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A Hardware Implementation of Neuro-PMD Model classifier based FPGA

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Abstract. A classifier (polarization mode dispersion) has been introduced in this article. The suggested NeuroPMD classifier uses various types of fiber optics, and its deviation effect properties to handle light transmission using Polarization Mode Dispersion (PMD). The suggested classifier receives an unspecified signal with many percentage points, classifies it based on stored signals and shows the reliability of the received signal. The proposed system is built using VHDL, modeled by the Xilinx package (ISE 9.2i), the proposed NeuroPMD is implemented on the Spartan-3A XC3S700A kit. simulation and Implementation behavioral results demonstrate that the proposed model satisfies the specified operational requirements and gives solutions to overcome the scattering problems in the optical systems.

Keywords: artificial intelligent AI; PMD; classifier; VHDL; signal deviation

1. Introduction

The machine has recently been the main tool for simulating the performance of fiber optics such as numerical calculation for visual device planning[1,2]. This computer updates each new generation faster and thus improves the speed of operation necessary to model multiple tasks so that many programs can be introduced with a barely visible delay[2]. Because of this requirement, this allows the researcher to improve the system and at the same time see the outcome in the form of graphics with a single motion[3].

The designer must now reflect the method, which means that instead of using software engineering to simulate the design of the fiber optics network, the production of fiber optics can be used to implement a new generation of artificially smart computers with optical transmission rather than electrical transmission[4,5]. The purpose of this paper is to design a VHDL model for a neural network classified technology based on a network of artificial intelligence to link photosynthesis. This technique depends on the optical polarization.

2. Neuro Optics

One of the most important features in the development of electronic circuits is high-efficiency communication and less data transmission loss. The optical connection for the artificial communication circuit where optics (instead of electronic) transmission offers an advantage in the model in terms of understanding, strong connection and flexibility[5]. Optic's connection for the neural memory is a public method that takes the interest of Scientifics for many years [6]. It can be believed that the transmission of light in the fiber optics transmitter is more efficient than the transmitter that operates according to the electronic signal to transmit the signal along the track. The simplicity in the design and the high-efficiency connection is the major backbone for the employment of the optical connection in the intelligent circuit design.

The optical connection value for the artificial intelligent circuit which operates as the classifier is shown to be [7, 8]:



$$K_n = J_{pd} \frac{\sin(x)}{\cos(x)} \quad (1)$$

where:

K_n is the optical weight connection, J_{pd} is photocurrent, x can be calculated from equation (2).

$$x = K_1 \frac{V_n - V_{n+1}}{2} \quad (2)$$

K_1 is constant, V_n is the initial input voltage for generating the optical current (n).

The proposed Neuro-PMD classifier is designed to satisfy the high-speed transmission, output efficiency, fast implementation, and high performance.

3. Polarization analysis

The polarization mode dispersion is a new method to control the deviation of the optical signal to put the signals on the right target [8]. The major serious problem is the light scattering and the highest fading of the optical signals; make a question to find the answer to maintain this problem. Fig (1) shows the method to polarize the signal toward the wanted optical frequency (e.g. filter the wanted signal from the unwanted signal) [9].

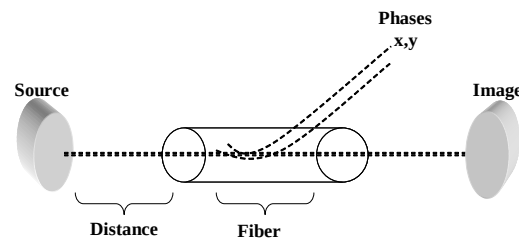


Figure 1. Proposed signal deviation block diagram

“Fig. 1” is in use to be under test in order to show the characteristics of the modeling of fiber coupling for more simulation software like MATLAB and Optics Software for Layout and Optimization (OSLO). The proposed VHDL model is implemented to give a finite parameter to such program analysis. The program must have many features, which are the type of the parameter source (laser and diode), the distance between source and fiber (it is a very important analysis for the signal transmission; it includes spacing and dispersion), and the type of fiber. The entire previous characteristic is required in optical design but the most important thing is the deviation of the optical signal in fiber, as illustrated in “Fig. 1”, so that the phase (x, y) is substantial in the connection for fiber coupling [10].

4. The proposed model

The proposed model has to classify the communication signals according to the circuit optical link instead of electronic connectivity. This classifier takes the required signals and stored it in the form of digital signals, and ranked them according to desired requirements. Therefore, it will recognize the unknown input signal based on the stored signal and display the type of unknown signal. “Fig. 2” shows the block diagram of the proposed model. In this figure, the model consists of input signals to insert the communication signals to model, artificial memory to store the signals, and the output signals to display the type of the recognized signals. All parts are connected through an optical fiber, which operates depending on polarization mode dispersion. The pin assignments of the model are illustrated in “Fig. 3”, it contains data pins to input the unknown signals to be recognized, write pin (wr) to enable input data to be entered to model, the display recognized signal pins (a0), and the matching pins (a1, a2, a3, and a4) to display the percentage of compatibility with the other of the stored signals.

