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New Approach of Performance and Security Enhancement in Optical Networks

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Abstract: A new technique is proposed for the enhancement of security levels against the eavesdropper in Optical code division multiple access (OCDMA) Spectral amplitude coding (SAC) System. This technique is the combination of real and virtual user's spectral chip, according to the newly developed Zero cross correlation code. The data bit sequence allocates to virtual user is kept in defined pattern and sequence, is complement to each other in a group of two users. Probability of code detection of individual user decreases due to virtual user and complement defined sequence of virtual user removes the occurrence probability of presence of single user's code in the channel. The simulation and analytical result show that the proposed scheme has a better performance than existing methods.

Key words: Zero Cross correlation (ZCC) · Multiple Access Interference (MAI) · Modified Double Weight Code (MDW)

INTRODUCTION

The main aim of ocdma system is to extract the information of a user in the presence of another user without affecting the security of system because other users interferes the desired user that is called the MAI (multiple access interference) [1]. That depends upon the cross-correlation between the users. It may be one or zero. In case of zero cross co-relation the MAI reduced [2,3]. Many methods exist with unity and zero cross correlation such RD Code, MQC and MD Code. At the decoder side in the MD method direct detection technique is applied for detecting the information [4-6]. In this case every pulse represents the information of bits. If an eavesdropper detects any pulse so it is easy for eavesdropper gets the information and this can be avoided by reducing the amount of power of individual chip by increasing the number of weights of a user but this method requires the wider spectral width. So a technique is described to eliminate these issues as explain in following section. Section II constructs the proposed method, section III Analyze the performance of the system with analytically and by simulation software. Result analysis is done in section IV and paper ends with the conclusion.

Proposed Method: The technique is shown in Figure 1 In this method the real users of N_r number, W_r weight and virtual user of N_v numbers, W_v weight are transmitted the modulated spectral chip simultaneously as specified coding method as given below.

The Virtual users of N_v placed between the real user with N_v weight. A defined sequence is provided to each virtual user and the sequence is complements to each other in a group of two users. The length of code is given as:

Length of code $L = N_rW_r + N_vW_v$
Coding method is as follows

Step 1: The basic code is generated and assign to a first user. The basic code is formed by placing the zeros between the equal weight. The number of zeros is equal to the sum of virtual users and the real users. The position of basic code in code is given by:

$$P_B = N_V \times \frac{W_V}{2} + 1$$

Step 2: The basic code is arranged for first virtual user is located from in initial position at $(W_v - 1)N_v$ and code for remaining virtual user shifted left with $\frac{W_V}{2}$ positions.

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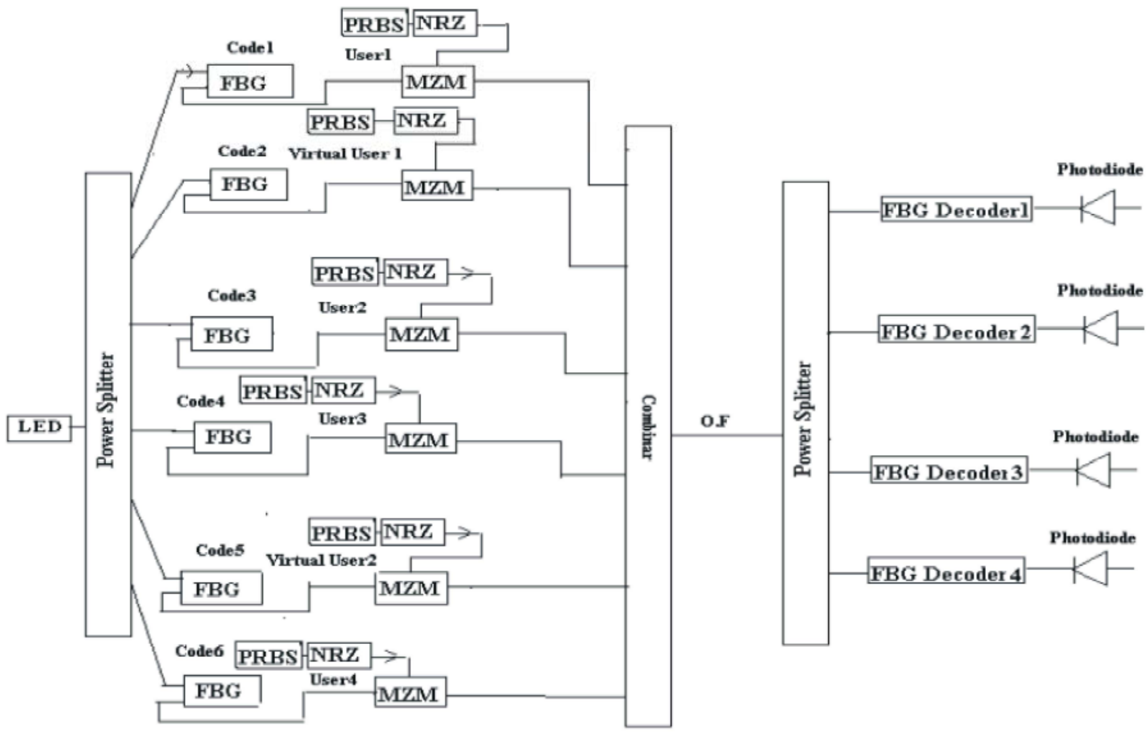

