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Pulse Compression In Radar System Using BFO

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Abstract: The most existing research works concentrate on matching the desired beam pattern and neglect the following signal processing, such as pulse compression and adaptive receiving beam forming. A novel BFO scheme via the determinate chirp mixing sequence is proposed to deal with this problem. The deterministic BFO sequence is proposed to replace the pseudo-random PN and Gaussian sequence as the mixing sequence for the AIC scheme, which is used to deal with the local non-sparse targets in the LFM pulse compression radar. By using BFO algorithm with LFM signal to noise ratio increased, processing speed is optimized and range resolution is also increased. Gain and compression success rate and reconstruction success rate are improved when compared with previous existing schemes.

Keywords: pulse compression, chirp mixing, Gaussian sequence, pulse compression radar, AIC scheme, sparse and non-sparse.

INTRODUCTION

Pulse compression is a signal processing technique that is used to describe a waveshaping process that is produced as a propagating waveform which is modified by the electrical network properties of the transmission line.This is achieved by modulating the transmitted pulse and then correlating the received signal with the transmitted pulse. It is used to increase the range resolution as well as the SNR of signal. The pulse is internally modulated in phase or in frequency, which provides a method to further resolve targets which may have overlapping returns (so called Intrapulse Modulation). Pulse compression originated with the desire to amplify the transmitted impulse (peak) power by temporal compression. It is a method which combines the high energy of a long pulse width with the high resolution of a short pulse width. To get the advantages of larger range detection ability of long pulse and better range resolution ability of short pulse, pulse compression techniques are used in radar systems.[10]

Figure 1. Explains the range resolution depends on the bandwidth of a pulse but not necessarily on the duration of the pulse.

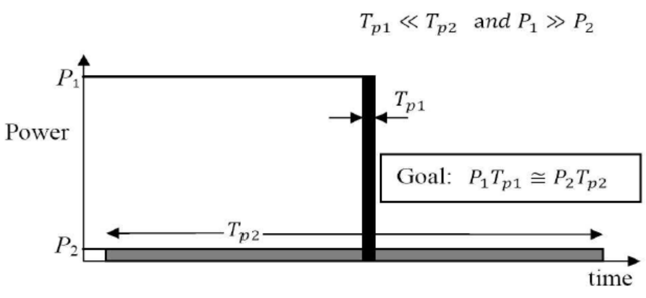

Figure 1:- Transmitter and receiver ultimate signals.

Some modulation techniques such as frequency and phase modulation are used to increase the bandwidth of a long duration pulse to get high range resolution having limited peak power.
This modulation or coding can be either

1. FM (frequency modulation)
    - linear (chirp radar) or
    - non-linear ,
    - time-frequency-coded waveform (e.g. Costas code) or
2. PM (phase modulation).

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PULSE COMPRESION IN RADAR USING BFO ALGORITHM

Bacteria Foraging Optimization Algorithm (BFOA), proposed by Passino and is a new comer to the family of nature-inspired optimization algorithms.[8] BFO Algorithm is.Bio-inspired from the social forging behavior of *Escherichia coli bacteria*. BFO is an AI based technique used here in the pulse compression in radar system. This optimization technique due to its advantages over earlier optimization techniques like Genetic Algorithm, Particle Swarm Optimization(PSO). The earlier optimization techniques are very efficient for pulse compressionbecause of the required output they compress the input pulse signal but the distortion in the message signal was high, these techniques produce distorted message signal at output due to which there is loss in information. By using novel BFO scheme, the deterministic BFO sequence is proposed to replace the pseudo-random PN and Gaussian sequence as the mixing sequence for the AIC scheme, which is used with the local non-sparse targets in LFM pulse compression radar.

The general BFO algorithm involves following processes:-

- Chemotaxis
- Swarming
- Reproduction
- Elimination and dispersal

Here in our work we replace bacterial specifications with the number of pulses, the earlier compression technique used chirp signal for mixing the pulse that consumes lots of time for compressing the pulse, here we are using PN sequence with the AWGN in combination with our bio inspired algorithm i.e BFO which produces optimized gain, reconstruction rate and success rate as compared with the earlier technique used for compression.

Let us define a chemotactic step to be a tumble followed by a tumble or a tumble followed by a run. Let j be the index for the chemotactic step. Let k be the index for the reproduction step. Let l be the index of the elimination-dispersal event.[8] The Figure.2 presents the algorithm.

