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Research paper

Merit factor analysis of polyphaser sequences using cyclic algorithm new with good correlation properties

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Abstract

Polyphase sequences such as Pn (n=1, 2, 3, 4, x), Golomb, Frank, and the Chu are with good correlation properties, lower sidelobe levels and large merit factor values are helpful in applications like radar, sonar and channel estimation and communications. The goodness of a sequence obtained from merit factor. The transmitted and received signal may not be the same due to noise. The correlation function of given sequence is expressed by ISL (Integrated Sidelobe Level) by minimizing the ISL metrics the performance parameter merit factor is improved. To make this possible the ISL metric is expressed in the frequency domain and minimized to its most recent values and fixing at their most recent value until the predefined threshold satisfied. Because of FFT operations, the Cyclic Algorithm New applied to very long length sequences say N~106. In this paper, the Merit factor and correlation levels compared with standard, and cyclic algorithm new initialized with Polyphase sequences for lengths 102~104. Moreover, the observations made for four consecutive even and odd integer lengths say 162, 172, 182, and 192. CAN (P3, Golomb) exhibits merit factor improvement of 3.77%. These sequences of sidelobe levels reduced.

Keywords: *Correlation Level; Cyclic Algorithm-New; Integrated Side Lobe Level; Merit Factor; Polyphaser Sequence.*

1. Introduction

Radar and sonar aim is for measuring the target distance, Doppler frequency shift by transmitting specific waveforms and analyzing the received waveform or echo signal. The performance of the system depends on two factors known as transmitted waveform and receiver filter. A well synthesized transmitted waveform brings out accurate parameter estimation and reduces the noise present at the receiver [1]. Periodic and aperiodic sequences with good correlation properties find many applications in radar, sonar and communications [2], [3]. There are some performance parameters in radar such as PSLR (peak sidelobe ration), ISL (integrated sidelobe level) and Merit Factor. Merit factor is one of the parameters to be improved for a transmitted waveform or sequence.

Barker R.H [4] Introduced the binary sequences for lengths N= 2, 3, 4, 5, 7, 11 and 13. Binary codes that produce minimum PSL but does not satisfy the barker condition known as Minimum peak sidelobe codes (MPSC) [5]. Golomb and Scholtz [6] generalized barker sequences investigated the first time and presented the six phase Barker sequences of lengths N≤13. However, for more considerable lengths, Polyphase barker sequences require larger alphabets, possibly for exhaustive search algorithms for obtaining two digit merit factor. M. Antweiler and Bömer L. [7] two widely accepted Polyphase sequences Chu and Frank sequences exist for square integer length in that, Frank sequence is better than the Chu sequence, and additional Polyphase sequences such as Pn{n=1,2,3,4,x} are P1, P2, P3, P4, Px and Golomb[8-9]. R. Frank [10] found that P1 and Frank's sequences are identical to each other exist for square integer length only.

P. B. Rapajic and R. A. Kennedy [11] the merit factor values of P1, P3, P4, Px, Golomb, Frank, and the Chu found. P3, P4, Golomb, and the Chu exist for any length. Px sequence exists for lengths N=D2 where D is an integer. H. He, D. Vu, P. Stoica, and J. Li [12] presented random initialization algorithms for the construction of unimodular sequences with periodic correlations. W. Roberts, H. He, J. Li, and P. Stoica [13] presented the necessary of cyclic algorithms for minimizing the ISL for improving the merit factor values. The cyclic algorithm new initialized with Frank sequences obtained for lengths 10^2 ~10^4 and corresponding correlation plots mentioned. P. Stoica, H. He, and J. Li [14] presented unimodular sequence generation with cyclic algorithms. Cyclic algorithms initialized with Golomb merit factor values found.

In this paper, the cyclic algorithm new initialized with Polyphase sequences known as P1, P2, P3, P4, Px, Golomb, Frank, and the Chu. The standard and cyclic algorithm new sequences merit factor values are plotted in log scale shown in Fig.1 (a)-(d) for lengths 3^2 5^2 10^2 16^2 17^2 18^2 19^2 32^2 70^2 100^2. The correlation level is plotted for 10^2~10^4 shown in Fig. 2 -4. Four consecutive even and odd integer (16-19) square length correlation plots are obtained.

2. Polyphaser sequences

The Polyphase sequences named Frank, Golomb, Chu, P1, P2, P3, P4, Px possibly exist for square integer length $L=D^2$ (where L is sequence Length, D is an integer) having elements Sn= (S_1, S_2, S_3,…S_L). These Polyphase sequences can be defined as follows. P1, P2, Px, and Frank denoted by f(n) sequences are defined by S(Dn+k+1). P3, P4, Golomb, and Chu defined by S(k+1). The P1, P2, P3, P4, Px, Golomb, Frank and Chu sequences [11], [15-16]. All the sequences are consider for square integer length. The sequences with equal merit factor values exhibit the same correlation. Sequences with large merit factor values have the lower sidelobes in correlation plots. Even though correlation levels are identical but the way in which the sequence representation differs from one another. The Performance parameters analysis, i.e., MF values and plotting the correlation levels are outlined in Figure 1

2.1. P1, P2, PX sequences

These sequences defined as S (Dn+k+1) = $e^{i\varphi n,k}$ for 0≤ k ≤ D and 0≤ n ≤ D, here the phase elements of the sequences [8, 13] defined as shown below.

$$\varphi_{n,k} = -(\pi / D)(D - 2n - 1)(nD + k) \tag{1}$$

$$\varphi_{n,k} = +(\pi / D)(D - 2n - 1)((D - 1)/(2 - k)) \tag{2}$$

$$\varphi_{n,k} = (\pi / D)[(D - 1)/2 - k](D - 2n - 1) \tag{3}$$

$$\varphi_{n,k} = (\pi / D)[(D - 2)/2 - k](D - 2n - 1) \tag{4}$$

Equations (1) and (2) are the phase elements of P1, P2 sequences respectively. Phase elements in Equations (3) and (4) of Px sequence of D even and odd integers

2.2. P3, P4 sequences

The Polyphase sequence elements Sn for n=1….L of integer length M for P3 and P4 sequence [11] defined as S (k+1) = $e^{i\varphi k+1}$ here 0≤ k ≤ D.

$$\varphi_{k+1} = \pi k^2 \tag{5}$$

$$\varphi_{k+1} = \pi(k - N)k \tag{6}$$

Equations (5) and (6) are phase elements of P3 and P4 sequences respectively. The mathematical equation of the two sequences exhibits the identical MFs and correlation levels.

