexed measurements. It is possible to operate large arrays of distributed sensors without active optoelectronic components in the measurement area by using a single optical source and detection unit. As a result, electromagnetic passiveness and environmental resistance can be preserved.

Optical fibre sensor systems are typically used in fixed locations. As a result, extensive lengths of fibre optic cable are required to connect all of the sensors and create an optical fibre network, which can be costly and impractical. Wireless Sensor Networks (WSNs) have received a lot of attention in recent years because of their ability to collect data on parameters like temperature, pressure, acceleration, and vibration. Nonetheless, most WSN systems do not incorporate optical fibre sensors and thus do not benefit from their unique properties and advantages [4,5]. As a result, incorporating optical fibre sensors into WSNs provides advantages and new capabilities for the design of advanced hybrid-sensing systems. An optical fibre is a cylindrical dielectric waveguide in which the core and cladding are made of glass or plastic, and the surrounding coatings are made of acrylate or polyimide materials. Multi-mode or single-mode optical fibres are available. An optical fibre sensor expands or contracts in response to strain or temperature changes. Light is modulated as it travels down the fibre to the sensor based on the amount of expansion or contraction. Following that, the sensor returns an optical signal to an analytical device, which converts the reflected light into numerical measurements of the sensor length change. These measurements indicate the strain or temperature.

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Conclusion

Intrinsic sensors employ an optical fibre as both the sensitive material (sensor head) and the medium for transporting the optical signal containing the information measured. They work by modulating the light that is guided into the optical fibre directly, and the light does not leave the fibre except at the detection end. Physical perturbations in this type of sensor change the properties of the optical fibre, thereby changing the properties of the light carried by the fibre. Alternatively, the modulated light may be reflected or scattered back into the same fibre and then guided back to the detection system. The most basic fibre sensors vary light intensity and require only a light source and a detector.

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Conflict of Interest

Authors declare no conflict of interest.

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