Fig. 1: Encoder and decoder design of proposed technique

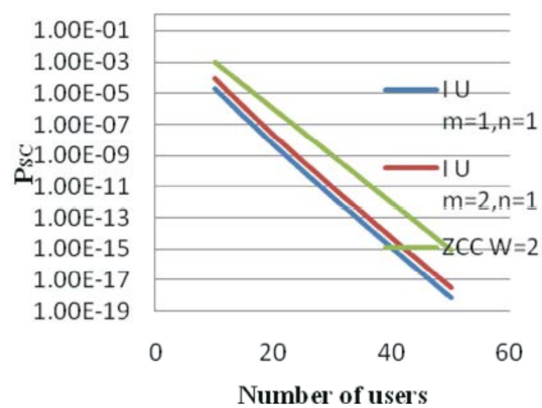

Fig. 2: Probability of code estimation in single chip detection

Table 1: Coding structure for proposed technique

		λ_1	λ_2	λ_3	λ_4	λ_5	λ_6	λ_7	λ_8	λ_9	λ_{10}	λ_{11}	λ_{12}	λ_{13}	λ_{14}	λ_{15}	λ_{16}	λ_{17}	λ_{18}	λ_{19}	λ_{20}
Random	N_{r1}	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
10101010	N_{v1}	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Random	N_{r2}	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
Random	N_{r3}	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
01010101	N_{v2}	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Random	N_{r4}	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Random	N_{r5}	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
10101010	N_{v3}	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Random	N_{r6}	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
010101010	N_{v4}	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

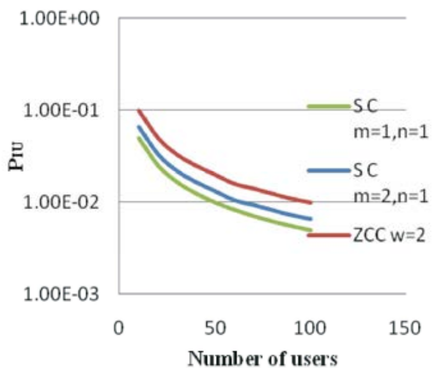

Fig. 3: Probability of code detection in presences of single user in network

Step 3: The basic code is arranged for second real user in such position the half weight is located at $W_vN_v + W_r$ and code for remaining real user shifted Weight with $\frac{W_r}{2}$ positions.

N_v = Number of virtual users
N_r = Number of real users
W_v = Weight assigns to virtual users
W_r = Weight is assigned to real users

For $N_r = 6$ $W_r = 2$ $N_v = 4$ $W_v = 2$ code formation shown in Table 1.

$W_r = mW_v$
$N_r = nN_v$

Mathematical Analysis: For analysis of this system we use the Gaussian approximation in our calculation (3,4). This system is based on the zero cross co –relation so, then we only consider the thermal noise (Rth) and shot noise (Rsn) in respect to PIIN. The SNR for electrical signal is the average signal power to noise power, SNR = [I/ R]

Let $C_K(i)$ denotes the ith element of K user in this code ZCC than

The following assumptions are made

- Each light source spectrum is flat over the bandwidth $[V_o-\Delta V/2, V_o- \Delta V/2]$ where V_o is central frequency and ΔV is the optical source bandwidth in Hertz.
- Each power spectral component has an identical spectral width.
- Each user has nearly equal power at the transmitter.
- Each user bit stream is synchronized.

