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To Improve the Speech Quality using Adaptive Filter Optimized by using Bacterial Foraging Optimization Technique

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Abstract- This paper proposes Bacterial Foraging Optimization Technique implemented on an adaptive Wiener Filtering method for speech enhancement. As adaptive wiener filter procedure lean on variation of filter transfer function from sample to sample situated on speech signal statistics; the local variance and local mean. It is achieved in time domain comparatively than in frequency domain in order to hold for time varying aspect of the speech signals. The SNR of proposed method is compared with the SNR of the existing method. The simulation results reveal the superiority of the proposed method by showing the SNR value higher as compared to the existing method.

Keywords- Adaptive wiener filtering, Bacterial Foraging Optimization, Local mean, Local variance, Speech enhancement

I. INTRODUCTION

Speech signals are the most generally used signals among humans, to transfer messages. Hence, the researchers commit a large consideration to speech processing and suggested lots of researches in hearing sciences and speech[1]. Speech signals are flawed through backdrop noise may well significantly reduced your speech top element and so confine your applicability about speech technological innovation[2].

Speech processing systems are used in a variation of applications such as speech recognition for automatic intelligence systems, speech pre-processing for aids to hearing impaired persons and speech coding for communications. These systems are described under the supposition that corruptive backdrop noises are absent. In a noisy situation, speech enhancement is proposed to enhance the performance of these systems. Speech enhancement is a word used to illustrate algorithms, which can be used to enhance the quality, reduce the hearing fatigue of noisy speech, raise intelligibility, and enhance the performance of the speech communication systems [3]. On another hand, no speech enhancement systems can enhance both intelligibility and speech quality. Basically, speech intelligibility can be considered as an aspect of quality, considering high-quality speech constantly gives good intelligibility, also unintelligible speech wouldnot be determined as having tremendous quality. In manyearlier researches, speech enhancement raises the quality but decreases the intelligibility [4].

Several methods have been suggested for this purpose like the signal subspace method, the Wiener filtering method, the spectral subtraction method, and the wavelet denoising method [5, 6, 7, 8, 9, 10] .The enhancement of the speech Signal-to-Noise Ratio (SNR) is the objective of most approaches. In this paper, we present aBacterial Foraging Optimization technique implemented on an adaptive Wiener filtering technique for speech enhancement.This technique carried out in the time domain and recognizes the local statistics of the speech signal.

II. ADAPTIVE WIENER FILTERING

The adaptive Wiener filter asset from the fluctuating local statistics of the speech signal. In this process, the predicted local variance σ_x^2 and local mean m_x of the signal x (n) are oppressed. It is simulated that the additive noise v (n) has a white nature with variance σ_v^2 and is of zero mean.

Examine a short segment of the speech signal in that the signal x (n) is simulated to be stationary, the signal x (n) can be formed by:

$$x(n) = m_x + \sigma_x w(n) \text{ - (1)}$$

Where σ_x and m_x are thestandard deviation and local mean of x (n).w (n) is unit variance babble with a zero mean.
In a period of short segment of voice, the wiener filter transfer function perhaps proximate by:

$$H(w) = \sigma_x^2 / \sigma_s^2 + \sigma_v^2 \text{ - (2)}$$

Within the local segments the enhanced signal can be expressed as:

$$\hat{s}(n) = m_s + \sigma_s^2 / \sigma_s^2 + \sigma_v^2 (x(n) - m_s) \text{ - (3)}$$

By this method the filter transfer function is fitting from sample to sample situated on the speech signal local statistics [6].

For the assessment purpose, we have used a speech signal for the sentence "Author of the damaged trail Philips deal six will be forgeted not at this particular case Tom apologize if it was for the 20 time at the evening the 2 men shake hands Lord but I am glad to be with u again Phil" for a male and the "Diesel" is the noise signal that is used in order to calculate the SNR. After taking the different signal i.e. the speech signal and the noisy signal merge both the signals in order to obtain the cleaned signal. The results of SNR obtained by using adaptive wiener filter enhancement technique explained above on the male speech and diesel noise for SNR of 2.1912 dB are shown in Figs. 1 to 3.

