Smart System in Optical Communication for Error Detection and Error Correction using SOA

B. Jeyasri[1], D. Jeyarani@Monika[1], G. Mohidha Priya[1], M. Anitha[1]
[1]*Department of Electronics and Communication Engineering*
NPR College of Engineering and Technology
Natham, Dindigul, Tamil Nadu

Abstract - *We present SOA logic gate based error correction codes for noisy storage and transmission channels with unknown gain and/or Offset. The proposed code utilizes redundant computation algorithm to obtain the maximum error detection capability. Moreover, the encoder-reuse technique (ERT) is proposed to minimize the area overhead of extra gates without disturbing the whole encoding and decoding processes. The proposed code is compared to well-known codes such as the existing Hamming, MCs, and punctured difference set (PDS) codes. Optisystem tool has been used to design SOA amplifier and logic gate in codes.*

Keywords – *Semiconductor Optical Amplifier (SOA), Punctured Difference Set (PDS), Encoder-Reuse Technique (ERT), Cross Gain Modulation (XGM), Cross Phase Modulation (XPM).*

I. INTRODUCTION

High speed Digital processing is required to increase the demand of Digital data processing. To perform various computational functionalities as packet buffering, bit length conversations, header processing, switching, retiming, reshaping and time division multi/demultiplexing photonic signal elaboration at the Optical layer is the most attractive feature[1]. To increase capacity, flexibility and scalability to the next generation systems in optical domain [2]. All Optical Digital processing is the most promising technology. For the realization of different logic functions SOAs are very attractive nonlinear elements, since they can exhibit a strong change of the refractive index together with high gain. The challenges involved in this are to improve the performance of the system and to reduce the complexity. Another challenge is feedback and we overcome it by connecting optical delay [3]. The gate operation can scale with data rate to a maximum of 10 Gbps and the power should be upto 0.5mw [4].A new approach is discussed in this paper.

This approach includes utilization of nonlinear properties of SOA to develop all optical logic gates which are further used in building All- Optical Flip-Flops. We tried to develop a methodology to make firstly all Optical AND Gate and NOR Gate. Next the digital circuitry consist of four AND Gates and two NOR Gates is used to make Flip-Flop. All-optical Flip-Flops using two coupled lasers operating at telecommunication wavelengths was analyzed [5] enough to integrate into almost any program on any computer.

The objective of this paper is to develop Optical Communication for error detection and error correction using SOA with Optisystem. The paper is organized as follows. In Section II, System model is described. In section III, Implementation of SOA-MZI based AND gate is described. In Section IV, Proposed system is discussed. In Section V Simulation results are presented. In section VI, concludes the paper.

II. SYSTEM MODEL

Mach-Zehnder interferometer (MZI) have been widely used to implement All optical logic gates and All Optical Flips. Using SOA-MZI All Optical AND and NOR Gates are performed upto 10 Gbps. For low energy requirement, simplicity, compactness by integration, capability, and stability SOA-MZI structure using XPM is the most attractive features. High Extinction Ratio, regenerative capability, high speed operation, and low chirp are the merits using SOA-MZI. So far, all-optical AND and NOR gates using SOA-MZI structure have been investigated. The design carried out in this paper is by means of (SOA). Various nonlinearities in SOAs including cross gain modulation (XGM), cross phase modulation (XPM), have been exploited for mplementing optical gates

A. Logic Gates Based on Nonlinearities on SOAs

SOA is a very interesting device in optical networks having nonlinear effects that have been characterized as: XPM and XGM.

1) Cross Gain Modulation

The Cross gain modulation is one of the wavelength conversions which employs high Gain saturation effect in active region of SOA. All Optical wavelength converter is a device which transforms the information from one wavelength to another without converting its domain. Here in XGM there is a variation of Gain at the input power. SOA is having a dynamic functionality i.e., its carrier density is very fast in the order of pico seconds, so variation of Gain is possible with bit to bit fluctuations in input power.

