International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-3 Issue-2, December 2013

Performance Analysis of Variable Weight multiple length QC-CHPC for On-Off keying optical CDMA

S.Premalatha, R. Vinodha

Abstract- The concept of a multiwavelength Quadratic Congruence Carrier Hopping prime code (QCCHPC) was recently introduced in order to support a large number of simultaneous users in optical code division multiple access (OCDMA). To support multimedia services with different bit rate requirements multiple length and variable weight QCCHPC is constructed and the performance is analyzed. In QCCHPC with zero autocorrelation side lobes, cross correlation values of at most two. Our analysis shows that code weight is important factor than code length in determining the code performance.

Index terms- Optical code division multiple access (OCDMA), Variable weight, Variable length, Wavelength-time code.

I. INTRODUCTION

In the recent years, Optical code division multiple access (OCDMA) is getting more attention owing to the utilization of the enormous fiber bandwidth. In the two dimensional (2D) QCCHPC system the signal is spread in both wavelength and time. The code is in 2D array, in which the rows represent the wavelength and columns represent the time spreed.The cardinality of the system is greatly increased.

Optical code division multiple access technique has recently received attention because of the advancement of the Wavelength hopping time spreading coding techniques [1]-[3].It is known that coherent O-CDMA has better performance than incoherent O-CDMA. We algebraically constructed and analyzed families of multiple lengths, Variable weight wavelength hopping time spreading codes. They always have zero auto-correlation side lobes and maximum cross-correlation of two, independent of code length.

On-off keying (OOK) is traditionally used of which each user was assigned distinct code matrix and only data bit ones was transmitted with a code matrix. One should use OOK for hardware simplicity and significant improvement in minimum SNR by reducing the signal bandwidth.

II. RELATED WORKS

Nasarugin et al [9]proposed multiweight optical orthogonal code for secure multimedia optical CDMA networks This method is got good bit error rate but the Number of active users is only fifty. Hen-Yuan et al[8] proposed Spectral Efficiency Study of QCCHPCs in Multirate Optical CDMA System. This code shows that the performance of Multiple length QCCHPC in OOK and Multi code Keying.

Manuscript published on 30 December 2013.
***** Correspondence Author (s)
Ms. S. Premalatha*, Department of Electronics and Communication Engineering, ULTRA College of Engineering and Technology for Women, Madurai, Tamil Nadu, India.
Ms. R. Vinodha, Department of Electronics and Communication Engineering, ULTRA College of Engineering and Technology for Women, Madurai, Tamil Nadu, India.

These multiple length codes improves as the code length decreases.Cheng-Yuan et al[10] proposed code is QCCHPC for multicode keying optical CDMA.In this paper compare the performance of CHPC and QCCHPC. From this above analysis of existing method a new method Variable weight Multilength QCCHPC is introduced. The performance mainly dependent on the code weight our analysis shows that multiple length variable weight and to increase the weight and get good performance.

The section III describes the construction and the correlation property. Section IV discus about the result obtained. Section V gives the conclusion of this work.

III. CODE CONSTRUCTION OF MULTIPLE LENGTH VARIABLE WEIGHT QC-CHPC

The generated multiple length variable weight QC-CHPC characterized by (N,W,A,B,D) where N,W are the code length and code weight for N= $\{n_1, n_2, \ldots\ldots\ldots n_i, \ldots..n_k,\}$ a set of code weight $W=\{w_1,w_2\}$,a set of autocorrelation constraints $A=\{\lambda^1{}_a,\lambda^2{}_{a\ldots.},\lambda^i{}_{a\ldots..}, \lambda^k{}_a\}$ a set of cross correlation constraints $B =\{\lambda^1{}_c,\lambda^2{}_{c\ldots.},\lambda^i{}_{c\ldots..},\lambda^k{}_c, \lambda\}$ and a set of matrix-length distributions $D=\{d_1,d_2,\ldots d_i,\ldots d_k\}$, where K is the number of different matrix lengths in C.

A Autocorrelation

For any matrix X Є C and prime integer ζ Є [1,N-1], the binary discrete two dimensional autocorrelation side lobe of X is no greater than a non negative integer λa, such that [1]

$$\sum_{s=0}^{L-1}\sum_{j=0}^{w-1} x_{s,j}x_{s,j\oplus\zeta} \le \lambda_a$$

Where $X_{s,j}=\{0,1\}$ in an element of X at the s^{th} row and j^{th} column, and '$\oplus$' denotes the modulo-N addition.