2.3. Golomb sequence

The Golomb sequence [11, 14] of Polyphase sequence elements Sn for n=1 L of an integer length D defined as S(k+1) = $e^{i\varphi k+1}$ here 0≤ k ≤ D. the phase elements defined as

$$\varphi_{k+1} = \pi(k + 1)k \tag{7}$$

Another way of Golomb sequence [14] represented as g (n) of length L for a positive integer.

$$g(n) = e^{j\pi(n-1)n/N} \tag{8}$$

Equations (7) and (8) shows the Golomb sequence g(n) for n=1…, L. these two mathematical representations bring out the same response.

2.4. Frank sequence

These sequences can be defined as S (Dn+k+1) = $e^{i\varphi k+1}$ for 0≤ k ≤ D and 0≤ n ≤ D, here the phase elements of the sequence [11] defined as

$$\varphi_{k+1} = 2\pi nk / D \tag{9}$$

Another way of Frank sequence [10] represented as f (n) of length L is given by

$$f(Dn + k + 1) = ej2\pi nk / D,\ k, n = 0,., M - 1 \tag{10}$$

Equations (9) and (10) demonstrates the f(n) for n=1… L. these two draw out a similar result.

2.5. Chu sequence

The Chu sequence [11, 15], phase elements Sn for n=1…L of a positive integer length L as S (k+1) = $e^{i\varphi k+1}$ here 0≤ k ≤ D

$$\varphi_{k+1} = \pi(k + 2q)k \tag{11}$$

$$\varphi_{k+1} = \pi(k + 1 + 2q)k \tag{12}$$

Equation (11) and (12) are the phase elements of Chu sequence for even and odd integers respectively.

3. Performance parameters

The elements of the Polyphase sequence Sn = $S_1, S_2, S_3 \ldots S_N$ that exist for square integer Length (L=D^2). Some parameters define the ability for improving the characteristics of the radar system. Some parameters, i.e., Merit Factor increasing in nature defines the performance improvement, and some are integrated sidelobe level decreasing in nature also defines the same. The sequences with good correlation properties and MF values helped in radar and sonar applications.

3.1. Correlation function & correlation level

The autocorrelation r=ρ(S) of a sequence Sn = ($S_1, S_2, S_3 \ldots S_N$) is a sequence length of 2K-1 defined as ρ(S) = v(s, s) the main lobe c_k, of the autocorrelation c, is given by c_k = s s^T and complex conjugates and transpose denoted by $(.)^T$ denotes the complex conjugate, conjugate transpose for scalars and vectors, matrices respectively [11].

$$c_k = \sum_{n=k+1}^{L} s_n s^T s_{n-k}^T = s_{-k}^T,\ k = 0,...., L-1 \tag{13}$$

$$CL = 20\log_{10}\left|\frac{c_k}{c_0}\right|, \quad k = 1,......., L-1 \tag{14}$$

Equation (13) is the autocorrelation function and Equation (14) defines the correlation level in dB, in Equation (13) correlation function is shown.

3.2. Integrated side-lobe level

The integrated sidelobe level from Equation (13) is defined as follows.

$$ISL = \sum_{k=1}^{L-1} \left|C_k\right|^2,\ k = 1,...., L-1 \tag{15}$$

Equation (15) defines that c0, c1, c2 ….cN-1 square modulus.

3.3. Merit factor

The merit factor is an essential measure of the collective smallness of the aperiodic autocorrelations of a sequence length N named by M. J. E Golay [18].

$$MF = \frac{\left|c_0\right|^2}{\sum_{\substack{k=-(N-1) \\ k\neq 0}}^{L-1} \left|c_k\right|^2} = \frac{L^2}{2ISL} \tag{16}$$

Equation (16) shows the Merit Factor and correlation levels in the denominator consider all except at k=0. From Eq. (16) multiplication by 2 in denominator shows the symmetry of the correlation function at zero.

4. Cyclic algorithm-new

For minimizing the ISL cyclically require representing the ISL in frequency domain frequency range of ω[0, 2π]

$$\left|\sum_{n=1}^{L} s_n e^{-j\omega n}\right|^2 = \sum_{k=-(L-1)}^{L-1} C_k e^{-j\omega k} \underline{\underline{\Delta}}\ \Phi(\omega) \quad (17)$$

P. Stoica and R. L. Moses [17] the ISL metric in Eq. (15) can be expressed as

$$ISL = \frac{1}{4L}\sum_{p=1}^{2L}\left[\Phi(\omega_p) - L\right]^2 \quad (18)$$

Here {ωp}are the Fourier frequencies represented as

$$\omega_p = \frac{2\pi}{2L} p, \quad p = 1,....,2L \quad (19)$$

Equation (18) is a Parseval-type equality. To prove the Eq. (18) δk denotes the Kronecker delta function

$$\delta_k = \begin{cases} 0 & for \ \ k \neq 0 \\ 1 & for \ \ k = 0 \end{cases} \quad (20)$$