Also let

p: Dimension of the search space,
S: Total number of bacteria in the population (number of pulses)
Nc: The number of chemotactic steps,
Ns: The swimming length.
Nre: The number of reproduction steps,(number of pulses received after forging)
Ned : The number of elimination-dispersal events,
Ped: Elimination-dispersal probability,
C (i): The size of the step taken in the random direction specified by the tumble.

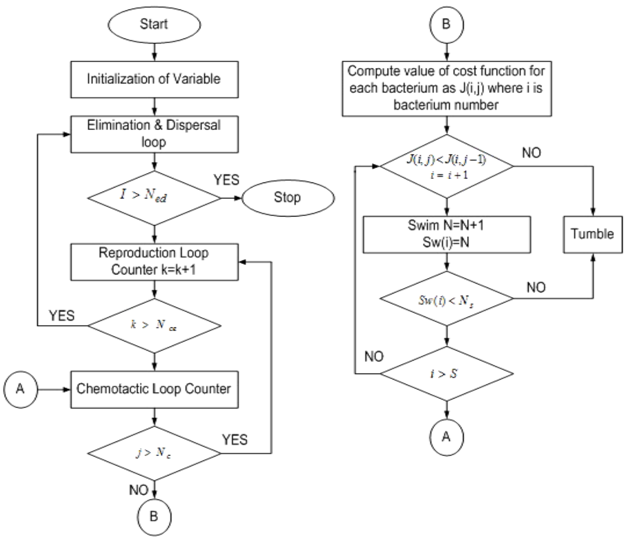

Figure 2:- Flow diagram illustrating the bacterial foraging optimization algorithm.

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LITERATURE SURVEY:-

Penget.al[11], has formulated the problem that, The analog to information conversion (AIC) viarandom demodulation (RD) has suffered the performance lossin reducing the sampling rate of linear frequency modulation(LFM) pulse compression radar, especially for the local non-sparsetargets in high resolution environment. In this paper, anovel AIC scheme via the determinate chirp mixing sequenceis proposed to deal with this problem.Due to the spread spectrumas well as the local narrowband characteristics in undersamplingcondition, the determinate chirp mixing sequence guaranteesthe reconstruction performance of local non-sparse targets withlow hardware consumption.Compared with traditional mixing sequence,the chirp mixing sequence guarantee the reconstruction performanceof both local sparse targets and non-sparse targets.

Chandan Singhet.al[10], has discussed , details of techniques which achieves high range resolution and low peaksidelobe levels under various noise conditions, Doppler shift and multiple target environments. The three veryimportant Radar Pulse Compression techniques called Polyphase, Biphase and Linear frequency modulated (LFM).the merits and demerits of different Pulse Compression techniques called LFM, Biphase and PolyphaseCodes are known taking into consideration the important parameters like the mainlobe width, range resolution and PSL.All the results of the simulations illustrate that Polyphase Codes have lowest Peak Sidelobe Level (PSL) compared toBiphase Codes and LFM Codes, Biphase Codes and Polyphase Codes have better range resolution compared to LFMand the mainlobe width is wider for LFM but the number of range sidelobes are less compared to the other Codes.

Swagatam et.al[8], has discussed with a lucid outline of the classical BFOA. It then analyses the dynamics of the simulated Chemotaxis step in BFOA with the help of a simplemathematical model. Taking a cue from the analysis, it presents a new adaptivevariant of BFOA, where the chemotactic step size is adjusted on the run accordingto the current fitness of a virtual bacterium. Nest, an analysis of the dynamics ofreproduction operator in BFOA is also discussed.BFOA is currently gaining popularity due to itsefficacy over other swarm and evolutionary computing algorithms in solving engineeringoptimization problems. It mimics the individual as well as grouped foragingbehavior of *E.coli*bacteria that live in our intestine. This paper explains the classical BFOA in sufficient details. It then developsa simple mathematical model of the simulated chemotaxis operation of BFOA.With the help of this model it analyses the chemotactic dynamics of a single bacteriummoving over a one-dimensional fitness landscape. The analysis indicates thatthe chemotactic dynamics has some striking similarity with the classical gradientdescent search although the former never uses an analytic expression of thederivative of the objective function. A problem of oscillations near the optimum isidentified from the presented analysis and two adaptation rules for the chemotacticstep-height have been proposed to promote the quick convergence of thealgorithm near the global optimum of the search space. The chapter also providesan analysis of the reproduction step of BFOA for a two-bacterium system. Theanalysis reveals how the dynamics of reproduction helps in avoiding prematureconvergence. This paper presents an account of the research efforts aimingat hybridizing BFOA with other popular optimization techniques like PSO, DE,and GA for improved global search and optimization. It also discusses the significantapplications of BFOA in diverse domains of science and engineering.