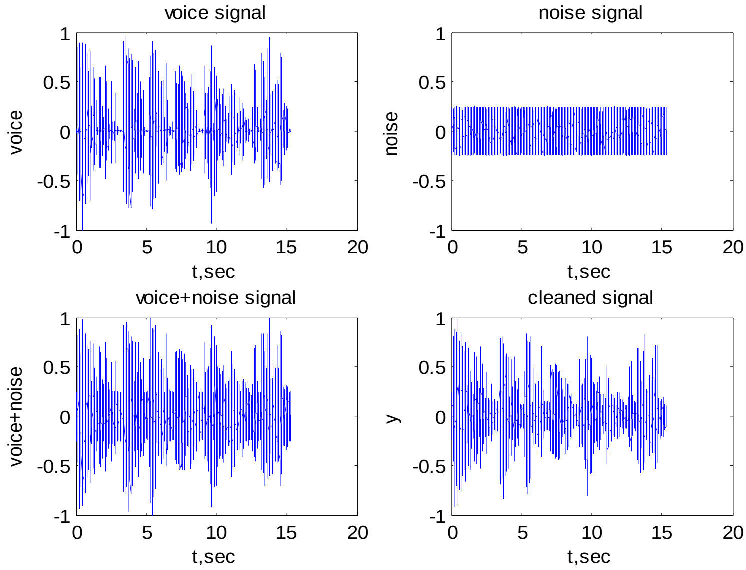

Fig.1 Time domain waveform of the male voice signal and the noisy diesel signal. After adding the voice and the noise signal the cleaned signal is obtained.

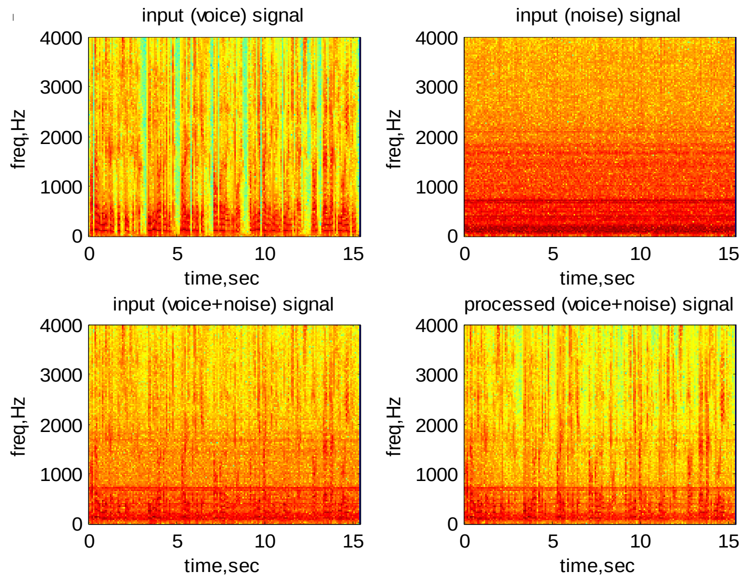

Fig.2 Time-domain spectrograms for comparing the original voice and the cleaned voice.

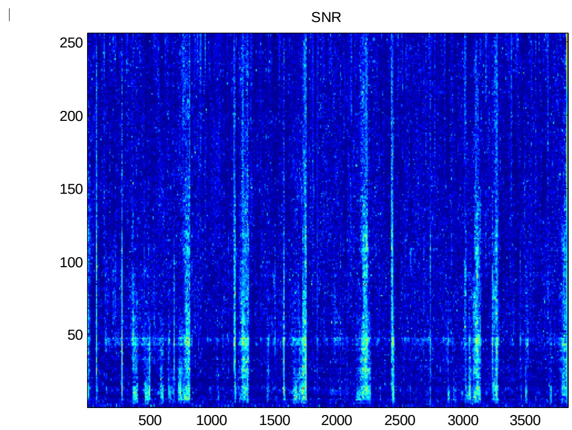

Fig.3 The desired SNR is obtained from the Adaptive wiener filter method.