B Cross-correlation

For any two distinct matrices X Є C and Y Є C and integer ζ Є [0,N-1], the binary discrete two-dimensional cross-correlation function of X and Y in no greater than a positive integer λc,such that[1]

$$\sum_{s=0}^{L-1}\sum_{j=0}^{w-1} x_{s,j}y_{s,j\oplus\zeta} \le \lambda_c$$

Where $Y_{s,j}=\{0,1\}$ is an element of Y at the s^{th} row and j^{th} column.

C Cardinality

The upper bound of the cardinality of the Mutilength carrier hopping prime code [1]

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

$$\varphi \le \frac{P_l \prod_{j=1}^{1} P_{j-1}}{\sum_{i=1}^{l} q_i \left(\prod_{j=i+1} P_j P_{i-1} - 1\right)}$$

Whose P_j is the prime number and q_j is the ratio of the number of matrices of length N_j, to the total number of matrices in the code set j= {1, 2,,,,l}

D Construction Algorithm

The multiple length variable weight QC-CHPCs are generated in this section. Each code matrix in the multiple length CHPCs is an $n_\lambda \times n_i$ two-dimensional (0, 1) pattern of weight w. In n_j rows related to the number of available wavelengths and n_i columns related to the number of time slots. A set of prime numbers $\{p_1,p_2,\ldots,p_k\}$ is used to determine the matrix lengths and a set of positive integers $\{t_1, t_2,\ldots, t_{k-1}\}$ is used to control the number of matrices in each length, such that $p_k \ge p_{k-1} \ge p_{k-2} \ge \ldots p_2 \ge p_1 \ge t_1 > t_2 \ge \ldots \ge t_{k-1} \ge 0$, where k is the number of different lengths in the code set. As shown in the following equations, we expand the code cardinality by modifying every element of the multiple length CHPC matrices with a quadratic-congruence (QC) operator, such as h (h+1)/2.g (mod p_1), where $g \in GF_{(P1)}$ represents the group number of the multiple-length QC-CHPC matrices and $h \in GF_{(P1)}$. In single length the code matrices, $X_{i_1,g}$, of length $n_1=p_1$ with the ordered pairs [8]

$$\{[(0,0),(1,(1\otimes_{p1} g)\oplus_{p1}(1\otimes_{p1} i_1)),(2,(3\otimes_{p1} g)\oplus_{p_1}(2\otimes_{p1} i_1)),\ldots\ldots\ldots\ldots, \quad (1)$$
$$((p_{1-}1),(((p_1-1)p_1/2)\otimes_{p_1} g)\oplus_{P1}((p_1-1)\otimes_{p1} i_1))]:$$
$$i_1=\{0,1,\ldots p_1-1\}, g=\{t_1,t_1+1,\ldots., p_1-1\}\}$$

In double length the Code matrices, $X_{i_1,i_2,g}$, of length $n_2=p_2p_1$ with the ordered pairs[8]

$$\{[(0,0)\ ,(1,((1\otimes_{p1} g)\oplus_{p1}(1\otimes_{p1} i_1))+(1\otimes_{p2} i_2)p_1),(2,(3\otimes_{p1} g)\oplus_{p_1}(2\otimes_{p1} i_1))+(2\otimes p_2 i_2)p_1)$$
$$,\ldots\ldots,((p_1-1),(((p_1-1)p_1/2)\otimes p_1 g)\oplus_{P1}((p_1-1)\otimes_{p1} i_1))+((p_1-1)\otimes p_2 i_2)p_1)]:$$
$$i_1=\{0,1,\ldots p_1-1\}, i_2=\{0,1,\ldots\ldots, p_2-1\}, g=\{t_2,t_2+1,\ldots., t_1-1\}\} \quad (2)$$