Equation (18) the correlation based expression verifies the following criteria in Equation (17) to verify that

$$\sum_{p=1}^{2L}\left[\Phi(\omega_p) - L\right]^2 = \sum_{p=1}^{2L}\left[\sum_{k=-(L-1)}^{L-1}(c_k - L\delta_k)e^{-j\omega_p k}\right]^2$$

$$= \sum_{k=-(L-1)}^{L-1}\sum_{\tilde{k}=-(L-1)}^{L-1}(c_k - L\delta_k)(c_{\tilde{k}} - N\delta_{\tilde{k}})^* \times \left[\sum_{p=1}^{2L} e^{-jp(k-\tilde{k})}\right] \quad (21)$$

But for |k- |≤ 2L-2From Equation (21) the following equation can derived.

$$\sum_{p=1}^{2L} e^{-j\omega p(k-\tilde{k})} = e^{-j\frac{2\pi}{2L}(k-\tilde{k})} \cdot \frac{e^{-j2\pi(k-\tilde{k})-1}}{e^{-j\frac{2\pi}{2L}(k-\tilde{k})-1}} = 2L\delta_{(k-\tilde{k})} \quad (22)$$

Equation (21) is obtained from the following Equation

$$\frac{1}{4L}\cdot\sum_{p=1}^{2L}\left[\Phi(\omega_p) - L\right]^2 = \frac{1}{2}\sum_{k=-(L-1)}^{L-1}\left|c_k - L\delta_k\right|^2 = \sum_{k=1}^{L-1}\left|c_k\right|^2 \quad (23)$$

This is the Eq. Eq (18). Periodogram-based expression is used for Φ(ω) (see the Eq(17) and (18)) shown the minimization of ISL metric problem is equivalent to the frequency domain metric minimization

$$ISL(f-domain) = \sum_{p=1}^{2L}\left[\left|\sum_{n=1}^{L} s_n e^{-j\omega_p n}\right|^2 - L\right]^2 \quad (24)$$

Minimizing ISL make the sequences act as white noise. Interns of frequency the Periodogram should be constant. From Eq(24) we can verify that minimization of Eq (24) with respect to $\{x_n\}$ is at most equivalent to the following simpler solution which is criterion is a quadratic function of $\{x_n\}$.

$$\{s_n\}_{n=1}^{L} \overset{\min}{;} \{\psi_p\}_{p=1}^{2L} \left|\sum_{n=1}^{L} s_n e^{-j\omega_p n} - \sqrt{L}e^{j\psi p}\right|^2 \quad (25)$$

$$b_p^* = [e^{-j\omega_p} \ \cdots \ e^{-j2L\omega_p}] \quad (26)$$

Let B* be the following unitary FFT matrix with order 2Lx2L

$$B^* = \frac{1}{\sqrt{2L}}\begin{bmatrix} b_1^* \\ \vdots \\ b_{2L}^* \end{bmatrix}_{2L\times 2L} \quad (27)$$

And let be the Polyphase sequence and padded with L zeroes

$$y = [s_1 \ \cdots \ s_L \ \ 0 \ \cdots \ 0]_{2L\times 1}^T \quad (28)$$

Then the Equation (25) can be rewritten in the following more compact form as (multiplication constant):

$$\left\|B^* y - w\right\|^2 \quad (29)$$

$$w = \frac{1}{\sqrt{2}}\left[e^{j\psi 1} \ \cdots \ e^{j\psi L}\right]^T \quad (30)$$

For a given Polyphase sequence, the minimization of Eq(12) with respect to{ψp} is shown below:
The above equation denotes the FFT of y. the minimization defined as

$$\psi_p = \arg(h_p), \ \ p = 1,.....2L. \quad (31)$$

Similarly for a given w the inverse FFT of w is given by

$$i = Bw \quad (32)$$

Above equation denotes the inverse FFT of w. Because $\left\|B^* y - w\right\|^2 = \left\|y - Bw\right\|^2$, it follows that the minimization of the Polyphase sequence from Equations. (1) - (12) is given by

$$s_n = e^{j\arg(g_n)}, \ \ n = 1,...., L. \quad (33)$$

The local minimization of ISL-related metric cyclically with CAN be summarized as follows.

4.1. Cyclic algorithmic-new systematic procedure

Step 1: Initialize Sn {n=1…N} with the known existing sequence such as (Golomb, Frank, Chu, Pn {n=1, 2, 3, 4, x} implies P1, P2, P3, P4, Px.
Step 2: Compute the {ψp} p=1…2L, minimization metric for {s (n)k=1}L compute {ψp} p=1…2L and fixing to their most recent values in Equation (31).
Step 3: computing the sequence {s (n)k=1}L that minimized the metric in Equation (33), for {ψp} p=1…2L fixing to the recent values.
Iteration: repeat step 2 & 3 until a practical convergence criterion is satisfied. $\left\|S^{(i)} - S^{(i+1)}\right\| < \varepsilon$, here S(i) is the obtained sequence at ith iteration and ε is preordained threshold, such as 10-2 or 10-3. This CAN uses the FFT and IFFT operations so it can used for large values of L>104.
This cyclic algorithm New procedure as a flowchart is shown in fig. 1. Integer values squared and loaded it into L, i.e., length of the sequence. Minimization problem in Eq. (31) Also, fixing to the most recent values. Checking the condition until the convergence

criterion satisfies the threshold value. The corresponding correlation plots shown in Figs. (2) - (4) are correlation levels for L=100, 1000 and 10000 and four consecutive even and odd square integer values respectively. The coincidence of correlation levels indicates that the two sequences produce the same merit factor values (see Figs. (2 - 8) (b)). From Fig. 4 (a) - (d) the correlation levels are reached maximum values i.e. -80dB (Max axis limit).