III. BACTERIAL FORAGING OPTIMIZATION TECHNIQUE

The Bacterial Foraging Optimization Algorithm (BFOA) resides to the field of Swarm Optimization and Bacteria Optimization Algorithms, and more usually to the fields of Metaheuristics and Computational Intelligence. It is linked to other Bacteria such as Swarm Intelligence algorithms and other Bacteria Chemotaxis Algorithm like Particle Swarm Optimization including Ant Colony Optimization. There have been many expansion of the approach that pursuit to hybridize the algorithm along other Metaheuristics and Computational Intelligence algorithms such as Genetic Algorithm, Tabu Search and Particle Swarm Optimization [7].

A. Inspiration

Bacterial Foraging Optimization Algorithm is situated on the social foraging action of Escherichia Coli (E. coli) bacteria being in human intestine [8]. Since initiation, the BFOA has drawn consideration of researchers as a great performance optimizer and many outstanding applications of BFOA in optimal restraint engineering image processing [9], electric load forecast [10] and network scheduling [11] etc.BFOA coupled with approaches of moment (MOM) has also been used in antenna applications. Many enhanced application based modification of BFO have also come up prominent to drastic contraction in convergence time and with greater accuracy.

B. Metaphor

The Bacteria Foraging is a developmental algorithm which concludes cost function after particular iterative step of the program at the timeof the program execution proceeds and points to progressively better fitness (less cost function). The parameters to be improved represent coordinates (position) of the bacteria. Every set of the discrete code display a point in the space coordinates that means that the parameters are discretized in the desirable range. Then one bacterium is positioned (created) at individual point. After each continuous step the bacteria shifts to new positions (new coordinate values) and at every position cost function is determined and then, with this dropping value of cost function, another action of bacteria is determined by dropping direction of cost function. This certainly leads the bacilli to a position with highest fitness.

C. Strategy

The foraging strategies of E. coli Bacteria are directed by four operations. These are chemotaxis (action of a cell or an organism in response to a chemical stimulant), swarming (no of bacteria in a motion), reproduction and elimination and dispersal (scatter in different direction). Chemotaxis is adept by swimming and tumbling. When the bacterium conformedfavorable environment (noxious free and rich in nutrients), it pursue swimming in the same direction. Drop in cost function indicatefavorable environment, while increment in cost function indicates unfavorable environment. When it conformedunfavorable environment it changes direction. In swarming, the bacterium shifts from their corresponding places in loop of cells by transferring mean square error to the minimal rate.

D. Chemo taxis and Swarming

Ensuing each chemo taxis step, the bacilli move and reach different points in space. Here, at these current locations, fitness of each bacilli is evaluated which further concludes next movement of the bacilli. Fitness of ith bacilli is represented byCost function Pi, j, k, l. less value of Cost function means better function.

E. Reproduction

After each complete chemo taxis process the fitness of every bacterium is calculated. $\sum_{j=1}^{Nc} P^{i,j,k,l}$ is overall sum of cost function, where NC is overall number of steps in an entire chemo taxis process. Region of healthier bacteria express improved sets of optimization parameters. This is executed in reproduction step. Healthiest half of bacteria are let to sustain with least value of cost function, while the other half of them die. Every sustaining bacterium splits up into two and these two are situated at the similar location. In this approach society of bacteria remains constant.

F. Elimination and Dispersal Event

The chemo taxis process implements reproduction and local search speeds up concurrence of search parameters. But, chemotaxis and reproduction may not be sufficient to reach the global minimal point (best enhanced set of parameters). The bacilli may also get captured in local minima considering it to be the finest fitness position in the neighboring patch. To avoid this to arise, elimination and dispersal event is executed. The bacterium having probability Pedis cancelled from present location also one bacterium is situated at a random location so as to recognize global search. The population of bacilli still remains consistent.

Procedure of the Bacterial Foraging Optimization step by step:

Initialize parameters

D = Dimension of search. It is sum of parameters to be optimized. In case that you have three parameters to be optimized, say m1, m2, m3, and then D will be identical to three.

