

Research on All-Optical Digital Signal Processing Technology in High-speed Optical Communication

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Abstract: This paper first describes the all-optical digital signal processing in high-speed optical communication. Then it analyzes the all-optical digital signal processing technology from the aspects of optical modulation technology, optical regeneration technology and optical interconnection technology. Take into account this, the idea of all-optical digital signal processing in high-speed optical communication is put forward.

1. Introduction

Under the background of the comprehensive development of science and technology in our country, the rapid progress of the communication industry has been promoted. High-speed optical communication, as a part of the communication industry, plays an important role in the development of the communication industry. In the long distance transmission process, the corresponding detection technology and digital signal processing technology are usually fully integrated, and the multi-dimensional high-order debugging technology is applied to realize the large-capacity information transmission. At the same time, in the digital field, to achieve the repair of each channel damage situation, can effectively improve the high spectral efficiency, to achieve high sensitivity information transmission. In the following, this paper will further elaborate and analyze the all-optical digital signal processing technology in high-speed optical communication.

2. All-optical digital signal processing in high-speed optical communication

In high-speed optical communication, optical model processing mode generally involves light generation, light transmission, light path control and light detection, etc. Therefore, to achieve fast optical communication requires optical devices support. Compared with electronic devices, photogenic devices are much higher than electronic devices in terms of both time response and single channel capacity. Because of the influence of low threshold, low power consumption and fast response semiconductor laser, the optical fiber communication presents practical characteristics, and the optical communication window is basically formed with the laser light sources of 0.8 micron and 1.3 micron [1]. With the comprehensive development of multi-quantum trap devices and high-density vertical cavity surface emitters, the laser threshold is gradually reduced, effectively improving the laser conversion efficiency and output power, the band is appropriately expanded, and the line width is also changed. By using DOFN to replace the conventional photoelectric intermediate system, it is the optical signal processing technology that provides the conditions for the reform of optical fiber communication. Therefore, it can be known that optical signal processing technology has been a part of optical communication technology.

3. All-optical digital signal processing technology

3.1 Optical modulation technique

Laser is the primary way of information transmission. In this process, the problem that needs to be dealt with is how to transmit the signal to the laser radiation. In other words, the signal is converted

from the original form into a form suitable for signal transmission, and the information to be transmitted is loaded into the laser radiation to become laser modulation. The whole process device can be called laser modulator. The light wave that completes the modulation is transmitted to the receiving end through the fiber channel, which is processed by the optical receiver, and then loaded in the original information, and this process is called photolysis modulation [2]. Among them, when the laser frequency is relatively high, it is a low-frequency signal that controls the information of light. In this process, the low-frequency signal should be converted into a modulated signal, and the modulated carrier low-frequency signal can be used as carrier or modulated light wave. In general, light modulation technology can be divided into different forms, in which, according to the carrier continuous degree, it is divided into continuous modulation and pulse modulation. According to the laser type, it is divided into direct modulation and indirect modulation.

3.2 Light regeneration technology

In a broad sense, optical regeneration is mainly optical signal regeneration, namely signal quality recovery. Under normal circumstances, optical signal regeneration technology involves optical amplification technology, optical shaping technology and so on. With ideal light regeneration technology, the following requirements should be met. Firstly, make sure the format is reasonable and standard. Secondly, less resource consumption. Finally, the operation is simple and the cost is low.

3.3 Light amplification technology

Optical amplifier is an important component in an optical communication system. Among them, the achievements of wave-split-complex technology in high-speed and large-capacity transmission system are affected by the factors of optical amplification technology to some extent. Because the loss of light will have a direct impact on the transmission distance and speed of optical fiber communication system. From the perspective of optical amplifiers, light amplification is different in combination with different wavelengths. In this process, high-speed optical communication technology is required [3]. Traditional photoelectric optical relay is not only technically tedious, but also costly. Because of the difference in wavelength between light waves, different types of Repeaters should be prepared to amplify light of different wavelengths. But at the same time, and the economic efficiency idea deviating, the application of the optical amplifier technology, can realize optical amplification processing, effectively reduce the application of repeater, let the fiber damage will not become an important factor restricting the distance, and for more open and transparent transmission link, realize intensive wave command technology rapid development.

3.4 Optical shaping technology

Transmission over long distances will gradually degrade the quality of optical signals. For example, the dispersion will lead to an increase in the width of the pulse, which will appear blurry in front of the eyes. This change needs to be observed with a spectral detection device. If the signal degradation accumulates to a certain extent due to the reduction of pulse width and signal-to-noise ratio, it will affect the signal to some extent. Among them, the more significant influence lies in the shaping, the significance of shaping lies in the restoration of the original pulse shape, and the most important link in the realization of optical shaping is to re-judge the signal. Therefore, light shaping is also called light judgment technology.

3.5 Optical clock recovery technology

As an indispensable part of all-optical regeneration technology, optical clock restoration technology is the basic of timing and shaping in all-optical regeneration. Under normal circumstances, optical clock recovery technology includes external cavity lock film laser, etc., under the effect of external cavity lock film laser, clock recovery can be realized. For example, the DFB laser self-pulsation can achieve information acquisition and clock recovery under the lock film fiber ring laser.

