Soft Optical Waveguides for Sensing Extreme Deformation

Soft optical waveguides help sense the shapes of deforming structures by changing the intensity and travel time of light. This presentation will describe their use as intrinsically stretchable alternatives to electronic sensors in soft robotics and other extreme-deformation environments. Because they're often made from polymers, oils, and gels, these materials are compatible with low temperature (< 200 C) additive manufacturing methods like 3D printing and syringe based deposition. There are parallels to the recent growth of soft and stretchable electronics, but the materials set for additively-manufactured soft optics is limited by low optical transmission and by the smoothness of sidewalls printed by additive methods, because rough sidewalls create scattering. Emerging additive manufacturing methods that incorporate ready-made threads, tubing and fibers with waveguiding properties offer fast routes around these limitations. This presentation gives some background information on fiber additive manufacturing and on optical sensing methods for intensity and time-of-flight, then shows examples of soft, stretchable, and liquid-core waveguides in human activity sensing and soft robotics.