2) Cross Phase Modulation

The Cross Phase Modulation is one of the wavelength conversion technique which is used to overcome the problem of Extinction Ratio degradation which is present in Cross Gain Modulation. The Cross Phase Modulation mainly depends upon Refractive index of carrier density in active regions of SOA. The incoming signal depletes the Carrier density which modulates the Refractive index and it results the cross phase modulation of CW signal.

III. IMPLEMENTATION OF SOA-MZI BASED AND GATE

The operation of AND Gate is if both the input signals are "1", then the output is logic "1" otherwise the output is logic "0".

This has been demonstrated with the SOA-MZI at the 2 Gb/s using same PRBS data and other parameters like power and bias current [6].

A. Principle of Operation

The data sequences to be compared and give it to the SOAMZI. The input data signal enters the device at the port 1 and port 3. While at port 2 control signal must be ensured. We get the Output of AND Gate as logic "1" when both the data signals of the Optical pulses are "1".

B. Experimental Result

Fig. 2. Implementation of SOA-MZI AND Gate in Optisystem software The two input Data Signals are generated in implementing AND Gate. The SOA-MZI setup is used to perform the AND operation. We have generated the data sequences at same wavelength and same optical power. At 1545 nm wavelength the two data signals are generated using optical Gaussian pulse generator. At 1540 nm a continuous waveform is generated. The two data signals and control signals are given to the SOAMZI ports for performing AND operation. A Gaussian optical filter with 20 GHz bandwidth is used for filtering purpose.This filter is centered at 1540 nm wavelength so that we obtain only the desired signal. This resultant signal is the AND operation between the two data signals applied at port 1 and port 3 of SOA-MZI setup[7].

Error detection is the detection of errors caused by noise or other impairments during transmission from the transmitter to the receiver. Summer is another name for error detection Error correction is the detection of errors and reconstruction of the original, error-free data The general idea for achieving error detection and correction is to add some redundancy (i.e., some extra data) to a message, which receivers can use to check consistency of the delivered message, and to recover data determined to be corrupted. Error-detection and correction schemes can be either systematic or non-systematic: In a systematic scheme, the transmitter sends the original data, and attaches a fixed number of check bits (or parity data), which are derived from the data bits by some deterministic algorithm. If only error detection is required, a receiver can simply apply the same algorithm to the received data bits and compare its output with the received check bits; if the values do not match, an error has occurred at some point during the transmission. In a system that uses a non-systematic code, the original message is transformed into an encoded message that has at least as many bits as the original message.

Related works :

1) punctured difference set (PDS) codes have been used to deal with MCUs in memories.

2) Interleaving technique has been used to restrain MCUs , which rearrange cells in the physical arrangement to separate the bits in the same logical word into different physical words.

3) Built-in current sensors (BICS) are proposed to assist with single-error correction and double-error detection codes to provide protection against MCUs

4) 2-D matrix codes (MCs) are proposed to efficiently correct MCUs per word with a low decoding delay, in which one word is divided into multiple rows and multiple columns in logical. The bits per row are protected by Hamming code, while parity code is added in each column.

IV. PROPOSED SYSTEM

In this paper, novel decimal matrix code (DMC) based on divide-symbol is proposed to provide enhanced memory reliability as shown in Fig.1. The proposed DMC utilizes decimal algorithm (decimal integer addition and decimal integer subtraction) to detect errors. The advantage of using decimal algorithm is that the error detection capability is maximized so that the reliability of memory is enhanced. Besides, the encoder-reuse technique (ERT) is proposed to minimize the area overhead of extra circuits (encoder and decoder) without disturbing the whole encoding and decoding processes, because ERT uses DMC encoder itself to be part of the decoder.