In multilength the code matrices, $X_{i_1,i_2,\ldots.,i_k,g}$, of length $n_k=p_kp_{k-1}\ldots p_1$, W={w_1,w_2} with the ordered pairs

$$\{[(0,0),(1,(1\otimes_{p1} g)\oplus_{p1}(1\otimes_{p1} i_1))+(1\otimes_{p2} i_2)p_1+\ldots+(1\otimes_{pk} i_k,)p_1p_2\ldots p_k-1),\ (2,((3\oplus_{p_1} g)\otimes p_1(2\otimes p_1 i_1)) \quad (3)$$
$$+(2\otimes_{p_1} i_2)p_1+\ldots.+(2\otimes_{pk} i_k)p_1p_2\ldots p_{k-1}),\ldots,((p_1-1),((((p_1-1)p_1/2)\otimes p_1 g)\otimes p_1((p_1-1)\otimes p_1 i_1))$$
$$+(p_1-1)\otimes p_2 i_2)p_1+\ldots+((p_1-1)\otimes p_k i_k).p_1p_2\ldots p_k-1)]: i_1=\{0,1,\ldots, p_1-1\}, i_2=\{0,1,\ldots, p_2-1\},\ldots.,$$
$$i_k=\{0,1,\ldots, p_k-1\}, g=\{0,1,\ldots.,t_{k-1}-1\}\}$$

In the multiple-length QC-CHPCs of weight p_1 with $\Phi_1=(p_1-t_1)n_1$ matrices of length $n_1=p_1$, $\Phi_2=(t_1-t_2)n_2$ matrices of length $n_2=p_2p_1$, $\Phi_3=(t_2-t_3)n_3$ matrices of length $n_3=p_3p_2p_1$,….. $\Phi_{k-1}=(t_{k-2}-t_{k-1})n_{k-1}$ matrices of length $n_k=p_kp_{k-1}\ldots p_1$, and $\Phi_k=t_{k-1}n_k$ matrices of length $n_k=p_kp_{k-1}\ldots p_1$, where"Φ_{p1}" denotes a modulo-p_1 addition and "$\otimes_{pi}$" denotes a modulo-p_i multiplication for i={1,2…,k}. The matrices can be separated into p_1 groups, according to the value of $g \in [0, p_1-1]$.

IV. PERFORMACE ANALYSIS

In General, the code performance in OOK wavelength time O-CDMA is determined by the cross-correlation function, which is related to code weight, code length, and the number of available wavelength [7]. Therefore, our multiple-length double weight QC-CHPC for ON-OFF keying are specially designed in section IV-A. .

A . Multiple-length QC-CHPCs in OOK O-CDMA

In OOK O-CDMA with our multilength QC-CHPCs the probabilities, $q_{i,\ j,\ h}$ of obtaining h= {0, 1, 2} hits for an address matrix of length n_i correlating with an arriving matrix of length n_j are given by [6]

(4) $$q_{i,j,0} = 1 - q_{i,j,1} - q_{i,j,2}$$

(5) $$q_{i,j,1} = \frac{w}{2n_j} - 2q_{i,j.2}$$

(6) $$q_{i,j,2} = \frac{1}{2} \cdot \frac{\binom{p_1}{2} - (p_1-w)w - \binom{p_1-w}{2}}{n_j} . F_{i,j} \cdot \frac{1}{n_j}$$

Where w is the code weight, the factor1/2 is due to equiprobable data bit zeros that are not transmitted in OOK, and $\binom{x}{y} = 0$ if $x<y$. For the numerators, $\binom{p_1}{2}$ represents the number of possible delay combinations among p_1 binary ones (i.e., pulses) in a code matrix, $(p_1-w)w$ represents the number of possible delay combinations among the w pulses after (p_1-w) pulses have been removed, and $\binom{p_1-w}{2}$ represents the number of possible delay combinations among the (p_1-w) removed pulses. The denominator, n_j, represents the number of code matrices of length n_j in the same g-group. The last, term, $1/n_j$, represents the number of possible time shifts in a matrix of length n_j. The factor $F_{i,j}$ represents the probability of choosing code matrices from different groups, out of all matrices of length n_j, in OOK.

For the case of i=j, all code matrices of length n_j can serve as interferers thus giving the total number of interferers of code length n_j, equal to (Φ_j-1) for i, $j \in [l,k]$. Whereas k is the number of different lengths in the code set and Φ_j is the number of code matrices of length n_j .Moreover, the number of code matrices from different g-groups is equal to $(\frac{\phi_j}{n_j}-1)$ n_j.