The power spectral density (PSD) of the received signals can be given as:

$$r(v) = \frac{P_{sr}}{\Delta v}\sum_{k-1}^{k} d_k \sum_{i-1}^{N} c_k(i)\, rect(i)$$

$$rect(i) = u\left[v - v_0 - \frac{\Delta v}{2L}(-L+2i-2)\right] - u\left[v - v_0 - \frac{\Delta v}{2L(-L+2i)}\right] = u\left[\frac{\Delta v}{L}\right]$$

re $u(v)$ is the unit step function expressed as:

$$u(v) = \begin{cases} 1, v \geq 0 \\ 0, v < 0 \end{cases}$$

$$\int_0^\infty G(v)dv = \int_0^\infty \left[\frac{P_{sr}}{\Delta v}\sum_{k-1}^{k} d_k \sum^{k} C_k(i) C_I(i)\, rect(i)\right] dv$$

$$\int_0^\infty G(v)dv = \frac{P_{sr}}{\Delta v}\left[\sum_{k-1}^{k} d_k . W . \frac{\Delta v}{L} + \sum_{k \neq 1}^{k} d_k . 0 . \frac{\Delta v}{N_r}\right]$$

The value of $\Sigma^k_{k-1} d_k$ is equal to the 1 and for above than

$$\int_0^\infty G_{dd}(v)dv = (P_{sr} w_r)/L$$

The photo current I can be expressed as:

$$I = I_{dd} = \Re \int_0^\infty G_{dd}(v)dv$$

The variation of photocurrent due to detection of an ideally un polarized thermal light. can be expressed as:

$$I = \Re\left[\frac{P_{sr}[w_r w_r]}{L}\right]$$

$$< I^2 > = 2eB(I_{dd}) + \frac{4K_bT_nB}{R_L} = 2eB\Re\left[\int_0^\infty G_{dd}(v)dv\right] + \frac{4K_bT_nB}{R_L}$$

when all user transmitting 1 than probability of each user sending 1 is ½ than equation …become:

$$< I^2 > = \frac{P_{sr}eB\Re}{L}[(w_r w_r] + \frac{4K_bT_nB}{R_L}$$

The signal to noise ratio of direct detection technique is given by following equation:

$$SNR = \frac{< I_{dd} >^2}{< I^2 >}$$

When putting all equation than new formula for SNR will be:

$$SNR = \frac{\frac{\Re^2 P_{sr}^{\ 2}(w_r)^2}{L^2}}{\frac{P_{sr}eB\Re}{L}((w_r + w_v)) + \frac{4K_bT_nB}{R_L}} = \frac{\frac{(\Re^2 P_{sr}^{\ 2})}{N_r}\left(\frac{mn}{nm+1}\right)^2}{\left(\frac{P_{sr}eB\Re}{N_r}\right)\frac{mn}{(1+nm)} + \frac{4K_bT_nB}{R_L}}$$

