



Industrial Consultancy & Sponsored Research (IC&SR)

METHOD AND APPARATUS FOR DYNAMIC MATCHING OF FIBER BRAGG GRATINGS FOR DYNAMIC INTERROGATION

IITM Technology Available for Licensing

PROBLEM STATEMENT

1

• **Structural Health Monitoring (SHM)** is a key requirement for capital intensive structures, which is aided by **Guided-Wave Non-Destructive Evaluation (NDE)** for damage identification.

2

• **Fiber-Based Grating (FBG) sensors** have been demonstrated as an excellent choice for **minimally invasive** guided wave measurements.

3

• FBG sensors have unique attributes due to their wavelength division multiplexing capability and amenability to **array sensing**.

4

• **Matched FBG filter-based interrogation** is an attractive approach for guided wave sensing and has been proven to be useful for SHM applications.

5

• **Dynamic matching of the Bragg wavelength of the interrogator FBG with the sensor FBG** is necessary for successful interrogation of high-frequency guided waves signals.

TECHNOLOGY CATEGORY MARKET

Technology: Fiber Bragg Gratings

Category: Photonics/Fiber Optic Sensor

Industry: Optic Cable Manufacturers

Application: Optical communications systems, Sensing Elements.

Market: The global market size of is estimated at **USD 0.76 billion in 2024**, and is expected to reach **USD 1.16 billion by 2029**, growing at a **CAGR of 8.83%** during the forecast period (2024-2029).

INTELLECTUAL PROPERTY

IITM IDF Ref. 2330

Patent No: IN 536709

TRL (Technology Readiness Level)

TRL-3, Experimental proof of concept

Research Lab

Prof. Balaji Srinivasan,
Dept. of Electrical Engineering, IIT Madras.

TECHNOLOGY

❖ An **apparatus** for dynamic matching of Fiber Bragg Gratings (FBG) for dynamic interrogation, wherein the apparatus comprises:

- ✓ An **optical broadband source (BBS)**
- ✓ An **optical circulator**
- ✓ A plurality of **FBG sensors**
- ✓ A plurality of **interrogator FBGs**

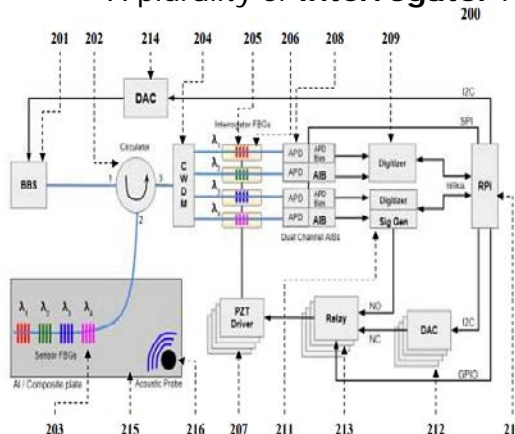


Fig 1 shows a schematic representation of Multi-Channel Dynamic Interrogation System - MCDIS

The **optical BBS** is connected to an optical circulator to **illuminate multiple FBG sensors** for surface-mounted interrogation on a test sample and receive optical reflection spectra.

The **optical circulator** directs broadband light from the optical BBS into multiple FBG sensors and feeds the **sensor reflection spectra** into a **Coarse Wavelength Division Multiplexer (CWDM)** filter.

The **Coarse Wavelength Division Multiplexer (CWDM)** is utilized to segment optical reflection spectra from FBG sensors and connect them to corresponding **interrogator FBGs mounted on voltage-controlled PZT stretchers**.

CONTACT US

Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
<https://ipm.icsr.in/ipm/>

Email: smipm-icsr@icsrpis.iitm.ac.in

sm-marketing@imail.iitm.ac.in

Phone: +91-44-2257 9756/ 9719

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PZT stretchers apply strain and sinusoidal perturbations to interrogator FBGs, causing a proportionate change in transmitted intensity. **Analog Interrogator Board** converts intensity waveform changes into voltage changes using multiple APDs.

Digitizers convert analog output waveforms into digital samples, generating DC and AC signals for calibrating interrogator FBGs.

