A new approach for spectrum sensing in cognitive radio using modified threshold and filtering Method

Research paper
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Abstract—Cognitive radio is one of the communication mean that resolves the issue related to inefficient utilization of spectrum by facilitating the secondary user to utilize the unused licensed bands. To perform more improvisations in cognitive radio the concept of spread spectrum has been developed which sense the spectrum and detect the primary user efficiently, In this the specific amount of spectrum is allotted to the primary users and no other users have authority to utilize this band. In this form of communication the carrier signals can also get affected by noise or narrow bandwidth.

To resolve the noise related issue various modulation and filtering techniques have been developed in last decades. In this study a novel approach has been developed by using Matched Filters to perform filtration of the signals so that the SNR of the system can be more efficient and effective. The proposed work also overcome a disadvantage of traditional work by using the concept of double threshold value to enhance the detection probability of the system. The performance of the proposed work is evaluated in the term of SNR and detection probability. The result section renders the comparison of proposed work with conventional work and proves that the proposal outnumbered the traditional spread spectrum sensing mechanisms.

Keywords—*Cognitive Radio, Spread Spectrum Sensing, Filtration, Noise, Matched Filters, SNR.*

I. INTRODUCTION

With the improvement in modern communication means, the need of high data transmission rate has been increased and to fulfill this requirement various communication traits such as OFDM [1], SCFDMA etc. had been developed.These communication mediums utilize the modulation techniques in order to modulate the carrier signals. But these traditional communication systems with modulation schemes sometimes fail to achieve the efficiency and satisfy the user[2]. Consequently, due to such lacking issues various enhanced communication systems other than OFDM has been developed and spread spectrum is one of such communication systems. It is a signaling mechanism that facilitates the user to communicate at a higher bandwidth rate as compare to data transmission rate[3].

Nowadays, the wireless networks are managed by a dynamic fixed spectrum standard[4] generated by government authorities. This spectrum is specifically assigned to only some of the users who have license and also assigned a long term basis for geographically distributed users[5]. The most of the assigned spectrum is periodically utilized as depicted in figure 1 below which renders the distribution of signal strength[6].

From the figure it is observed that there is a rigorous usage of spectrum in some of the spectrum portion whereas momentous spectrum left useless[7].

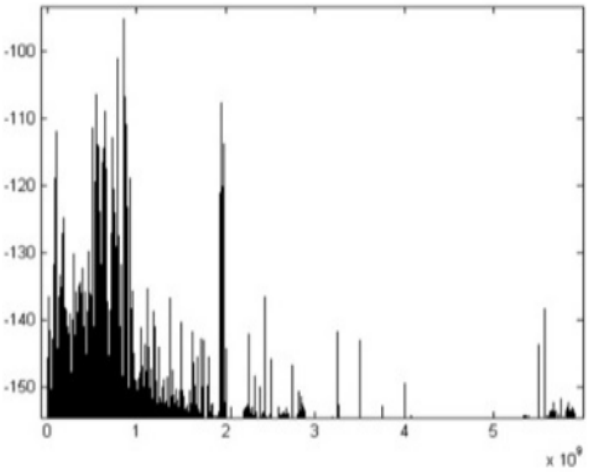


Fig1 Spectrum Utilization[2]

SS is a communication system which comprised of process which[8] transmits the present carrier signals by modulating them with a higher bandwidth, coding waveforms with PN sequences[9]. In this the size of the bandwidth of the carrier signal is greater than the information bandwidth. Such type of communication systems has various characteristics which makes them differ from other narrowband communication systems. SS communication system is less prone to data jamming and interference issues[10]. This system also adds security to the signals because due to wider bandwidth it becomes hard to recognize form noise. Spread spectrum is not used for optical communication[11].

II. MATCH FILTERS

Filtration is a process which is performed to remove the unwanted [12] information from carrier signals [13]. It is done by applying filtration mechanism. Here are many filters that can be applied to a signal but in this study we have utilized the match filters which is explained in this section of the study [14].Matched filter is a filtration mechanism that is much efficient and proficient as compare to other filters that are used for spectrum sensing nowadays in order to enhance the Signal to Noise Ratio of output carrier signals. It falls in the category of linear filters which works on the basis of consistent recognition of main user signal. It attenuates the noisy content and forwards the useful information from the signal when it passes from filters [15]. If wanted signal is presented in the carrier signal then it will lead to an increase in peak value of the output signal and if the peak value is low than this depicts that there is no information in the signal as it only comprised of noise. The primary user information comprised of knowledge of order and kind of modulation applied to signals [16], pulse shaping, format of data packets, bandwidth for the signals and signal operation frequency.

In matched signal filtration mechanism the signal at the receiver side is combined with a filter impulse feedback which is the form of time [17] shifted and replicated form of references signals. The following equation is used for match filtration:

$$y[n] = \sum_{k=-\infty}^{+\infty} h[n-k]z[k] \dots\dots\dots (1)$$

In above formulation the term z depicts an unknown signal which is combined with h. The characteristics of matched filter are as below:

1. It consumes less detection time because the users of cognitive radio has knowledge about licensed user signals.
2. It requires short time to attain a probability of wrong alarm or missed detection.