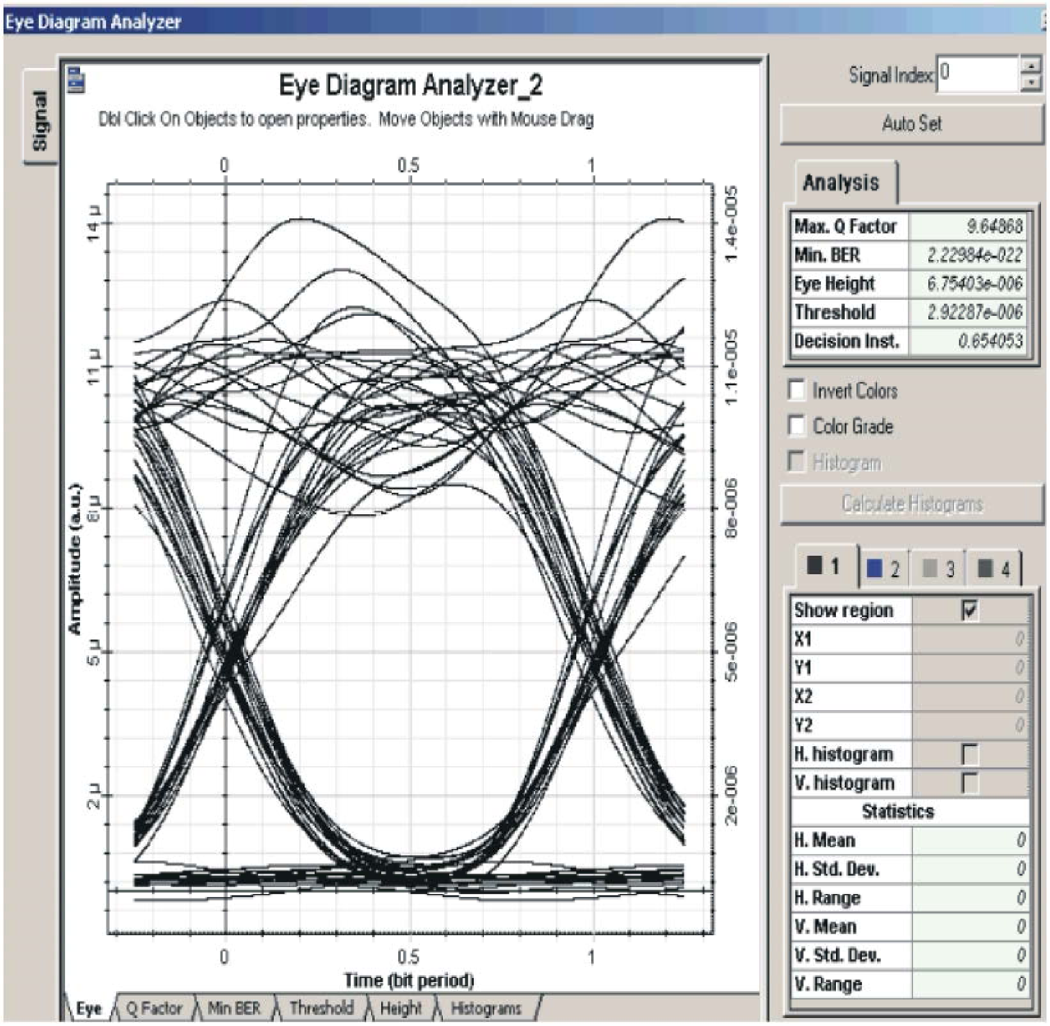

Fig. 4: Eye pattern for 4 real and 2 virtual users at 40 for622Mbits/s

Thus BER is $BER = \frac{1}{2} erfc \sqrt{\frac{SNR}{8}}$

Typical parameters used in the calculation as below:
Photo detector quantum efficiency (g) 0.6
Line-width broadband source (DV) 3.75 THz
Operating wavelength (ko) 1552 nm
Electrical bandwidth (B) 311 MHz
Data bit rate (Rb) 622 Mbps
Receiver noise temperature (Tn) 300 K
Receiver load resistor (RL) 1030 Ω
Simulation Analysis

(i) n>>1 then or m >>1 then

$$SNR = \frac{\frac{\left(\Re^2 P_{sr}{}^2\right)}{N_r{}^2}}{\left(\frac{P_{sr} eB\Re}{N_r}\right) + \frac{4K_b T_n B}{R_L}}$$

Security Level Analysis:

- Security against the presence of single user in network.

