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A Short Note On Fiber Optic Sensors

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Description

A fiber-optic sensor is one that uses optical fiber as a sensing element or to transport signals from a remote sensor to the electronics that process them. Fibers offer a wide range of applications in remote sensing. Fiber is sometimes used because of its small size, or because no electrical power is required at the remote location, or because many sensors can be multiplexed along the length of a fiber by using light wavelength shift for each sensor, or by sensing the time delay as light passes through each sensor, depending on the application. A device such as an optical time-domain reflectometer can be used to detect time delay, while an instrument that implements optical frequency domain reflectometry can be used to calculate wavelength shift.

Fiber-optic sensors are also impervious to electromagnetic interference and do not conduct electricity, allowing them to be employed in environments with high voltage electricity or volatile materials like jet fuel. Fiber-optic sensors can also be made to endure extreme temperatures. By altering a fiber so that the quantity to be measured alters the intensity, phase, polarization, wavelength, or transit time of light in the fiber, optical fibers can be used as sensors to monitor strain, temperature, pressure, and other quantities. The simplest sensors are those that adjust the intensity of light, as they simply require a simple source and detector. The ability of intrinsic fiber-optic sensors to enable distributed sensing across long distances is a particularly useful characteristic.

Temperature can be determined by studying the Rayleigh Scattering, Raman Scattering, or Brillouin Scattering in the optical fiber, or by employing a fiber with evanescent loss that fluctuates with temperature. Nonlinear optical phenomena in specially-doped fiber can sense electrical voltage by altering the polarization of light as a function of voltage or electric field. The Sagnac effect can be used to create angle measurement sensors.

For direction recognition, special fibers that are used in optical fibers such as Long-Period Fiber Grating (LPG) optical fibers can be employed. Aston University's Photonics Research Group has various articles on vectorial bend sensor applications.

Hydrophones made of optical fibers are employed in seismic and sonar applications. There have been built hydrophone systems with over a hundred sensors per fiber line. The oil sector, as well as a few countries navies, utilizes hydrophone sensor systems. Towed streamer systems and bottom-mounted hydrophone arrays are also in use. Sennheiser, a German corporation, created a laser microphone for use with optical fibers. In regions with strong electrical or magnetic fields, such as communication among the team of personnel working on a patient inside a magnetic resonance imaging machine during MRI-guided surgery, a fiber-optic microphone and fiber-optic based headphone are beneficial. Temperature and pressure optical fiber sensors have been created for down hole measurement in oil wells. Because it operates at temperatures too high for semiconductor sensors, the fiber-optic sensor is well suited for this environment.

Using fiber Bragg gratings, fiber-optic sensors have been designed to monitor co-located temperature and strain simultaneously with very high accuracy. This is very useful for extracting data from small or complex structures. Fiber optic sensors are also ideally suited for remote monitoring, as they can be probed over an optical fiber cable up to 290 kilometers away from the monitoring station. Over long distances, Brillouin scattering effects can be employed to determine strain and temperature.

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