B= Number of bacilli in the population. It should be identical to number of sets of points achievedby discretizing the expansion parameter. Presume m1, m2, m3 individual parameter is discretized to permit ten values in range [1, 2]. Then each set will displays a point in space (m1, m2, m3-coordinates). Hence there will be ten points (region) in the optimization domain. So, ten bacteria are required to be situated at these points to start the research.

p=2 (dimension of search space).

s=26 (number of bacteria).

NC = 50 (Number of chemotaxis steps a bacterium has to shift in a complete chemotaxis method since going for reproduction).
Ns = 4 (Number of swimming steps).
Nre = 4 (Number of reproduction steps).
Ned = 2 (Number of elimination and dispersal steps).
Ped = 0.25 (Elimination and dispersal probability)
C (i) = Unit run-length
fi,j,k,l (m1,m2,m3)= Position vector of ith bacterium, in jthchemo taxis step, in kth reproduction step includingith elimination and dispersal step at a mark in m1,m2,m3-coordinates for inference given above.
Step 1: Elimination and dispersal loop l = l+1
Step 2: Reproduction loop l = l+1
Step 3: Chemo taxis loop j = j+1
For i= 1, 2, and 3.....B, a chemo taxis step for ith bacilli will be as follows:
Determine fitness function Pi, j, k, l.
Save this amount in Plast= Pi, j, k, l so that we can find improved fitness (cost) via run. Tumble: Achieve direction vector Del (i) is appoint a new value which is an arbitrary number lying among [-1, 1].
using equation fi,j+1,k,l m1,m2,m3 = fi,j,k,l m1,m2,m3 + C(i) del(i) delT i del(i)
Determine fitness function Pi, j, k, l
Swim: (1) Initialize swim counter SC = 0.
(2) If SC< Ns
If Pi, j, k, l<Plast, Let Plast= Pi, j, k, l, and use statementgiven in step e) to shift in the same direction.
Use the new accomplish location fi, j, k, l for new rate of m1, m2, m3 to determine Pi, j, k, l and pursue in the loop.
Else SC=Ns
Do the similar process for next bacilli i=i+1, go step b) if i≠S.
Step 4: If j<NC, go to step 3 for laterchemo taxis step at the time that the chemo taxis process does not complete.
Step 5: Reproduction. With present values of k, l, figure out overall fitness (cost function) Pi, j, k, $lNcj$=1 for every ith bacilli and sort the fitness in downward order. Less fitness means higher value of cost function.
Step 6: Half of the bacilli with less fitness will expire and the other half will emulate. They will split into two and situated at the same locale of their parents. So, population remnant constant.
Step 7: If k< Nre, go to step 2. Increase the reproduction counter also starts new chemo taxis process.
Step 8: Elimination-dispersion. Eliminate the bacilli with probability Ped and circulate one at a random locale in the optimization space.
Step 9: If l< Ned, go to step1. Otherwise end.

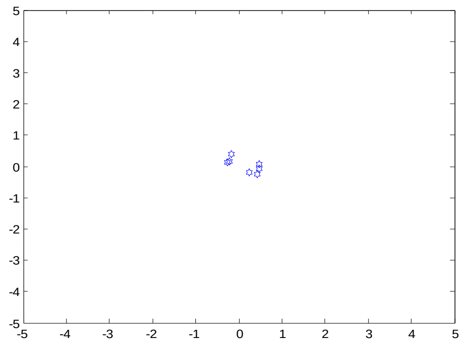

Fig 4. Movement of the bacteria

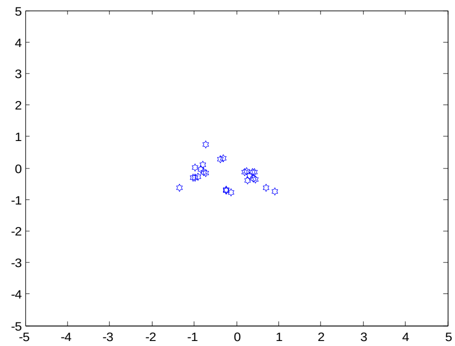

Fig 5 displays the colony of the bacteria after implementing all the four steps and it generates the less cost function for progressively better fitness.