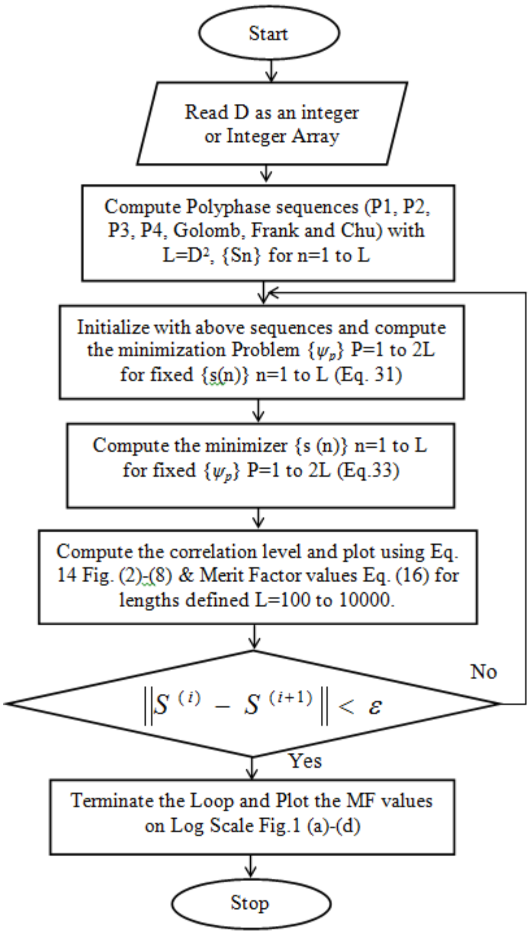
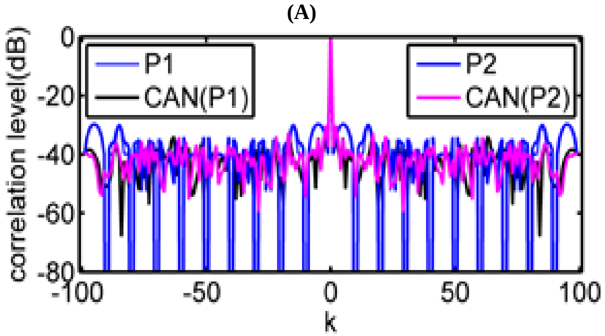
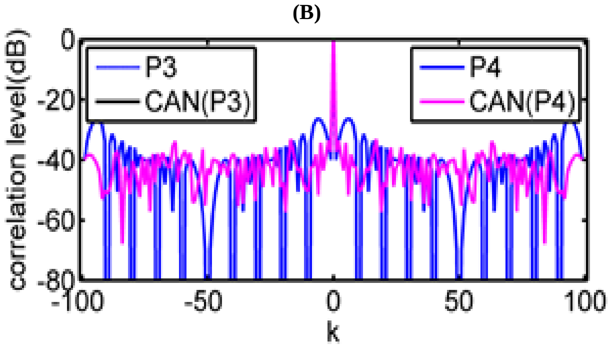


Fig. 1: Flow Chart for CA-New Algorithm with Polyphase Sequences (P1, P2, P3, P4, Px, Golomb, Frank and Chu).

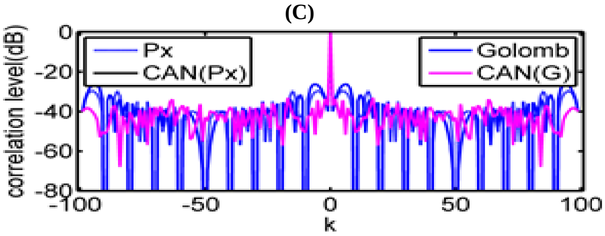
(A)



(B)



(C)



(D)

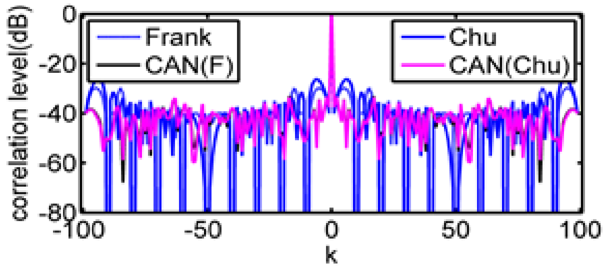
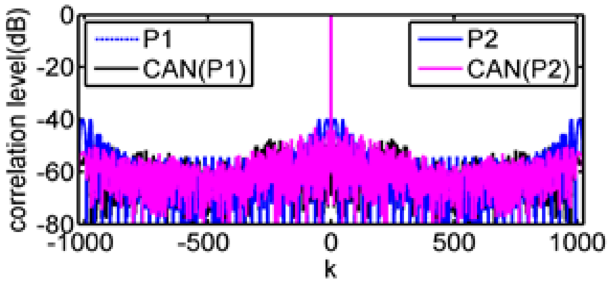
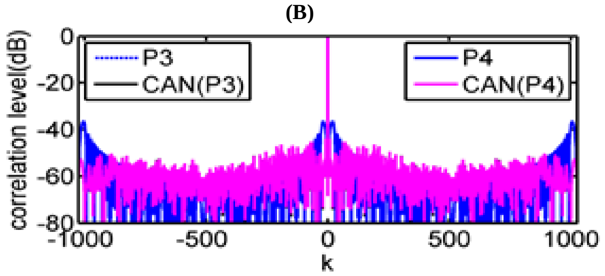


Fig. 2: Correlation Levels of Standard Polyphase Sequences and CAN Applied Polyphase Sequences of Length L=100.