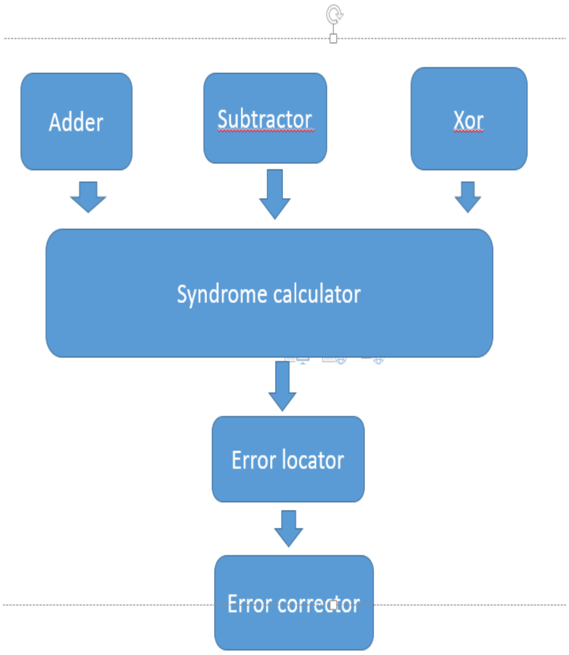

Fig.1. Proposed architecture

A. All-Optical Gates with SOA.

Again the gates are divided according to the interferometer techniques such as ultra-high nonlinear interferometer (UNI), sagnac interferometer (SI), Michelson interferometer (MI), Mach-Zehnder interferometer (MZI), and delay interferometer (DI) to implement the nonlinearity in SOA. In the following sections the nonlinearity of SOA may be used in several ways. Different design structures and categories of SOA-based all-optical gates have been investigated in this section. SOA is a small size nonlinear amplifier that offers advantages to be integrated to produce a subsequent system essential in optical communication system.The SOAs exhibit low power consumption and their single mode waveguide structures make them particularly appropriate for use with single mode fiber [3]. At present, SOA is the most developed optical amplifier that makes a rapid progress towards optical signal processing. The nonlinearity effect in SOA makes it a promising module for optical logic gates. The three nonlinearity effects that is cross gain modulation (XGM), cross phase modulation (XPM), and four wave mixing (FWM) make it possible to use it as nonlinear medium for gates.

In XGM data pulses at one wavelength, modulates the carrier density and at the same time results as a gain variation indentation in inverted copy of the clock pulse injected into the SOA Due to the modulation of a carrier density there is a gain compression in the pump signal that produces a chirping of the converted signal. The SOA is operated under the high optical intensity to reduce the gain recovery time. The problem related to XGM is at longer wavelength extinction ratio penalty associated with it. This phenomenon can be easily accommodated at high bit rate. The chirp of the converted signal is used as an advantage byincluding the SOA in an interferometer configuration that converts this XPM into an intensity modulation.

This can be done by SOA, incorporated with interferometer configuration. To obtain a complete extinction in an interferometer a phase shift of π is needed as in Figure 9(b), which can be achieved with gain compression in SOA.The phase shift is independent of wavelength, so the conversion to a longer wavelength has no problem with XPM. The disadvantage of an interferometer structure is that if the phase shift increases more than π, it impairs the extinction ratio which may be controlled by changing the bias condition of SOA. The interferometer configuration may be defined in two ways, co propagation and counter propagation

V.EXPERIMENTAL RESULTS

The proposed are simulated by using Xilinx ISE 12.1i and implemented in Virtex-5 FPGA processor. The experimental results are given in Table 1.

TABLE I.