IV. SIMULATION RESULTS

When the function that is obtained from the Bacterial Foraging Optimization Technique is implemented on the adaptive wiener filter in order to obtain the better SNR as compared to the SNR of the adaptive wiener filter. While implementing the proposed technique we obtain the various iterations as output.

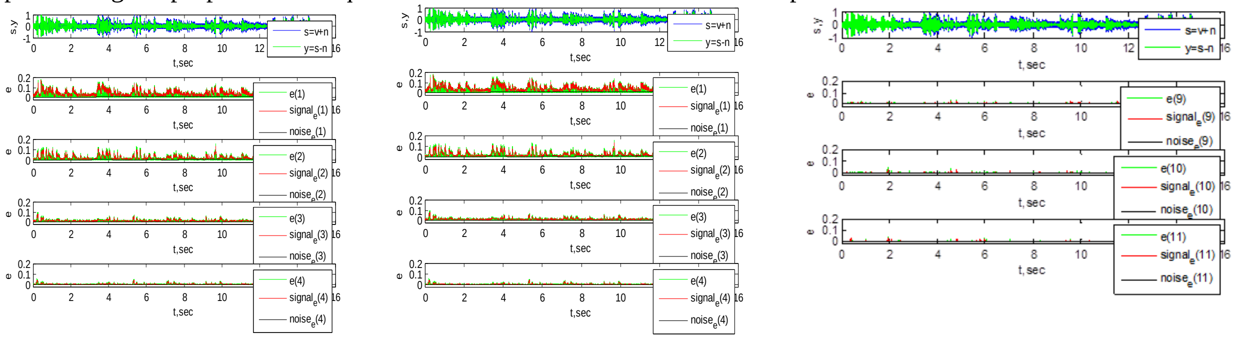

Fig 6. Displays the iterations caused by BFO implementing on Adaptive filter where s represents the SNR and y represents the absolute SNR and e is the error.

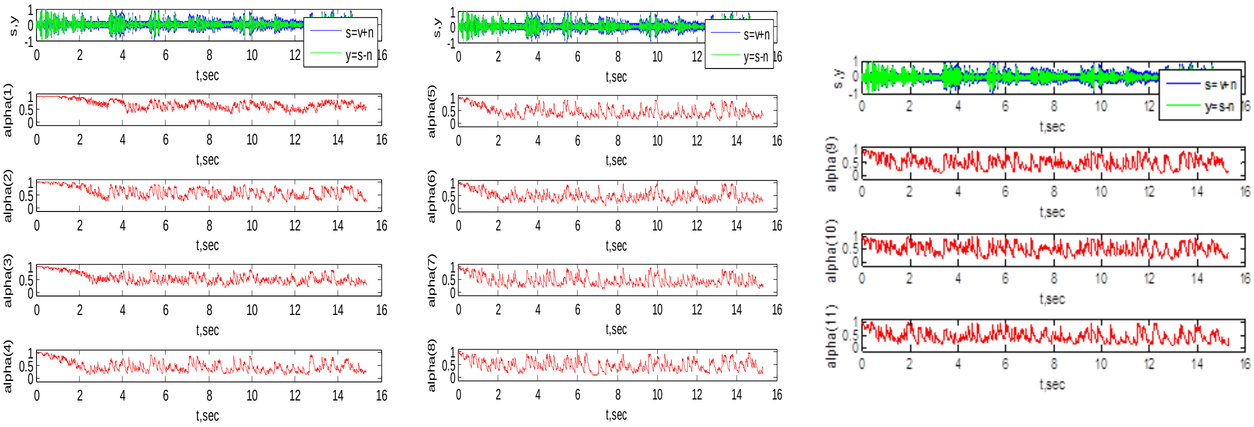

Fig 7. Displays the iterations caused by BFO implementing on Adaptive filter where s represents the SNR and y represents the absolute SNR and alpha is the pre emphasis coefficients.