Probability of presence of single real user in network $= 1/2^{Nr}$

At a time probability of code detection of single user in group of virtual user $= \left(\left(\frac{N_v}{2} \right) w_v \right)_{C_{(W_r)}}$

Then total probability of code detection in group of virtual users $P_{IU} = \frac{1}{2^{N_r}} \left(\left(\left(\frac{N_v}{2} \right) w_v \right)_{C_{(W_r)}} \right)$

- Probability of information estimation by single weight (Direct detection) $P_{SC} = \frac{W_r}{W_r N_r + W_v N_v} = \frac{mn}{N_r (mn+1)}$

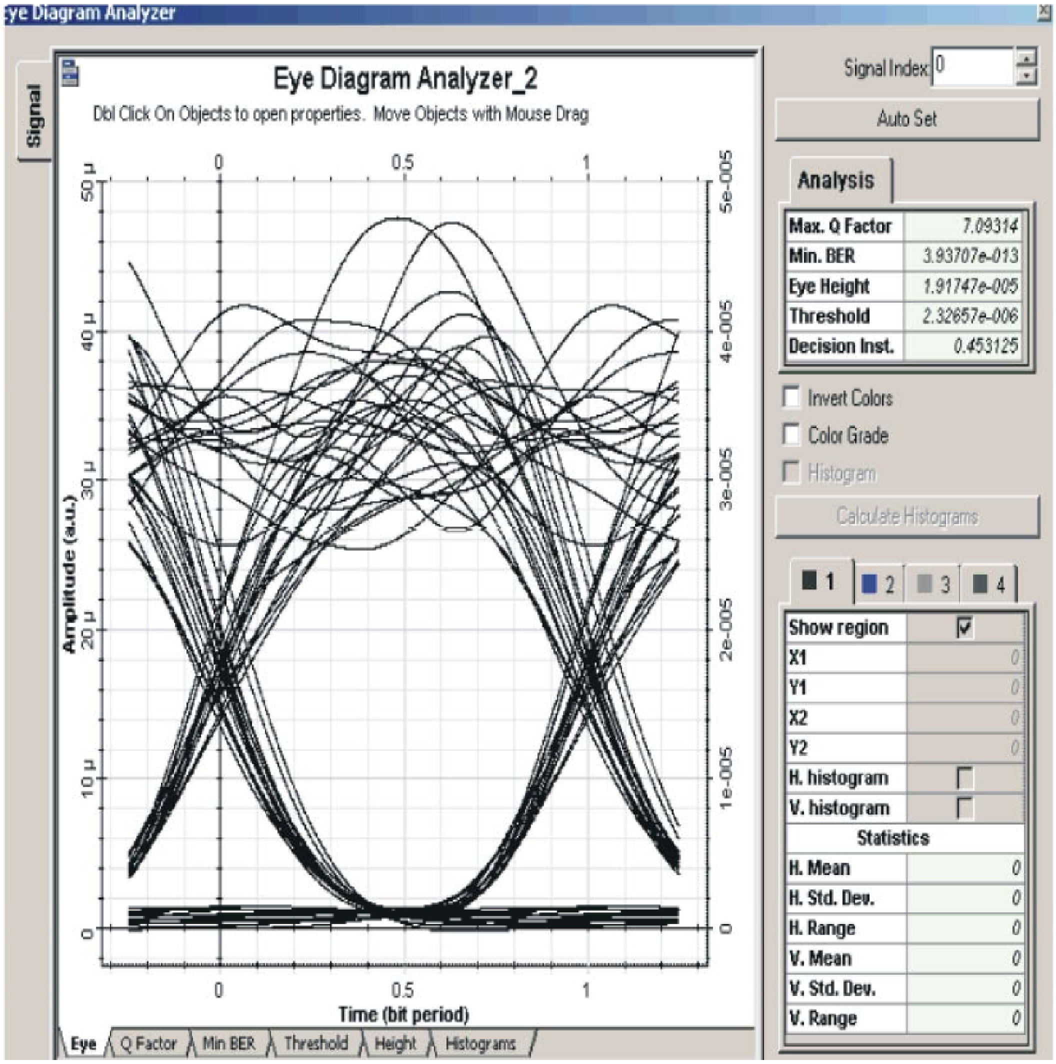

Fig. 5: Eye pattern for 4 real and 2 virtual users at 20 for 1.25Gbits/s

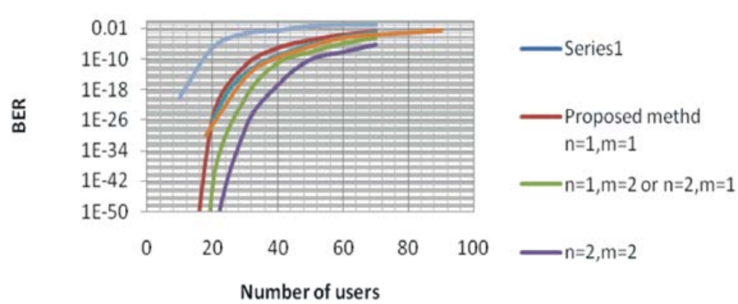

Fig. 6: A graph between the BER and number of users in network

The block diagram of proposed scheme shown in Figure 1 the simulation is done for 4 real user and 2 virtual with a weight of 2. The width of each spectral chip kept 0.6 nm. The simulation is done in a practical environment in all, with all nonlinear effect is kept on. Simulation is performed for the 622Mbit/s for 40 km length of fiber and 1.25 Gbit/s for 20 km length of fiber with ITU standard single mode fiber (SMF). All the attenuation (α= 0.25dB/km), Dispersion (18ps/nm) is maintained. Decoder side after decoding the signal, the signal covert to electrical by passing to the photo detector and 0.75 GHz low pass Bessel filter (LPF) The dark current value was 5 nA and the thermal noise coefficient was $1.8x10^{-23}$ W/Hz for each of the photo-detectors. The performance of the system was characterized by referring to the BER and eye pattern as shown in Figure 4 and Figure 5. As in Figure 6 BER of the proposed Scheme shown the best performance as the number user is increasing.

Probability of information retrieving by the single chip (direction detection) by the eavesdropper is compared with ZCC code as shown in Figure 2 and probability of code estimation in while single user present in a network is given in Figure 3 shows the lesser probability than the present schemes. As the values of m and n increases than performance decreases but probability of code detection decreases more effectively [7-10].

CONCLUSION