3.6 Optical interconnection technology

In the current information system processing data volume increasing gradually, people on the processor operation efficiency and processing ability put forward strict standards. People can from two aspects to achieve the improvement of the computer system. Firstly, improve the efficiency of computer processing; secondly, adopt large-scale processing method to improve the efficiency of system processing. But in this process, what kind of processor needs to be adopted and how to realize the connection between processor and template is the current issue that people need to focus on and deal with. Even if the scale integrated circuit technology has been developed stably and the processing level has been greatly improved at the present stage, this method based on electrical interconnection will have some shortcomings. For example, the speed of electrical interconnection will be affected by factors such as resistance and capacitance, causing problems such as clock skew and string [4]. It can be seen that the emergence of these problems have a direct impact on the performance of electrical interconnection properties, and relevant technologies cannot be directly adopted to deal with them. Only by adopting reasonable interconnection mode, can this kind of problem be dealt with and the application function of integrated circuit be effectively expanded. In the process of making a feasible plan, the electric interconnection is usually replaced by the optical interconnection, and the interconnection communication problem is effectively dealt with. Optical interconnection can be used as a medium of data transmission to realize interconnection communication. In general, compared with the electric interconnection mode, the optical interconnection mode has more advantages. Under the action of the optical interconnection mode, since the optical signal will not interfere with each other, it can effectively reduce the influence brought by the external electromagnetic field.

4. The idea of all-optical digital signal processing in high-speed optical communication

4.1 All-optical logic based on cross-gain modulation effect

In combination with the SOA system, in the process of high-speed optical communication all-optical digital signal processing, to obtain the ideal processing results, it is necessary to combine the requirements of cross-gain regulation, do a good job in processing, and ensure that the SOA system is in the state of gain saturation. In the process of signal pulse flowing through SOA, no great benefit will be gained, and the pump light will present a state of “0” effectively, and the probe light can pass through SOA [5]. All-optical XOR logic based on cross gain modulation is shown in figure 1:

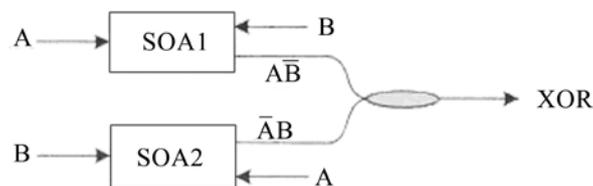


Figure 1. All-optical logic based on cross-gain modulation effect

According to the figure above, two SOA systems are involved in high-speed optical communication, one is SOA1 and the other is SOA2. After two SOA systems are connected in parallel, the logical data is obtained. At the same time, signal A plays the role of detection light, while signal B is the pump light. In this process, signal B power through SOA1 is much higher than the signal A power. Through this process, it can be known that SOA1 realizes the logical operation of a-b [5]. In addition, taking signal B as the detection light and signal A as the pump light, the \overline{ab} logical operation result can be obtained in SOA2. In other words, after the signal light influences the nonlinear phase difference through which the contact light passes, it will be all different or the logic itself will be fully functional. In this process, two SOA are required, while the requirement for two interference arms is relatively high.

4.2 Optical interconnection technology

In the environment of continuous improvement of information level, the information system processing information has been greatly increased. In the process of processing these information, people put forward strict standards for the operational efficiency and quality of processors. In the process of reforming the computer structure, we mainly start from two aspects, one is to change the computer structure, and the other is to adopt large-scale processing method to improve the system processing efficiency. At the same time, it can cause problems with the connection between the processor and other templates. With the rapid development of centralized circuit technology, the processing efficiency has been improved. However, this kind of processing technology based on the mode of electrical interconnection has some problems, such as slow operation efficiency of electrical interconnection, affected by capacitance, clock skew or crosstalk. These phenomena are the inherent attributes of electrical interconnection, which cannot be dealt with. Only by adopting new connection methods, can these problems be scaled up and the functions of integrated circuits be improved. In this process, optical interconnection technology has been widely used, which can effectively appeal various problems existing in interconnection communication. As a new information transmission medium, optical interconnection technology has incomparable advantages compared with electrical interconnection. Under the effect of optical interconnection technology, the interference caused by an external electromagnetic field can be effectively reduced because there is no interference between optical signals. Optical interconnection technology is shown in figure 2:



Figure 2. Optical interconnection technology

Packet caching technology plays an important role in all-optical switching control. In general, the all-optical caching technology cannot only provide tunable cache time, but also facilitate the frame header processing of nodes and properly handle the competition for the same port. It can be seen that all-optical caching technology play a key role in all-optical routing control and channel competition processing. At present, there is no application model and data of workers for all-optical cache, but the direction of exploration is unified. The all-optical cache period is generally divided into two forms: one is to implement optical packet caching and processing by using fiber delay lines; the other is to reduce the speed of light by changing the refractive index of the medium. By controlling the closed state of optical switch, the data packet can be saved and interpreted.

5. Summary

In a word, all-optical signal processing technology, as a modern technology, is widely used in high-speed optical communication. By strengthening the research and application of all-optical signal processing technology, the transmission level of high-speed optical communication can be effectively improved, the signal capacity function can be fully played, and the development of China's communication industry can be guided.

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