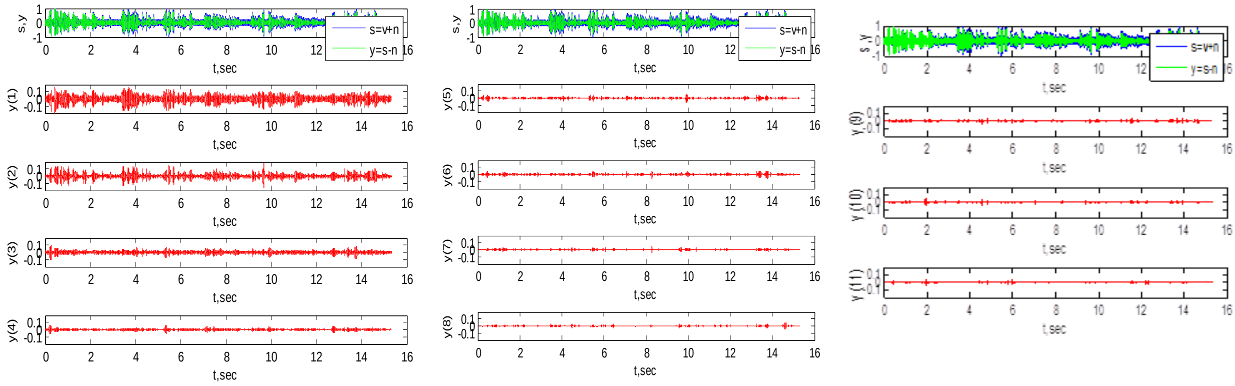

Fig 8. Displays the iterations caused by BGO implementing on Adaptive filter where y is the final output SNR which represents the maximum removal of noise from the signal and the SNR obtained is 7. 9517.

V. COMPARISON BETWEEN THE EXISTING AND PROPOSED TECHNIQUE

In this section there is comparison between the existing and the proposed technique in order to obtain the better results of the SNR.

