Ultra high resolution programmable arbitrary optical filter design and applications

Mots clés :

● Directeur de thèse : YVES JAOUEN
● Co-encadrant(s) :
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Résumé du projet de recherche (Langue 1)

With the rapid development of high speed optical transmission system, high precision optical signal processing and microwave photonics, the precise control of the optical spectrum, optical pulse and microwave spectrum has become particularly important. One ideal solution is to realize a programmable arbitrary shape optical filter or processor, which can change the frequency composition of the signal freely and enables flexible optical spectral transformation precisely. By using this kind of filter, optical signals can be processed in frequency domain directly or in time domain after time-frequency transformation. Microwave signals can also be processed once they have been modulated on a CW light. A widely used product is the wavelength selective switching (WSS) produced by Finisar. Based on Finisar’s Liquid Crystal on Silicon (LCoS) optical engine, the optical transfer function can be software-specified across the entire 5 THz of operation, which allows the generation of arbitrary, complex filters as well as control of filter bandwidth and center frequency. But this technology presents a minimum ~10 GHz bandwidth due to the grating and liquid crystal resolutions which are almost insurmountable. There is still no feasible solution for ultra-precise signal processing with bandwidth of ~GHz and resolution of ~MHz. Even though several methods have been proposed to implement narrowband optical filters including specially designed fiber Bragg gratings (FBG), cascaded micro-ring resonators and stimulated Brillouin scattering (SBS). The flexibility and precision cannot meet the application requirements yet. Among all the above methods, SBS-based filter has been considered as one of the most promising techniques with inherent flexibility. The wavelength of the SBS-based filter can be tuned easily by tuning the wavelength of the pump wave. The filter bandwidth and the shape can also be changed by controlling the pump spectrum. The natural Brillouin linewidth can be as small as ~20 MHz which makes it possible to control the filter shape precisely. Shanghai Jiao Tong University (SJTU) and Telecom ParisTech (TPT) have cooperated in realizing a rectangular optical filter based on SBS in optical fiber and demonstrating a high precision reconfigurable optical add and drop multiplexer (ROADM) successfully. The next step is to realize an arbitrary optical filter and to solve the inherent issues of the SBS-based technique to make the proposed filter feasible in various applications.

Résumé du projet de recherche (Langue 2)

The arbitrary filter shape can be obtained by controlling the Brillouin pump more precisely. New delicate feedback compensation method needs to be designed carefully. Other nonlinear effects (especially four wave mixing) should also be taken into account ensuring the accurate pump control. The filter parameters such as passband flatness, and selectivity need to be improved on the basis of the present level. The main issues of the SBS-based technique are polarization-dependent gain and degradation on signal performance due to high noise level. These two issues need to be studied in details. Once the issues have been solved, the filter applications should also be demonstrated in which the superiority of the proposed arbitrary filter will emerge. Another important research content is to find the suitable SBS media. Compared with standard single mode fibers, the chalcogenide fiber has a way higher Brillouin efficiency and strong SBS effect was observed in it. Thus the evaluation of the chalcogenide fibers for Brillouin-based optical processing is very meaningful and may bring about better performance. This work can be done in TPT. The PhD work program will be applying between Shanghai Jiao Tong University (2 years) and Telecom ParisTech (1 year).

Informations complémentaires (Langue 1)

This PhD will be realized in a Joint Supervised PhD agreement between Telecom ParisTech and The School of Electronic Information & Electrical Engineering of Shanghai Jiao Tong University.

Informations complémentaires (Langue 2)

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