Therefore, we obtain $F_{i,j}=(\frac{\phi_j}{n_j}-1)n_j/(\phi_j-1)=(\phi_j-n_j)/(\phi_j-1)$ for the i=j case. For the case of i≠j, all code matrices of length n_j can serve as interferers, thus giving ϕ_j interferers. Moreover, the number of code matrices from different g-groups is equal to ϕ_j. Therefore, we obtain $F_{i,j}= \phi_j / \phi_j = 1$ for the i≠j case. It is because the code matrices with different lengths always come from different g-groups, according to (1)-(3).The hard –limiting BEP, $P_{e,i(hard)}$, of the address matrix of length n_i can be obtained by modifying [8, eq.(7)] as

$$P_{e,i(hard)} = \frac{1}{2} \sum_{s=0}^{w} \{(-1)^s \binom{w}{s} [q_{i,i,0} + \frac{q_{i,i,1}(w-s)}{w}$$

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

$$+\frac{q_{i,i,2}(w-s)(w-s-1)}{w(w-1)}]^{k_i-1}\prod_{j=1,j\neq i}^{k}[q_{i,j,0}+\frac{q_{i,j,1}(w-s)}{w(w-1)}+\frac{q_{i,j,2}(w-s)(w-s-1)}{w(w-1)}]^{k_j}$$

(7)

where K_j is the number of arriving matrices of length n_j.

we consider the extreme case of only one matrix length (i.e., k=1) in use and, therefore, set $K_j=0$ and $q_{i,j,h}=0$ in (7), where h={1,2} and all $j\neq$ i. the BEP equation is then degenerated to

$$P_{e,i(hard)}=\frac{1}{2}\sum_{s=0}^{w}\{(-1)^s\binom{w}{s}[q_{i,i,0}+\frac{q_{i,i,1}(w-s)}{w}$$

$$+\frac{q_{i,i,2}(w-s)(w-s-1)}{w(w-1)}]^{k_i-1} \quad (8)$$

which is identical to the corresponding hard-limiting BEP equation of the single –length QC-CHPCs in [6]

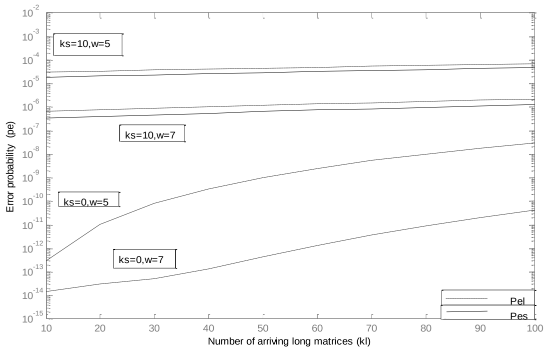

Fig. 1. Hard limiting BEP versus the number of arriving long matrices $K_l$for double length and double weight QC-CHPC with w=5 and 7 .(ks represents the number of arriving shot matrices).

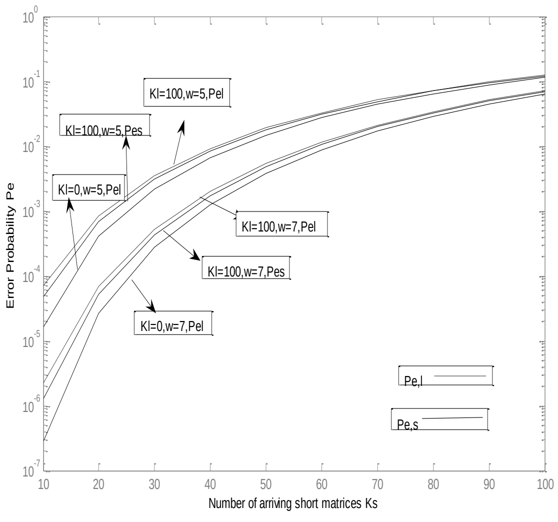

Fig.2 . Hard limiting BEP versus the number of arriving short matrices Ks for double length and double weight QC-CHPC with w=5 and 7 .