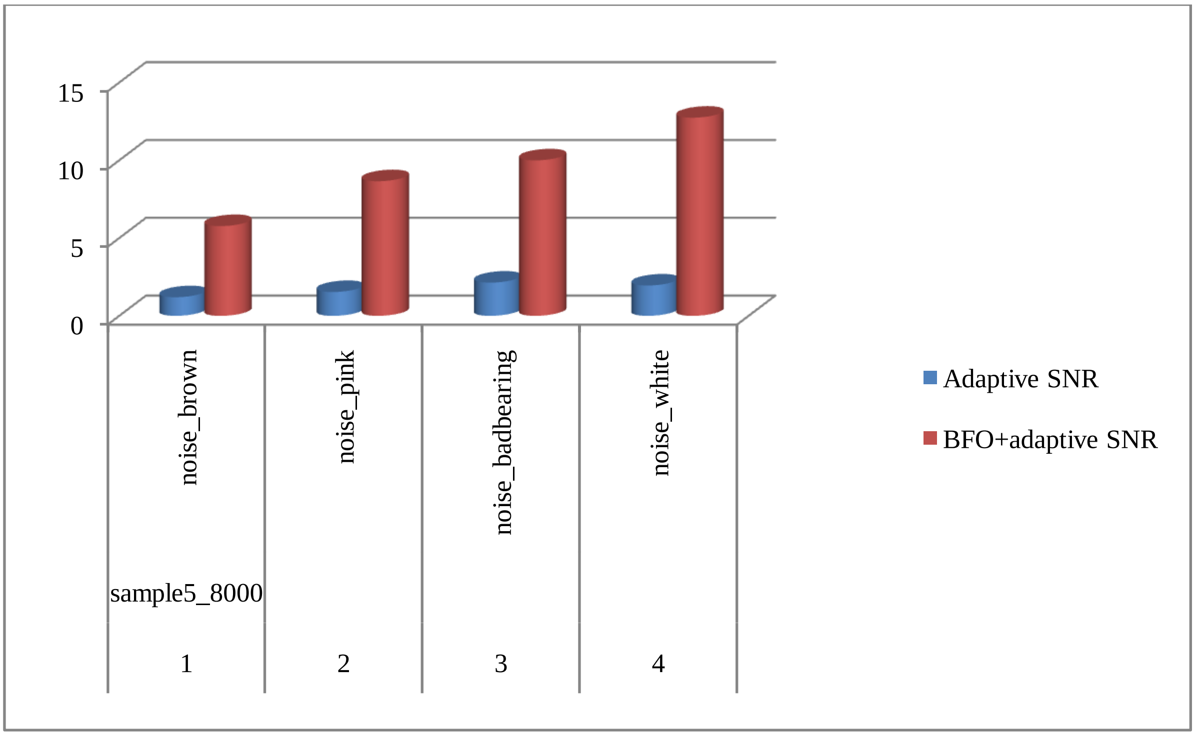

Fig 9.Shows the variations of the Adaptive SNR and the BFO+adaptive SNR .hence this graph displays that the SNR of the BFO+ Adaptive is better than the SNR of the adaptive filter.

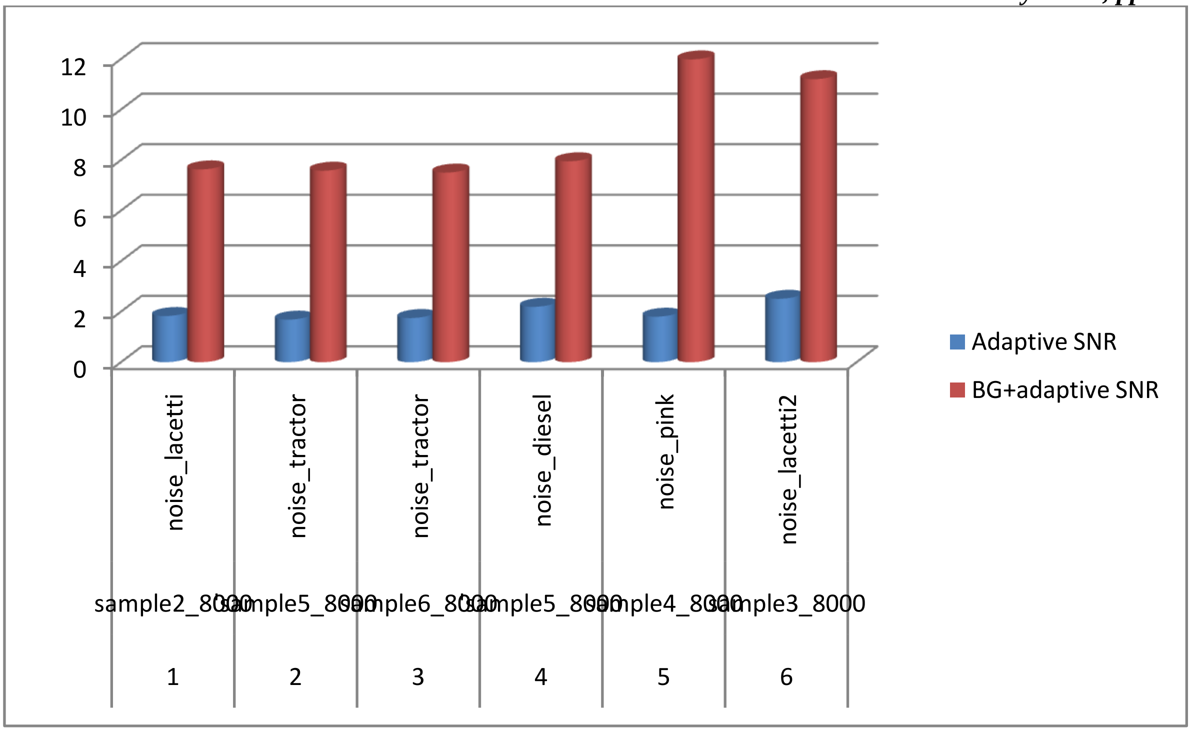

Fig 10.Shows the variations of the Adaptive SNR and the BFO+adaptive SNR .Hence this graph displays that the SNR of the BFO+ Adaptive is better than the SNR of the adaptive filter.

VI. CONCLUSION

From the experimental results and the various graphs showing different values of the SNR it is concluded that the results of the proposed algorithm is better than the existing algorithm as by taking two conditions: firstly by taking same speech signals and then by taking different noisy signals and secondly by taking different speech signals as well as by taking different noisy signals.

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