

**Optical Fiber Fabry-Perot Interferometer based Sensor Instrumentation System for  
Low Magnetic Field Measurement**

by  
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Electrical and Computer Engineering

(Abstract)

This dissertation proposes a miniaturized optical fiber based sensor system for the measurement of 3-dimensional vector magnetic fields. The operation of the sensor system is based on the detection of magnetostrictive dimensional changes in the sensor gage using a modified extrinsic Fabry-Perot Interferometer configuration. Because of the magnetostrictive reflector the gap length depends on the magnetic fields applied to the sensor. Since the diameter of the magnetostrictive sensor gage is 125  $\mu\text{m}$  which is the same as that of the input/output fiber, the sensor is simply constructed by inserting the sensor gage and the input/output fiber into a small glass tube. The glass tube serves as both an aligner for the sensor gage and input/out fiber, and a passive temperature compensator. In addition, it also enhances the mechanical strength and compactness of the sensor. This sensor design shows 98% suppression of the thermally induced sensor output changes. The linear output of the sensor system is enhanced by transverse field annealing which increases magnetostrictive induction in the ferromagnetic sensor gage material and controls the sensor gage geometry. A 5-times increase in sensor sensitivity is obtained with the transverse field annealing and the use of a new magnetostrictive material. A modified sensor gage endface demonstrates 92% of fringe visibility, which further improves the performance of the interferometer. The signal fading in the interferometric sensors at the peak or bottom of a fringe is reduced by using a quadrature signal demodulation method. The system has been shown to have a resolution better than 100 nT over a measurement range from 100 to 40,000 nT. This research is supported financially by the Phillips Laboratory of the U.S. Air Force.