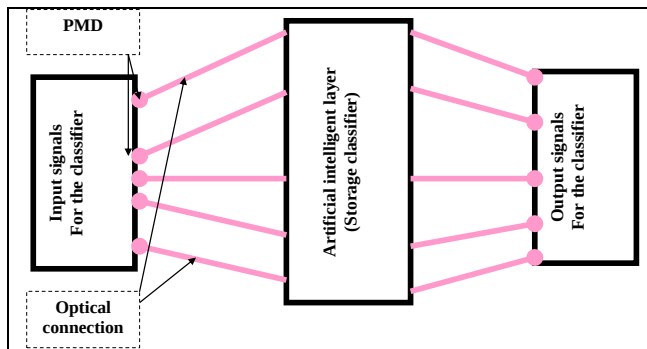


Figure 2. Block diagram of the proposed model.

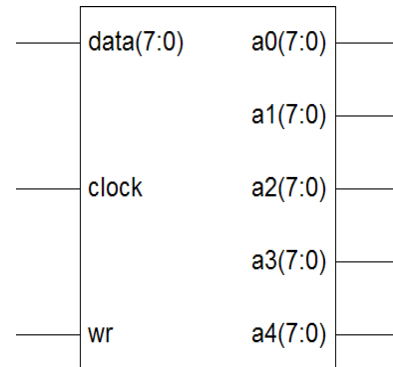


Figure 3. The pin assignments of the proposed model.

The proposed model has a major advantage over the traditional models in that it accepts multiple bits signal instead of one bit.

5. The VHDL model

The VHDL model of the proposed intelligent classifier is built using the Xilinx ISE 9.2i package and implemented using the Spartan-3A XC3S700A FPGA kit. This model consists of an entity declaration, processes, and sub-model. The entity declaration is used to declare the signals of the classifier. The process is assigned to store the designed signals, read the unknown communication signals, recognized the unknown signals, displayed the type of signals that match with the stored signals and showed the compatibility with the other stored signals. This model classified the unknown signals according to artificial intelligent optical weight. The sub-model is designed to receive the signal sequentially and prepares them for the classifier in the parallel form. “Fig. 4” shows the flowchart of the proposed classifier.

In this paper, four different signals have been selected and non-specific as shown in the “Table. 1”, where the signals are (x, x1, x2, and x3), all the signals are dissimilar. After building the program in a VHDL language, the signals have been introduced to the program so that the signals are stored. Subsequently, when the real operation of the light classifier is examined, the signal must be inserted sequentially at the beginning of the program. As is clear in “Fig. 5” the (a0) indicates that the signal input is identical with x signal after the implementation of the program and lists the compatibility with the other of the signals in (a1, a2, a3). The previous events are demonstrated in “Figs. 6-8” whenever the input signal is (x1, x2, and x3) are simulated via the program. When the unknown signal is inserted to the classifier, it has not been compatible with any of the stored signals as illustrated in “Fig. 9”. “Fig. 10” shows the implementation of the proposed classifier using the Spartan-3A XC3S700A FPGA kit.

TABLE I. THE FOUR DIFFERENT SIGNALS

Signal name	Optical weight							
X	1	11	4	3	6	13	8	5
	14	7	15	12	10	16	9	2
X1	13	10	12	9	3	1	6	14
	5	8	16	7	4	15	2	11
X2	12	5	1	9	14	2	8	15
	10	3	11	16	13	7	6	4
X3	16	10	1	14	4	2	8	9
	15	3	7	13	5	12	11	6