In this paper new technique is proposed for enhancing the security level against the eavesdropper with use of virtual user with real user according to the proposed coding method. The performance of this technique is evaluated analytically and with the simulation of the design. The result shows that the performance is better than the conventional method for large number of users. This technique degrades the code detection probability when single user presents in the network and also decreases the direct detection probability

REFERENCES

1. Aljunid, S.A., M. Ismail, A.R. Ramli, B.M. Ali and M.K. Abdullah, 2004. A new family of optical code sequence for spectral amplitude coding optical CDMA systems. IEEE Photon. Technol. Lett., 16(10).
2. Salehi, J.A., 1989. Code division multiple-access techniques in optical fiber networks. Part 1: fundamental principles. IEEE Trans. Commun., 37(8).
3. Huang, Jen-Fa and Chao-Chin Yang, 2002. Reductions of multiple-access interference in fiber-grating-based optical CDMA network. IEEE Trans. Commun., 50(10): 1680-1687.
4. Wei, Z. and H. Ghafouri-Shiraz, 2002. Codes for spectral-amplitude-coding optical CDMA systems. J. Ligtwave Technol., 50: 1209-1212.
5. Fadhil, H.A., S.A. Aljunid and R. Badlisha, 2007. Random diagonal code for spectral amplitude-coding optical CDMA system. Int. J. Computer Science and Network Security, 7: 258-262.
6. Wei, X., H.M.H. shalaby and H. Ghafouri-Shiraz, 2001. Modified quadratic congruence codes for fiber-Bragg grating-based spectral amplitude-coding optical CDMA systems. J. Lightwave Technol., 9: 1274-1281.
7. Wei, Z. and H. Ghafouri-Shiraz, 2002. Unipolar codes with ideal in-phase cross-correlation for spectral-amplitude-coding optical CDMA systems, IEEE Trans. Commun., 50: 1209-1212.
8. Anuar, M.S., S.A. Aljunid, N.M. Saad and S.M. Hamzah, 2009. New design of spectral amplitude coding in OCDMA with zero cross correlation. Opt. Commun., 282: 2659-2664.
9. Anuar, M.S., S.A. Aljunid and N.M. Saad, 2005. A. Mohammed and E.I. Babekir, 2006. Development of a zero cross-correlation code for Spectral-Amplitude Coding Optical Code Division Multiple Access (OCDMA). Int. J. Comput. Sci. Network Secur., 6(12).
10. Shake, T., Security performance of optical CDMA against eavesdropping, J. Lightwave Technol., 23(2): 655-670.