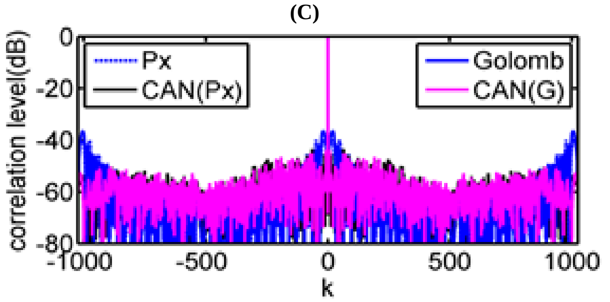
(A)



(B)



(C)



(D)

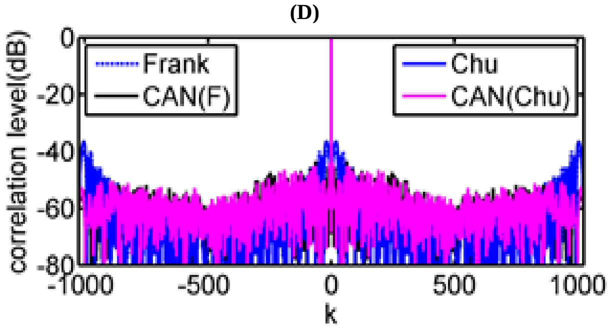
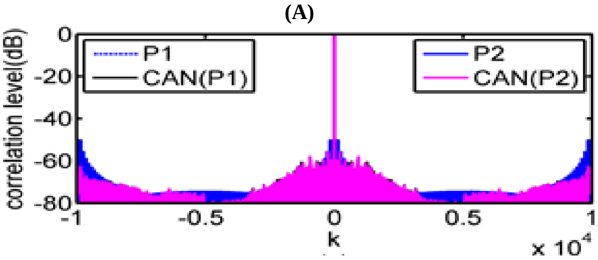
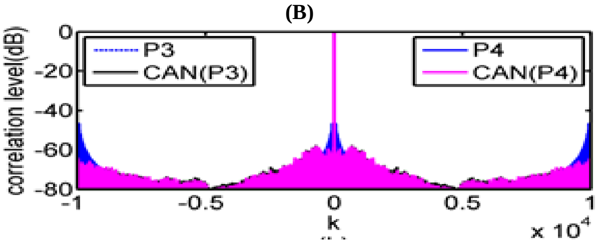


Fig. 3: Correlation Levels of Standard Polyphase Sequences and CAN Applied Polyphase Sequences of Length L=1000.

(A)



(B)



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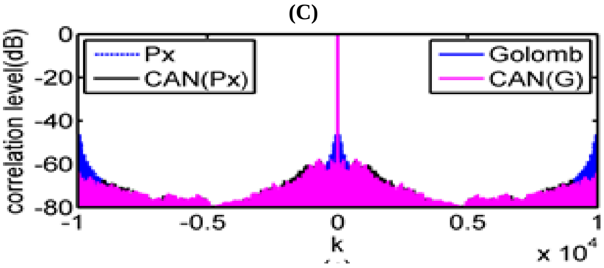


(D)

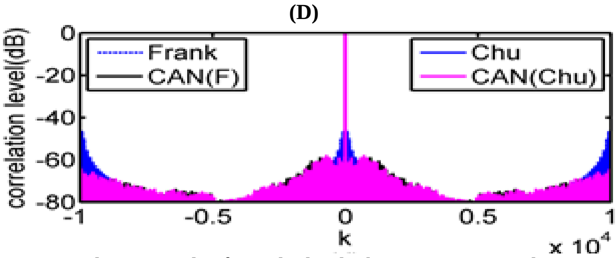
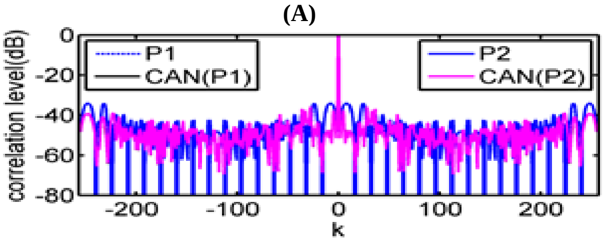
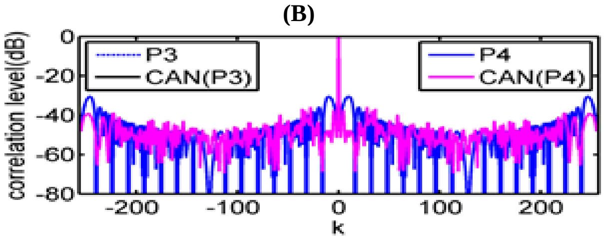


Fig. 4: Correlation Levels of Standard Polyphase Sequences and CAN Applied Polyphase Sequences of Length L=10000.

(A)



(B)



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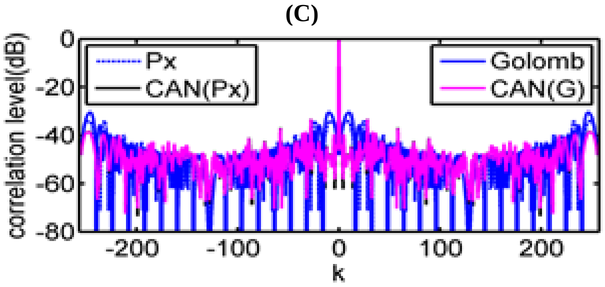


(D)

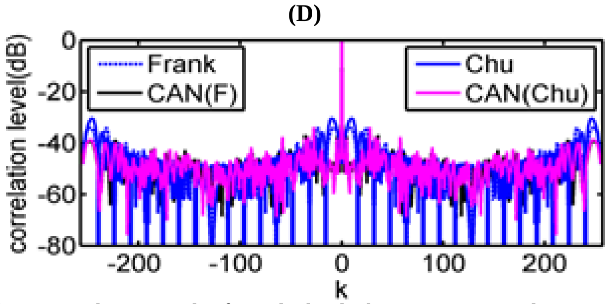
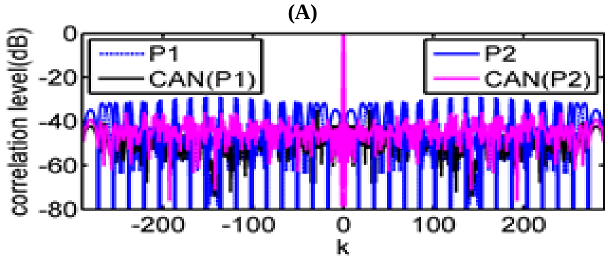
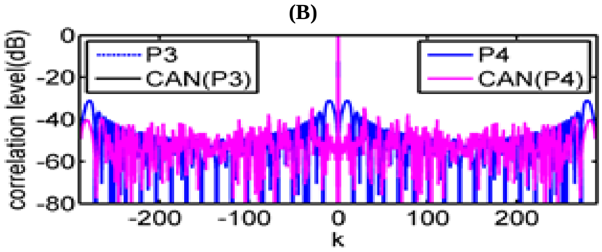


Fig. 5: Correlation Levels of Standard Polyphase Sequences and CAN Applied Polyphase Sequences of Length L=162.

