Decision Threshold Control Method for the Optical Receiver of a WDM PON using PSO

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ABSTRACT:

An attempt is made to improve the performance of an optical receiver with beat noises by adjusting the threshold level [1] automatically according to the detected average power using MATLAB/SIMULINK model.Observations are made at different noise power levels,number of iterations,values of bit error rate,gain and error count within time elapsed in seconds.Optical communication systems have good speed,accuracy and efficiency but accuracy of high speed communication is unstable due to internal noise. This paper attempts to focus on eliminating one of the major internal noise known as Beat noise.The proposed method is useful for the optical receiver using WDM-PON.When compared to TDM-PON,WDM –PON provides point to point connectivity and pair of wavelengths for a single user. Thus a WDM-PON network is suitable for present and future generation networks.

General Terms:

Swarm optimization, genetic algorithm

Keywords:

wavelength division multiplexing passive optical networks(WDM PON) , Particle swarm optimization(PSO),Beat noise

1. INTRODUCTION

Beat noise is caused due to loosely coupled components.The possibilities of Beat noises in the optical receiver occurs also due to back reflections[5] caused by amplifiers and optical filters.optical communication network support good speed,high data rate and secure communication. In optically amplified transmission systems, the components act directly and provide signal photon multiplication by several order of magnitude than the incoming signal intensity.

1.1 Existing system:

In the existing system , the decision threshold level is adjusted automatically according to the detected average optical power.It consists of a conventional receiver ,a decision control part and a power monitoring part as shown in fig1.A power comparator circuit with reference power (VDC) will be compared with received power and the reference power is used to predict the threshold value to further reduce the received power.

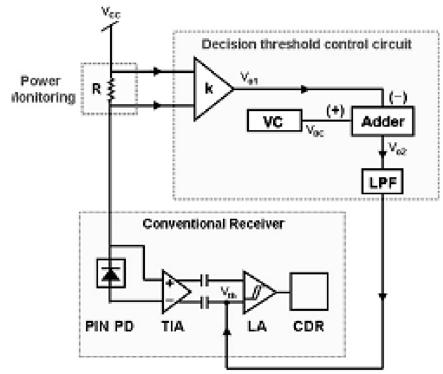

Fig 1 Configuration of the optical receiver with the automatic decision threshold control

1.2 Proposed system

In the proposed system the reference power is unknown and the decision is purely based on particle swarm optimization .PSO analyser is introduced in the decision threshold circuit as shown in the fig2.

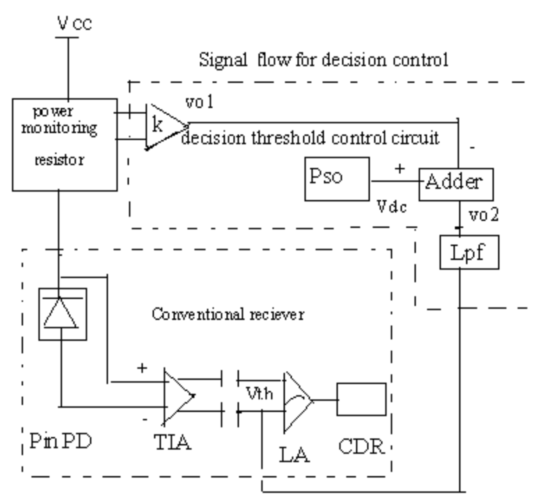

Fig 2 proposed block diagram

1.3. Particle Swarm optimization

Particle swarm optimization (PSO) [8],is a population based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995, inspired by social behavior of bird flocking or fish schooling. It is based on the notion that simple local interactions often lead to complex global behaviors. In a PSO algorithm, each member of the population (swarm) is called a *particle*. Each particle has a position and a velocity. The position of the particle represents a candidate solution to the problem being addressed. The velocity is used to move the particle from one position to another position. PSO algorithms start by initializing all the particles in the swarm. A fitness function is used to quantize the quality of the solution represented by each particle. The particle having the best fitness value in the swarm is marked as the global-best particle (*gbest)*.. The particle having best fitness value in each neighborhood is marked as the local-best particle (*lbest*). In a single iteration, for each particle, new velocity is computed based on the positions of the global-best (or local-best) particles.

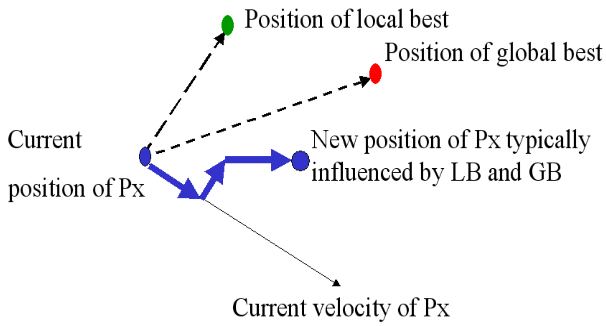

Fig3. Velocity computation and position updating of a particle P_x.

The magnitude of this move is a function of the current position of the particle and the distance between itself and the best particle in the neighborhood (local-best / global-best particle). Particles continue to move around the problem search space trying to better themselves in comparison with their own performance and that of their neighbors. This process continues until either the whole swarm converges or till the given number of iterations completes. In PSO, each particle keeps a record of the best position it has traversed over the problem space, so far. This position is called the personal-best position (*pbest*) of the particle. This way, the particle not only does its own search, it also learns from the search done by the particle having the best fitness value in the swarm (or sub-swarm). The classical PSO equations have the position and velocity represents physical attributes of the particles.

