INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The present thesis work is focused on the design and analysis of novel fiber Bragg grating (FBG) structures for its efficient application in quasi-distributed sensing network (QDSN). Novel grating structures are designed to achieve widest possible dynamic range and to enhance the sensing capabilities manifold. A comprehensive theoretical study is carried out to achieve the objective of the research work. In order to devise an efficient WDM/QDSN for the given source-bandwidth, critically important characteristics, e.g., reflectivity/transmissivity, FWHM, side-lobe suppression ratio (SLSR), maximum side lobe (MSL) and delay need to be optimized w.r.t. the grating design parameters, such as, length (L), index-change (δn), apodization profile and loss (α). In the first part of the research, a novel apodization profile to device FBG that can efficiently resolve strain and temperature in QDSN is proposed. Optical characteristics of the grating employing novel apodization are optimized w.r.t. L and δn. For the optimum grating based five-stage QDSN, dynamic range for the temperature measurement as high as 131.6°C and for the strain measurement as high as 1450με are obtained. Further, an isolation of 10.07 dB and the total isolation of 33.818 dB, highest among the other apodization profiles recently reported in the literature, are observed for the proposed FBG. In order to further enhance the sensing efficiency, slow-light π-FBG based QDSN is proposed. A novel π-FBG is designed by optimizing optical and sensing characteristics with respect to the parameters L, δn, α and employing the novel apodization profile proposed earlier in the research. Strain sensitivity as high as 8.380 $(\mu\varepsilon)^{-1}$ and temperature sensitivity as high as 91.064 $°C^{-1}$, manifold higher than the maximum sensitivity reported in the literature, are achieved for the proposed slow-light π-FBG. Optimized slow-light π-FBG is employed in a five-stage QDSN. Dynamic range for the strain measurement as high as 1469με and for the temperature measurement as high as 133°C are obtained. Finally, π-FBG based fiber Mach-Zehnder interferometer is proposed to develop ultrasonic acoustic sensor. With the optimized characteristics of π-FBG achieved at L = 5 mm, $\delta n = 1.2\times10^{-3}$ and employing the proposed novel apodization profile, strain sensitivity as high as $1.21321\times10^{8}/\varepsilon$ and resolution as high as 4.1 fε/√Hz are achieved from the proposed sensing system. Observed strain sensitivity and resolution are much better than the best reported in the literature.