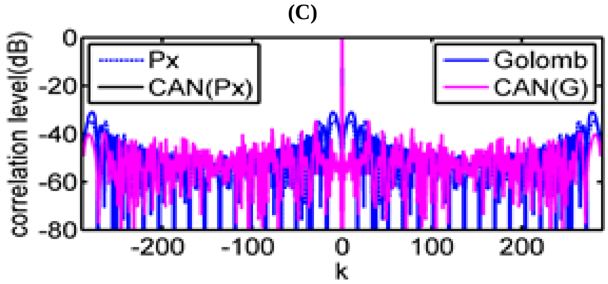
(A)



(B)



(C)



(D)

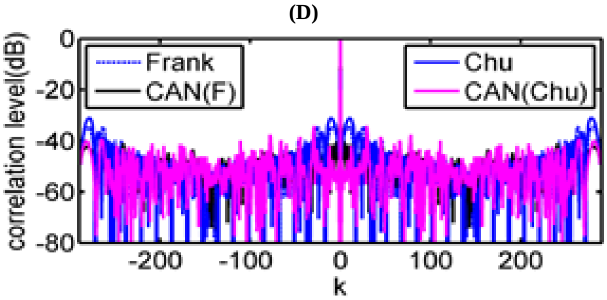
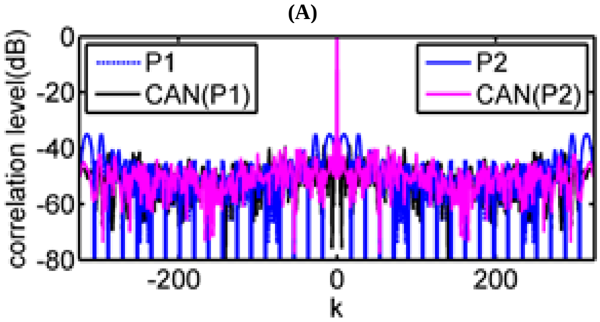


Fig. 6: Correlation Levels of Standard Polyphase Sequences and CAN Applied Polyphase Sequences of Length L=172.

(A)



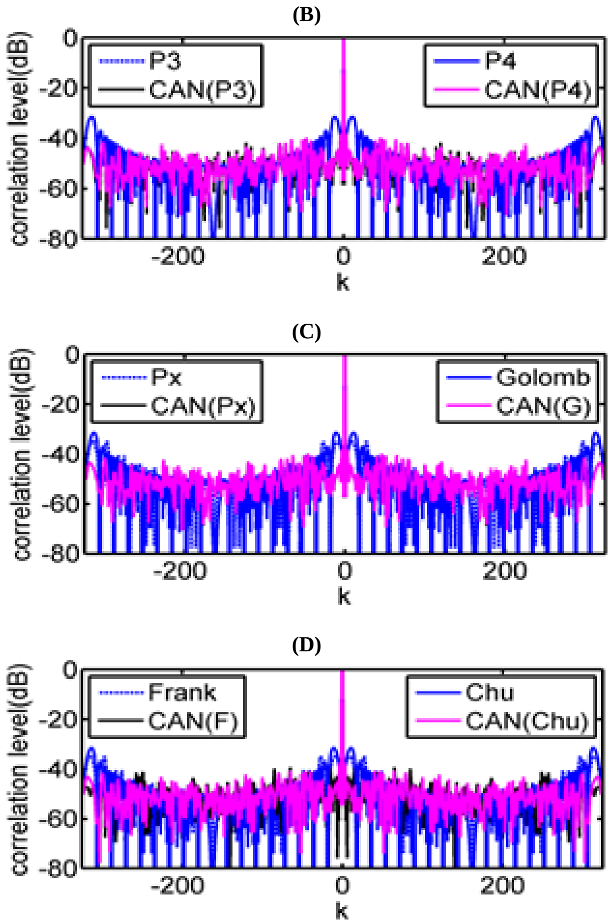
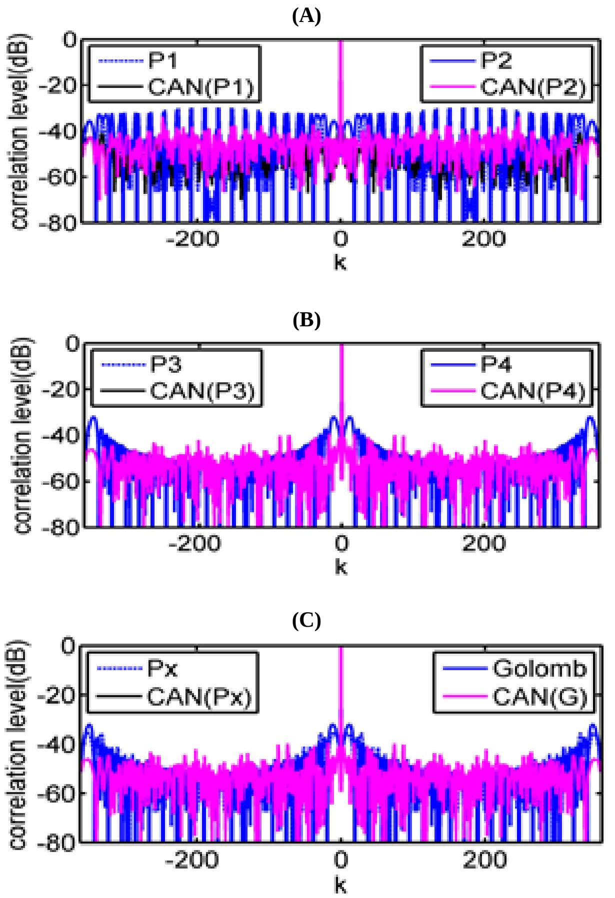


Fig. 7: Correlation Levels of Standard Polyphase Sequences and CAN Applied Polyphase Sequences of Length L=182.