PSO shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA). The system is initialized with a population of random solutions and searches for optima by updating generations. However, unlike GA, PSO has no evolution operators such as cross over and mutation. In PSO, the potential solutions, called particles, fly through the problem space by following the current optimum particles.

Each particle keeps track of its coordinates in the problem space which are associated with the best solution (fitness) it has achieved so far. (The fitness value is also stored). This value is called *pbest*. Another "best" value that is tracked by the particle swarm optimizer is the Best value, obtained so far by any particle in the neighbors of the particle. This location is called *lbest*. When a particle takes all the population as its topological neighbors, the best value is a global best and is called *gbest*.

The particle swarm optimization concept consists of, at each time step, changing the velocity of (accelerating) each particle toward its *pbest* and *lbest* locations (local version of PSO). Acceleration is weighted by a random term, with separate random numbers being generated for acceleration toward *pbest* and *lbest* locations.

In past several years, PSO has been successfully applied in many research and applications areas. It is demonstrated that PSO gets better results in a faster, cheaper way compared with other methods. Another reason that PSO is attractive is that there are few parameters to adjust. One version, with slight variations, works well in a wide variety of applications. Particle swarm optimization has been used for approaches that can be used across a wide range of application, as well as for specific applications focused on a specific requirement. PSO has successfully been used to solve many industrial and engineering optimization problems in the diverse areas including biomedical, communication networks, prediction, neural network, graphics and visualization, signal processing, electronics, antenna design, modeling, fuzzy and neuro-fuzzy logic, prediction and forecasting, scheduling, robotics etc. Some of the advantages of using PSO algorithm are that it is an easy implementation of a problem search algorithm Possesses fewer algorithmic parameters to adjust than other evolutionary algorithms like genetic algorithms and robust in terms of controlling parameters is computationally efficient.

2. EXPERIMENTAL SETUP

The unknown receiver power is predicted for the minimum bit error rate value. The accuracy of the threshold increases by increasing the iteration level ,for each iteration our circuit generates a random new threshold model and filter the received optical signal with the predicted threshold at first iteration, the calculated bit error rate is stored.The generation of optical signal using simulink,Improper coupling results in back reflections , the beat noise increase the actual power of the generated signal.The voltage control circuit of the exixting system is replaced using a paticle swarm optimizer.

3. ITERATION VS ERROR COUNT

Error count is the number of symbols mismatched with the actual pattern, increasing the iteration (time taken for predicting the threshold level) will reduce the magnitude of error count. Various readings are tabulated between error count Vs iteration by keeping the noise power constant.

By this graph as shown in fig 4, we can grasp the relation between the error count and the time (iteration), thus by analyzing this graph we can recommend an optimum iteration cycle for various noise power in real time optical communication system

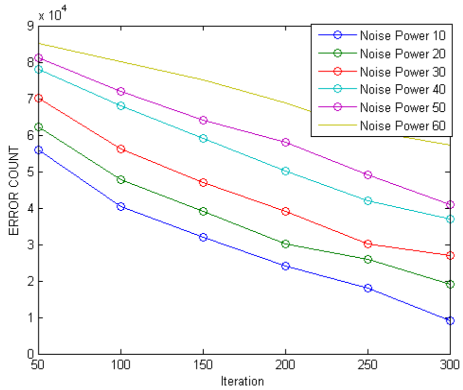

Fig 4 bit error rate characteristics

4. EXPERIMENTAL RESULTS

Noise power is kept constant, as the number of iteration is increased, the bit error rate is reduced. The following graph denotes the optical back reflections and predicts results for various iteration levels. The observations are tabulated in table 1.The process can be repeated for different values of noise power for several number of iterations.

Table 1 comparison between several iterations and noise power levels

No of iterations	Noise power in percentage	Bit error rate	Time elapsed in seconds
50	10	0.101	5.6
100	10	0.051	7.8
150	10	0.034	12.2
200	10	0.024	14.6
250	10	0.024	16.1
300	10	0.017	19.4

ITERATION=50 NOISE POWER=10%

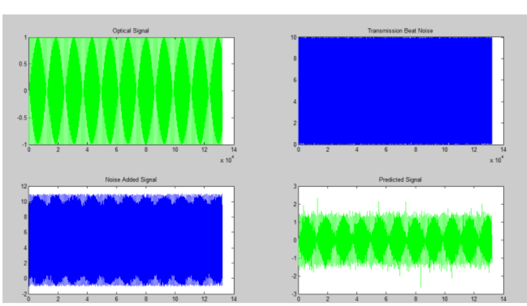

fig 5 noise power for 50 iterations

ITERATION =250 NOISE POWER=10%

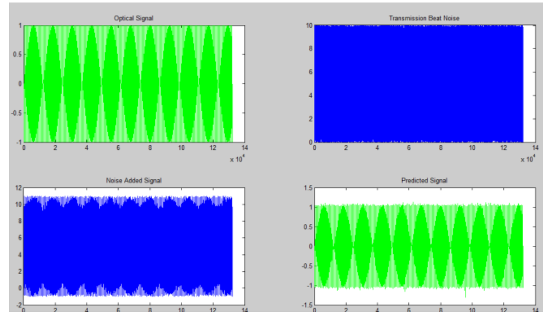

fig 6 noise power for 250 iterations

From the above results, we conclude that for maximum number of iterations the bit error rate is reduced to a minimum value.

5. ACKNOWLEDGMENT

I would like to thank Mr. Maheshwaravenkatesh ,assistant professor,anna university , Anna University of Technology, Trichy, For his guidance and support for the successful completion of the paper.

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