Monitoring Respiration and Cardiac Activity Using Fiber Bragg Grating-Based Sensor

Seminar Presentation

January 15, 2013
The device consists of a Bragg grating inscribed into a single mode optical fiber and operating on a wavelength of around 1550 nm. The fiber Bragg grating (FBG) is mounted inside a pneumatic cushion to be placed between the backrest of the seat and the back of the monitored person. Vibrations, i.e., dynamic strains transferred to the FBGs involve changes of the instantaneous Bragg wavelength values (proportional to the vibrations). Their detection with the interrogation system (with proper resolution and dynamic characteristics) provides information on breathing activity and heart rate.
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FIBER BRAGG GRATINGS (FBGS)

Fiber Bragg grating is a periodic perturbation of the effective refractive index in the core of an optical fiber. Typically, the perturbation is approximately periodic over a certain length of e.g. a few millimeters or centimeters, and the period is of the order of hundreds of nanometers, or much longer for long-period fiber gratings.

When incident light, $I$, is launched down the fiber, each plate reflects part of the light beam. Thus, the FBG acts as a stop-band filter.

The reflected beams from each of the plates destructively interfere with each other unless the beams are all in phase. This only occurs only at one wavelength, the Bragg wavelength (central wavelength), which is given by,

$$\lambda = 2n\Lambda$$

The application of strain, pressure, or temperature to an FBG causes a shift in the Bragg wavelength, $\Delta \varepsilon = \Delta (\lambda)/k\varepsilon$.
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Figure: FBG acting as stop band filter
Planar Microwave Filters

Micro strip transmission lines (as well as CPW or strip line) can also make good resonators and filters and offer a better compromise in terms of size and performance than lumped element filters.

Precision planar filters are manufactured using a thin-film process.

Higher Q factors can be obtained by using low loss tangent dielectric materials for the substrate such as quartz or sapphire and lower resistance metals such as gold.
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Design and Application of Quasi-Elliptic Band-stop Filters

In this paper the design and implementation of a new type of bandstop filter having transmission zeros is presented. Detailed design aspects of 3 and 4 pole bandstop quasi-elliptic filters are discussed, where transmission zeroes are attained by a source-load cross coupling line.
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J inverters are used to provide the coupling.
Method to design microwave bandstop filter based on CPW

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- The impedances of coplanar-waveguide (CPW) structures are used to design the filter, and the conformal transformation is utilised to calculate the capacitance of structures in the coplanar-waveguide.
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- It transforms the lumped circuits to distributed circuits in coplanar-waveguide structures by utilising the Richard transformation and Kuroda rule.
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  - Reactance of inductor
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- Inductor can be replaced with a short-circuited stub of length BL and characteristic impedance L, while a capacitor can be replaced with an open circuited stub of length BL and characteristic impedance 1/C
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- Kurodas identity
  - It perform any of the following operations.
    - Physically separate transmission line stubs.
    - Transform series stubs into shunt stubs or vice versa.
    - Change impractical characteristic impedance into more realisable one.
Method to design microwave bandstop filter based on CPW
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Next it is necessary to transform the short transmission line to structures in the CPW. The method where the impedances of the CPW are mapped to the impedances of the short transmission line is used to transform the short transmission line circuit to structures in the CPW.
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- In the process of band-stop filter: TEMPAX glass is used as the material of the substrate, while the metal material is aluminium.
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THANK YOU