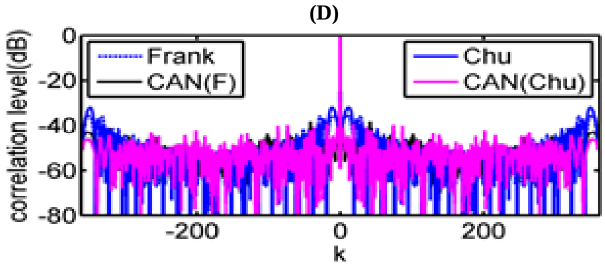
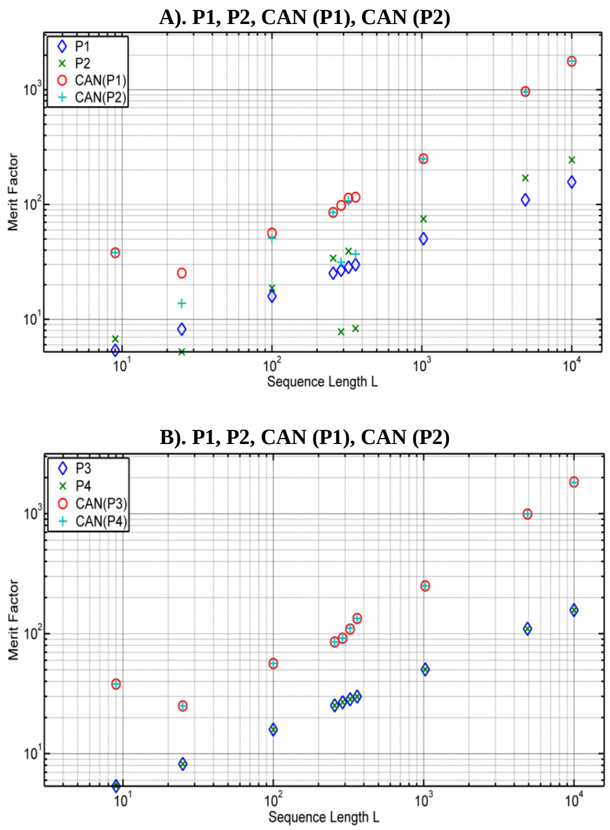


Fig. 8: Correlation Levels of Standard Polyphase Sequences and CAN Applied Polyphase Sequences of Length L=192.

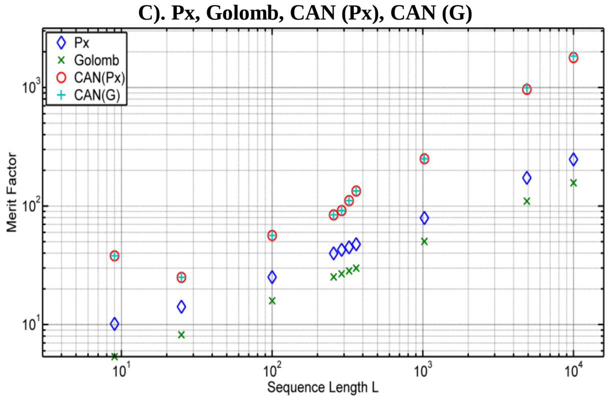
Figures (5) – (8) indicates the correlation plots for four consecutive even and odd square integer values, i.e., 162, 172, 182, 192. From Fig. (6-(a)) & (8-(a)) odd integer square lengths crust in P2 sequence indicates nature of the P2 sequence that exists for even integer square lengths. The merit factor values for P2 and CAN (P2) sequence in Table. 2 for 172 and 192 are too low compared to all the remaining sequences. Even though the CAN initialized with Polyphase sequences correlation levels are little above the standard sequences, however near zero the correlation levels are far below this could maximize the merit factor to a greater extent.

5. Results and discussions

The merit factors values are computed using Eq. (16) also, Cyclic Algorithm-New plotted in log scale (sequences length L vs. Merit Factor) are shown in Fig. (9). From fig. 9 (a) - (d) except the P2 sequence all the sequences exhibit the improvement in merit factor proportional to the sequence length for even and odd integer square lengths. However, Cyclic Algorithm-New initialized with Polyphase sequences shows improvement in merit factor except at L= 52. From fig. 9 (b) (P3, P4) and (CAN (P3), CAN (P4)) merit factor values obtained are equal except at L=104.exhibit same merit factor values for the two cases. Px sequence merit factor values more significant than all the remaining sequences. However, CAN (Px) and CAN (G) differ by small value at L= 104.



C). Px, Golomb, CAN (Px), CAN (G)



D). Frank, Chu, CAN (F), CAN (Chu)

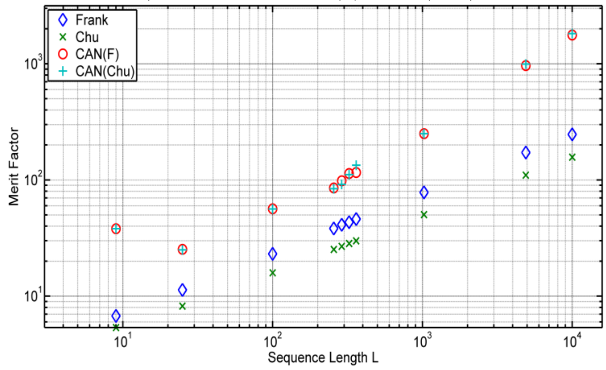


Fig. 9: Merit Factor Values of P1, P2, P3, P4, Px, Golomb, Frank and Chu Sequences of Length 3^2,5^2, 100, 16^2, 17^2, 18^2, 19^2, 1000, 70^2, 100^2 for Standard and CAN Applied.