Control unit coordinates components for determining optimum bias voltages for BBS, APD, and PZT sensors. **Digital to Analog Convertors** apply optimal PZT bias voltage to PZT stretchers.

Electromagnetic relays connect signal generators to PZT drivers for calibration and acoustic signal measurement.

Method

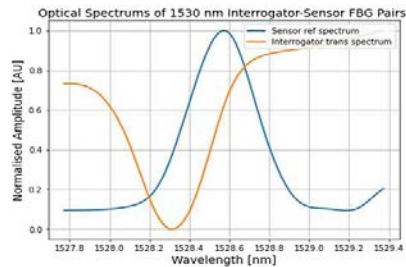
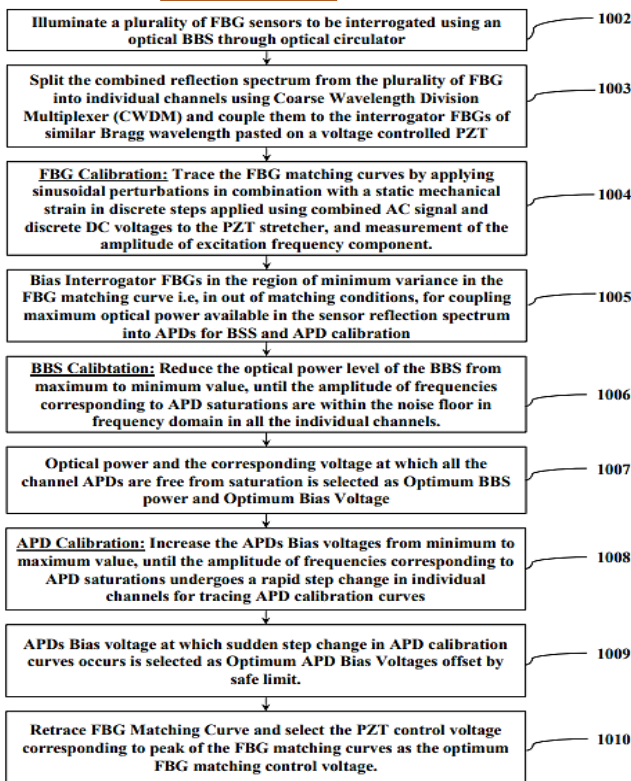


Fig1
The graph shows a matching or alignment of the interrogator transmission spectrum and sensor reflection spectrum

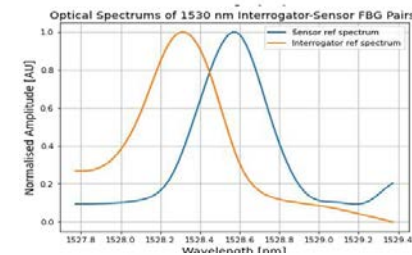


Fig 3
The graph shows a matching or alignment of the interrogator reflection spectrum and sensor reflection spectrum

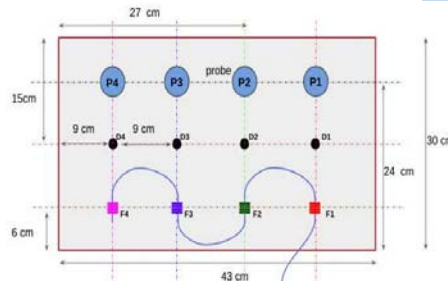


Fig4
The graph shows an experimental setup for four channel dynamic strain sensing consisting of 1530, 1550, 1570 and 1590 nm FBGs

Key Features / Value Proposition

- **Dynamic Matching** of Fiber Bragg Grating pairs for ultrasound guided wave sensing.
- Aligns **interrogator's transmission spectrum** with **sensor's reflection spectrum**.
- **DC** voltage is applied to **PZT stretchers** to shift the **Bragg wavelength**.
- Tracing APD calibration curves to APD saturation (**35 kHz to 40 kHz**).
- Capturing **acoustics** measurements.
- **Auto calibration** mode is available.
- Used as **sensing elements in optical fiber sensors** and for temperature & strain sensing etc.
- Ensures **safety by detecting defects**, fatigue, or corrosion in structural like buildings, dams etc.

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