Uttamet.al[], has formulated , Linear Frequency Modulation (LFM) pulse compression technique on a generic signal model. The pulse compression technique plays a very important role for designing a radar system. Since a short pulse requires a high peak power which is unattainable for many constraints such as voltage breakdown, dimension of waveguide etc, the radar system uses a longer pulse and pulse compression technique. For high range resolution radar, the need for pulse compression is inevitable. The focus of this paper is time frequency autocorrelation and ambiguity functions' role in waveform design and then application of LFM pulse compression technique to a generic signal waveform.The LFM pulse compression technique, high range resolution from LFM pulse compression, range-Doppler coupling, and aliasing issue associated with sampling has been addressed.

PROPOSED SCHEME

The following steps are involved in the pulse compression by using BFO algorithm.

Step1: Create system generation system.

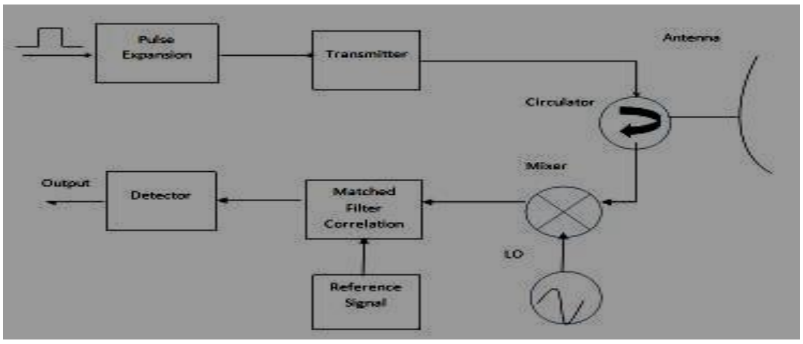


Figure.3:- System generation system

Step2: initialize general specification
Step3: generate artificial algorithm for LFM .
Step4: generate LFM waveform.
Step5: Denoise signal.

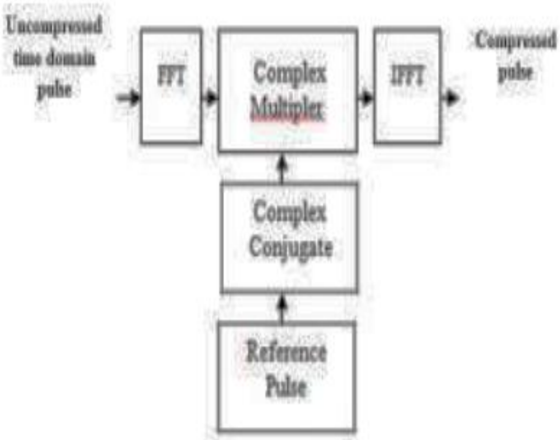
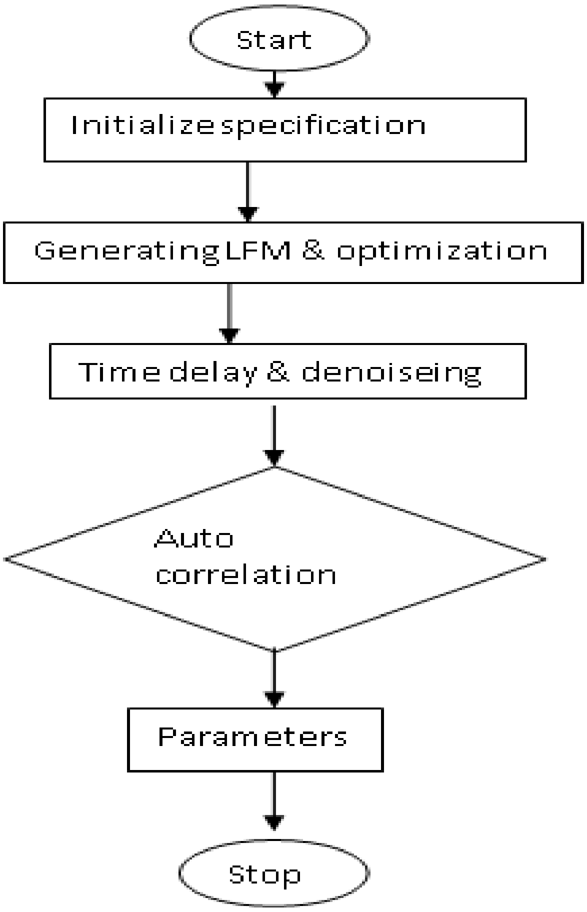


Figure. 4 Denoising of signal

Step6: Auto correlation.
Step7: analyzing gain and other parameters.
Step8: comparison parameter of previous methods.