For the lengths, L=100 and 1000 CAN initialized with Polyphase sequences exhibit same merit factor values except for CAN (P2) sequence. Form Table 1. CAN (P3) exhibit the large merit factor of 1839.769. Note that all the calculations considered for square integer length only. The length L= 1000 seems to be 103, but it is L=1024, i.e., L= 322. Because of the FFT operations in the CAN, the merit factor values can be obtained for lengths greater than 104 upto 106.

Table 1: A). Merit Factor Values Comparison of Polyphase Sequences Standard and Cyclic Algorithm- New Approach for Lengths N= 100

Parameter	Merit Factor	
Length	L=100	
Approach	Standard	Cyclic Algorithm-New
P1, CAN(P1)	23.099	56.470
P2, CAN(P2)	18.722	50.860
P3, CAN(P3)	15.873	56.470
P4, CAN(P4)	15.873	56.469
Px, CAN(Px)	25.124	56.470
Golomb, CAN(G)	15.873	56.470
Frank, CAN(F)	23.099	56.470
Chu, CAN(Chu)	15.873	56.252

Table 1: B). Merit Factor Values Comparison of Polyphase Sequences Standard and Cyclic Algorithm- New Approach for Lengths N= 1000

Parameter	Merit Factor	
Length	L=100	
Approach	Standard	Cyclic Algorithm-New
P1, CAN(P1)	78.145	250.574
P2, CAN(P2)	75.041	248.872
P3, CAN(P3)	50.316	250.262
P4, CAN(P4)	50.316	250.336
Px, CAN(Px)	79.241	250.572
Golomb, CAN(G)	50.316	250.292
Frank, CAN(F)	78.145	250.574
Chu, CAN(Chu)	50.316	250.268

Table 1: C). Merit Factor Values Comparison of Polyphase Sequences Standard and Cyclic Algorithm- New Approach for Lengths N= 10000

Parameter	Merit Factor	
Length	L=100	
Approach	Standard	Cyclic Algorithm-New
P1, CAN(P1)	246.385	1769.051
P2, CAN(P2)	244.924	1772.185
P3, CAN(P3)	157.096	1839.769
P4, CAN(P4)	157.096	1815.717
Px, CAN(Px)	246.877	1788.534
Golomb, CAN(G)	157.096	1839.757
Frank, CAN(F)	246.385	1769.051
Chu, CAN(Chu)	157.096	1816.171

Table 2: A). Merit Factor Values Comparison of Polyphase Sequences Standard and Cyclic Algorithm- New Approach for Lengths N= 162

Parameter	Merit Factor	
Length	L=16^2	
Approach	Standard	Cyclic Algorithm-New
P1, CAN(P1)	38.230	85.339
P2, CAN(P2)	34.067	85.354
P3, CAN(P3)	25.235	85.350
P4, CAN(P4)	25.235	85.357
Px, CAN(Px)	39.875	84.138
Golomb, CAN(G)	25.235	84.131
Frank, CAN(F)	38.230	85.339
Chu, CAN(Chu)	25.235	84.045

Table 2: B). Merit Factor Values Comparison of Polyphase Sequences Standard and Cyclic Algorithm- New Approach for Lengths N= 17^2

Parameter	Merit Factor	
Length	L=17^2	
Approach	Standard	Cyclic Algorithm-New
P1, CAN(P1)	41.077	98.411
P2, CAN(P2)	7.781	31.298
P3, CAN(P3)	26.800	91.656
P4, CAN(P4)	26.800	91.656
Px, CAN(Px)	42.701	91.657
Golomb, CAN(G)	26.800	91.656
Frank, CAN(F)	41.077	98.411
Chu, CAN(Chu)	26.800	91.656

Table 2: C). Merit Factor Values Comparison of Polyphase Sequences Standard and Cyclic Algorithm- New Approach for Lengths N= 18^2

Parameter	Merit Factor	
Length	L=17^2	
Approach	Standard	Cyclic Algorithm-New
P1, CAN(P1)	41.077	98.411
P2, CAN(P2)	7.781	31.298
P3, CAN(P3)	26.800	91.656
P4, CAN(P4)	26.800	91.656
Px, CAN(Px)	42.701	91.657
Golomb, CAN(G)	26.800	91.656
Frank, CAN(F)	41.077	98.411
Chu, CAN(Chu)	26.800	91.656

Table 2: D). Merit Factor Values Comparison of Polyphase Sequences Standard and Cyclic Algorithm- New Approach for Lengths N= 19^2

Parameter	Merit Factor	
Length	L=18^2	
Approach	Standard	Cyclic Algorithm-New
P1, CAN(P1)	46.054	116.043
P2, CAN(P2)	8.319	37.005
P3, CAN(P3)	29.932	134.027
P4, CAN(P4)	29.932	134.027
Px, CAN(Px)	47.578	134.027
Golomb, CAN(G)	29.932	134.027
Frank, CAN(F)	46.054	116.043
Chu, CAN(Chu)	29.932	134.027

6. Conclusion

The performance parameters of Polyphase sequence for square integer length studied for both standard case and Cyclic Algorithm-New approach. The study makes the following observations

- Sequences with same merit factor values have the overlapped correlation levels.

- CAN (P3) and CAN (Golomb) exhibit the same merit factor as L=104. Remaining all CAN sequence exhibit the equal merit factor values except CAN (P2).
- For odd integer square length CAN (P1) and CAN (Frank) exhibit maximum among all sequences.
- Px has the maximum merit factor in the standard case. However, it is same as that of Frank sequences.
- For the length L= 52, all Cyclic Algorithm-New sequences exhibit least merit factor.
- P3 and P4 merit factor values same for standard and Cyclic Algorithm-New sequences.
- By using higher end systems the computational time required for execution can be reduced.

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