An (7 x {37,1369}, 5 x {37,1369}) double length and double weight QC-CHPC with P_2=P_1=37 shown in Fig.1.are the Hard limiting BER versus the Number of arriving long address matrices K_l . While the solid curves correspond to the performance of short matrices, the dashed curves show the performance of long matrices. The dashed curve with ks = 0 shows the performance of a single length QCCHPC with the long matrices only. The total number of arriving matrices increases the performance is decreased. In Fig.2 The dashed curve with K_l = 0 shows the performance of a single length QCCHPC with the short matrices only

Shown in figs. 1 and 2 are the Bit Error Probabilities of long and short address matrices, We can see from both figures that is short matrices perform better than long matrices. Both figures show that short matrices are dominating the performance. To increase in code length and code weight the net effect is the improvement of Bit Error Rate. The amount of interference in OOK is reduced by half in average as data bit zero are not transmitted

V. CONCLUSION

The QC-CHPC multiple length multiple weight On-Off keying wavelength-time O-CDMA was analyzed. We should that the performance of multiple length variable weight code could be controlled by matrix length and weight. Our result shows that higher-rate media had better performance than lower-rate media because the longer matrices used by lower rate media Suffered from stronger interference created by the shorter matrices of high-rate media. We also showed that code weight was the dominating factor in controlling the code performance.

REFERENCES

[1] P.R.Pruncnal, Ed., optical Code Division Multiple Accesses: Fundamentals and Applications. New York: Taylor & Francis Books, 2005.

[2] V.J.Hernandez, W.Cong, J.Hu, C.Yang, N.K.Fontaine, R.P. Scott, D.Zhi, B.H.Kolner, J.P.Heritabe, and S.J.B Yoo, "A 320-Gb/s capacity (32-user x 10Gb/s) SPECTS O-CDMA Network testbed with enhanced spectral efficiency through forward error correction," J.Lightwave Technol., vol.25, no.1, pp. 79-86, Jan.2007.

[3] J.Cao, R.G.Broeke, N.K.Fontaine, C.Ji, Y.Du, N.Chubun, K.Aihara, A-V.Pham, F.Olsson, S.Lourdudoss, and S.J.B.Yoo, "Demonstration of spectral phase O-CDMA encoding and decoding in monolithically integrated arrayed-waveguide-grating-based encoder," IEEE Photon. Technol.Lett., Vol.18, no.24, pp. 2602-2604, Dec.2006.

[4] G.C.Yang, Variable –weight optical orthogonal codes for CDMA network with multiple performance requirements,IEEE Trans,commun,vol 44, no 1,pp 476-55,Jan.1996

[5] M.Azizoglu, J.A.Salehi, and Y.Li, "Optical CDMA via temporal codes,' IEEE Trans. Commun., vol.40, no.7, pp.1162-1170, July 1992.

[6] C.Y.Chang, G.C.Yang, and W.C.K.Wong, "Wavelength –time codes with maximum cross- correlation function of two for multicode –keying optical CDMA," J.Ligthwave Technol., vol.24. no.3, pp.1093-1100, Mar.2006.

[7] G.C.Yang and W.C.Kwong ," Prime codes with application to CDMA Optical and Wireless Networks", Artece Hoad,Norwood, May.2002.

[8] Cheng-Yuan Chang, Hung-Tachen, Guu-Chang Yang Wing, C.K.Kwong "Spectral Effciency Study of QC-CHPC in multirate optical CDMA system "IEEE Journal,vol 25, no 9 ,Dec.2007 .

[9] Nasaruddin and Tetsuo Tsujioka Design of Reconfigurable Multiweight Wavelength-Time Optical codes for secure multimedia optical CDMA Networks ICC2008 proceedings

[10] Wing c.Kwong,Cheng-Yuan Chang Quadratic Congruence Carrier Hopping Prime code for Multicode Keying optical CDMA ICC2007 proceeedings

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Ms. S. Premalatha is currently working towards research in Optical Communication and working as Associate Professor in ULTRA College of Engineering and Technology for Women, Madurai, TamilNadu, India. Her research interests include Optical CDMA.

Ms. R. Vinodha is currently working towards research in Optical Networking and working as Assistant Professor in ULTRA College of Engineering and Technology for Women, Madurai, TamilNadu, India.Her research interests include Improvement QoS in Optical Networking.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)