



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis focuses on the development of novel, all-optical Fiber Bragg Grating (FBG)-based tilt and liquid level sensors, designed for structural health monitoring (SHM) applications. The primary aim is to realize highly sensitive, accurate, and temperature-insensitive sensors with tunable response characteristics. Initially, a temperature-insensitive, non-pendulum type FBG tilt sensor is proposed, offering tunable performance via variable loaded mass and eliminating thermal effects through wavelength separation modulation between two FBGs. The sensor achieves a sensitivity of $0.0300 \text{ nm}/^\circ$, accuracy of $\pm 0.033^\circ$, and angular resolution of 0.067° . An improved design enhances sensitivity to $0.0415 \text{ nm}/^\circ$, accuracy to $\pm 0.024^\circ$, and resolution to 0.012° , maintaining excellent reversibility and reliability. A third design further boosts sensitivity to $0.3198 \text{ nm}/^\circ$, accuracy to $\pm 0.0031^\circ$, and resolution to 0.0016° , while preserving design simplicity and experimental fidelity.

The next innovation introduces an etched FBG (EFBG)-based tilt sensor exploiting effective refractive index (RI) sensitivity to modulate intensity for tilt detection—an approach demonstrated for the first time. It achieves sensitivities up to $2.41 \text{ dB}/^\circ$ and effectively measures tilt within $\pm 10^\circ$ with strong temperature insensitivity. Lastly, a novel FBG-based liquid level sensor is developed using Archimedes' principle, attaining high sensitivity (77.5 pm/cm), excellent resolution (0.006 cm), and accuracy ($< 0.03\% \text{ FSR}$) over a 30 cm range. All sensors show strong experimental agreement, reversibility, and practical applicability. This research offers significant contributions to SHM through innovative all-optical sensor designs and mechanisms.