RESULTS:-

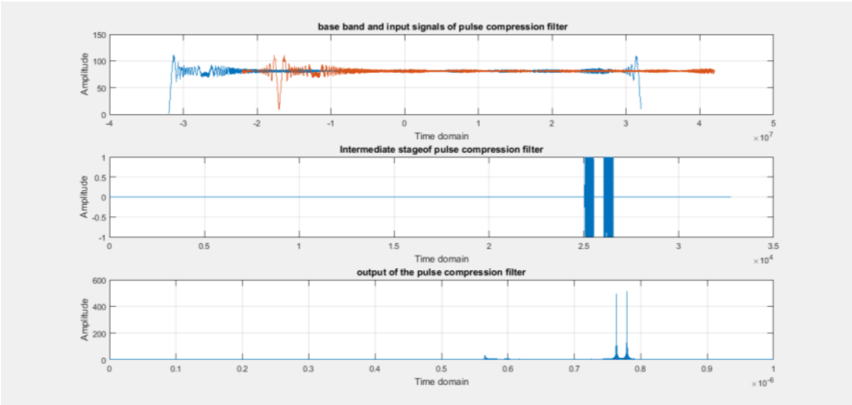


Figure.5:- Comparison of pulse compression technique by using BFO-LFM with LFM

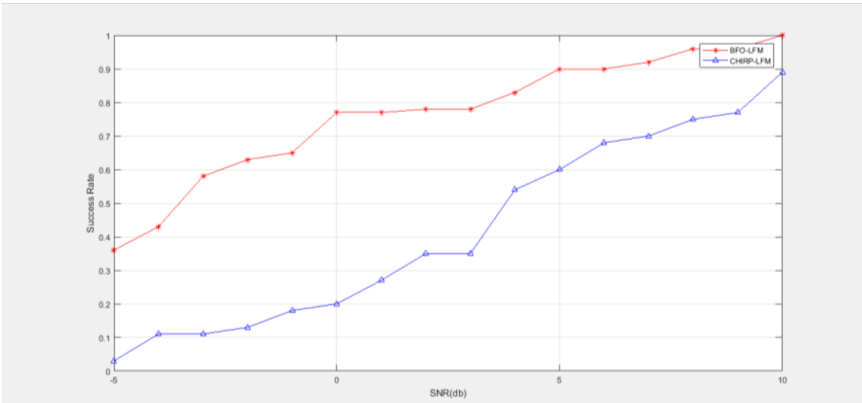


Figure.6:- Comparison of success rates of BFO-LFM and CHIRP-LFM

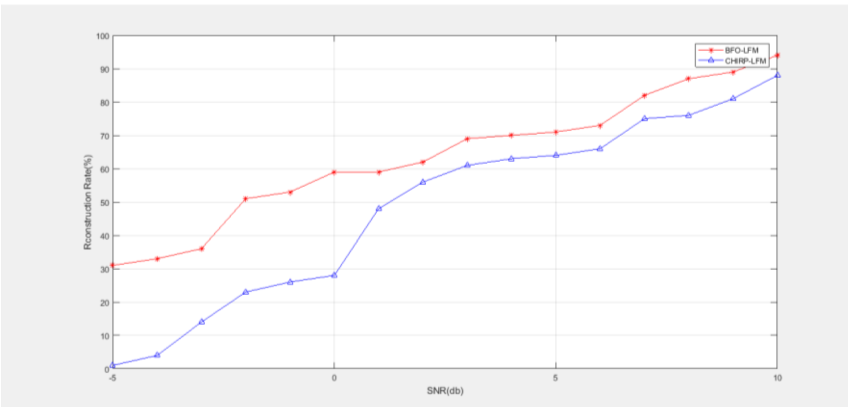


Figure.7:- Comparison of reconstruction rate of BFO-LFM and CHIRP-LFM

The average value of gain comes out to be 95db which is 3db more as compared to previous techniques used.

Conclusion

The deterministic forging is proposed to replace the pseudo-random PN and Gaussian sequence as the mixing sequence for the AIC scheme, which is used todeal with the local non-sparse targets in the LFM pulse compression radar. Compared with traditional mixing sequence, the chirp mixing sequence guarantee the reconstruction performance, compression success rate and gain of both local sparse targets and non-sparse targets.

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