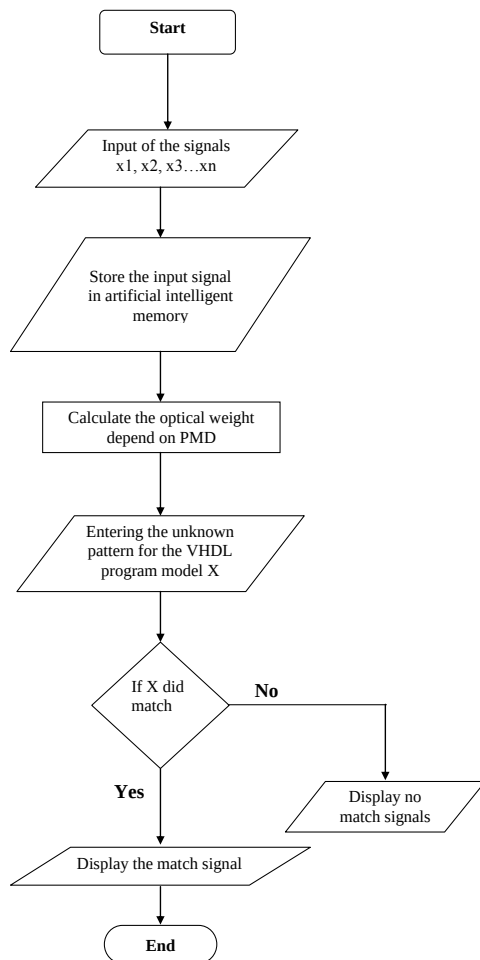


Figure 4. The flowchart of the proposed classifier

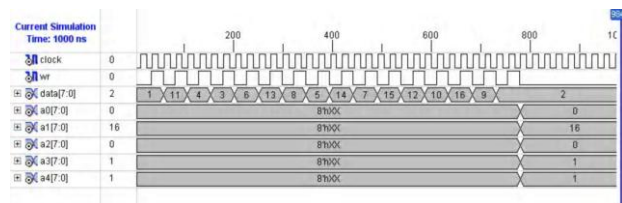


Figure 5. Classifier simulation results when a signal match with x.

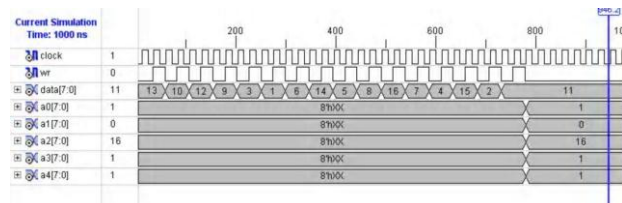


Figure 6. Classifier simulation results when a signal match with x1.

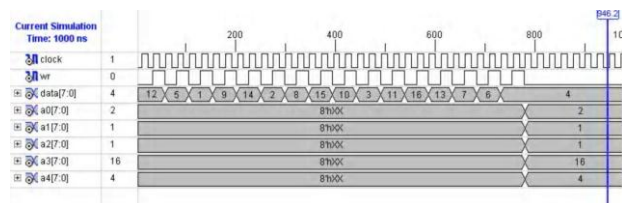


Figure 7. Classifier simulation results when a signal match with x2.

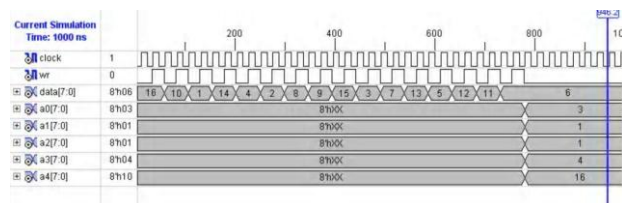


Figure 8. Classifier simulation results when a signal match with x3.

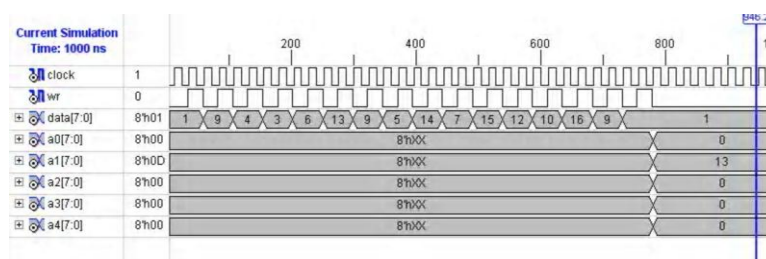


Figure 9. Classifier simulation results when the signal mismatch any signal.

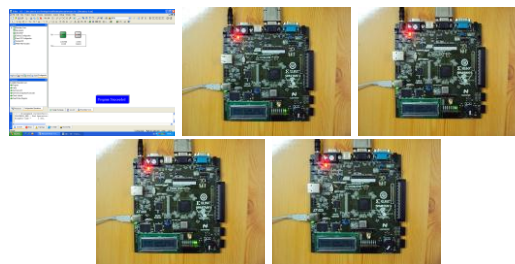


Figure 10. Implementation of the proposed classifier using the Spartan-3A XC3S700A FPGA kit.

6. Conclusions

Most of the traditional classifier receives the signals with one bit. These processes determine the type of signal within the classifier as well as make the classification process need more time to classify the signals. So it was necessary to design a classifier that works with multi-bit signals and high-speed classification. In this paper, a VHDL model of a proposed artificial intelligent optical classifier has been presented. The classifier receives multi-bit signals, classifies them according to optical weight storage, which depends on the polarization mode dissipation to transmit the signals, display the classified signal in high-speed, and lists the compatibility with the others signal. Furthermore, this model's high efficiency has a signal connection and fewer losses. This classifier operation is based on the PMD so the scattering of the optical signal is fading. The proposed model is very useful in encryption and smart storage for multiple signals.

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