S.NO	PARAMETER	USED
1	NUMBER OF SLICES	129
2	IOB'S	40
3	LUT'S	235

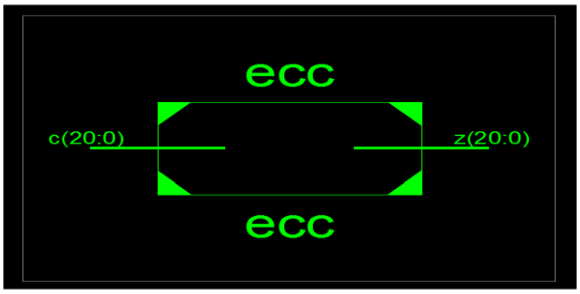

Fig. 2. Technology Schematic

A. Simulation Results

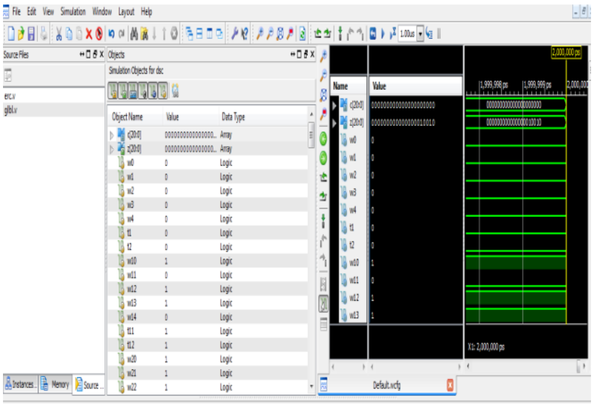

Fig. 3. Result Without Error

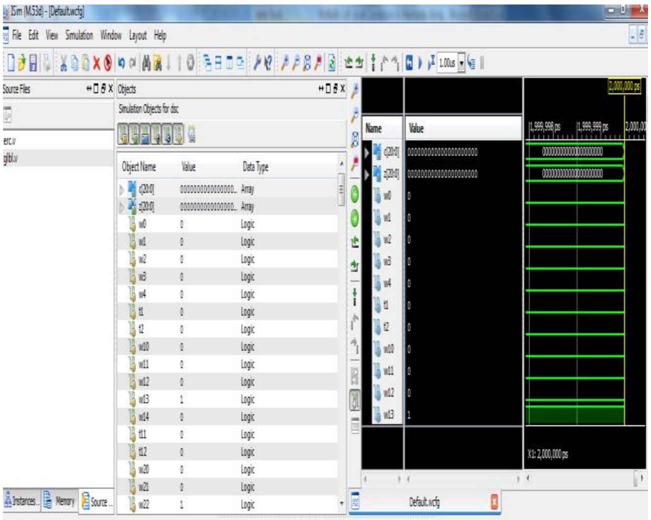

Fig. 4. Result With Error

Fig 3 and 4 shows the result of 21 bit decoder with more than and less than three errors The equation in which the errors are inserted is selected randomly. The bit positions on which the errors are inserted are then randomly selected These results indicate that the implementation of the proposed scheme is feasible at an acceptable cost and performance

VI. CONCLUSION

In this paper, we proposed a successive segmentation-based matrix coding scheme for broadcasting a binary source over a multi receiver erasure broadcast channel. Each receiver has individual distortion constraints and experiences distinct channel erasure rates. The proposed scheme partitions the source sequence into multiple segments and applies a systematic erasure code to each segment. We provided optimal choices for segment sizes and code rates for each segment, which were based on the users' channel erasure rates, and distortion constraints. Not only does this proposed scheme outperform Raptor and network coding, it also has two other practical advantages, namely simplicity and scalability

REFERENCES

[1] L. Tan, Y. Li, A. Khisti, and E. Soljanin, "Source broadcasting over erasure channels: Distortion bounds and code design," in Proc. IEEE Information Theory Workshop (ITW), Seville, Spain, Aug 2013.

[2] Y. Li, L. Tan, A. Khisti, and E. Soljanin, "Successive segmentationbased coding for broadcasting over erasure channels," in Proc. IEEE International Symposium on Information Theory, Honolulu, Hawaii, Jun2014.

[3] M. A. Shokrollahi and M. Luby, "Raptor codes," Foundations and Trendsin Communications and Information Theory, vol. 6, no. 3-4, 2009.

[4] V. Goyal, "Multiple description coding: compression meets the network,"Signal Processing Magazine, IEEE, vol. 18, no. 5, pp. 74–93, Sep 2001.

[5] Y. Wang, A. Reibman, and S. Lin, "Multiple description coding forvideo delivery," Proceedings of the IEEE, vol. 93, no. 1, pp. 57–70, Jan 2005.

[6] F. H. P. Fitzek, B. Can, R. Prasad, and M. Katz,"Overhead and quality measurements for multiple description coding for video services," in Wireless Personal Multimedia Communications (WPMC, 2004, pp. 524–528).