Disadvantages:

The disadvantages of matched filters are given as follows:

1. It is mandatory to have a knowledge about primary user signals which is not feasible sometimes.
2. There is a requirement of dedicated receiver corresponding to primary user.
3. It increases the complexity because it needs to have receivers corresponding to all signal types.

III. PROBLEM FORMULATION

A "Cognitive Radio" senses the spectral environment over a wide range of frequency bands and exploits the temporally unoccupied bands for opportunistic wireless transmissions. Since a cognitive radio operates as a secondary user which does not have primary rights to any pre assigned frequency bands, it is necessary for it to dynamically detect the presence of primary users. Spectrum sensing is the basic and essential mechanisms of Cognitive Radio (CR) to find the unused spectrum. Spectrum sensing (spectrum detection technique)is the main task in cognitive cycle and the main challenge to the CRs. Energy detection (also denoted as non coherent detection), is the signal detection mechanism using an energy detector (also known as radiometer) to specify the presence or absence of signal in the band. Various techniques have been developed traditionally to detect the energy in the cognitive radio but are not able to perform efficiently because the techniques faces the variations in the value of the detected value of the energy. Other backlog was that none of filtration was performed over the signals in order o remove the noise from the signals. The traditional method is based on the single threshold value which is again a lacking point. Hence there is a need to develop such a technique which can overcome the problems of the existing techniques.

IV. PROPOSED WORK

After having a review to the previous work it is detected that the problem of variations in the value of the energy, single threshold value and existence of noise in the signals were faced. Hence in order to solve these issues the proposed work aims to implement the double threshold value in order to overcome the issues of the single threshold value, and match filters to remove the noise from the signals.

The proposed methodology is divided into two parts i.e. transmitter side processing and receiver side processing the diagrams below depicts the flow of the proposed work on both ends.

1. Transmitter End

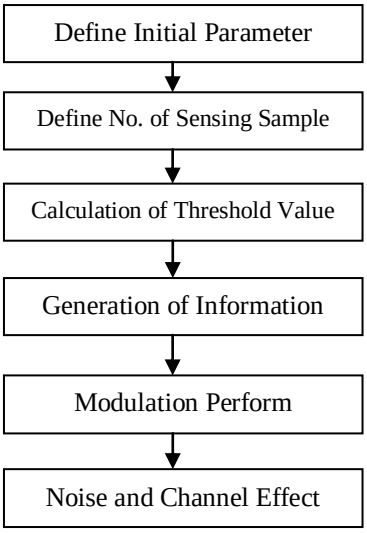


Fig 2 Block diagram of transmitter end

1. In the first step Define the initial Parameters
2. After define the initial parameter then next step is to Define the no of Sensing Sample
3. Then the next step to Calculate the threshold value on the basis of noise
4. After calculate the threshold then the generate the information on basis of threshold
5. Then perform the modulation process
6. At last Describe the noise and channel effect

2. Receiver end

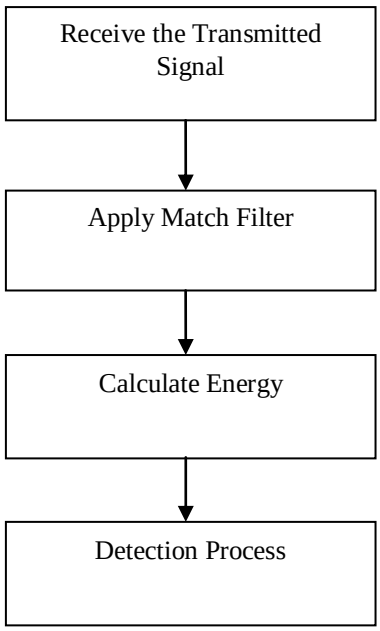


Fig 3 Block diagram of receiver end

1. In the first step Receive the Transmitted Signal
2. After receive the transmitted signal then apply the Match Filter
3. Next step is to calculate the energy.
4. After calculate the energy then perform the detection process

V. RESULTS

This section renders the simulation results of proposedwork that are obtained using MATLAB. The objective of the proposed work is to apply matched filters to remove noise from carrier signal and to enhance the value of SNR. The graph below shows the relationship among SNR and detection probability. Detection probability is a term that is used to evaluate the probability time taken by the filter to detect the noisy content from the signals. Higher detection probability results to higher value of signal to noise ratio.

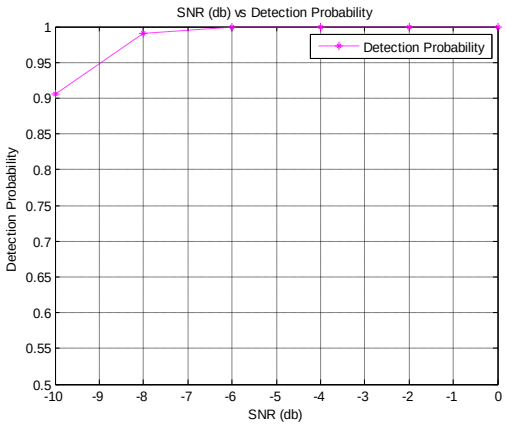


Fig 4 SNR and Detection Probability

The figure 5 shows the comparison of various traditional techniques used for spread spectrum with respect to their detection probability and SNR. And it is observed that SSCD has the highest detection probability and SNR whereas FDFW has lowest detection probability and SNR.

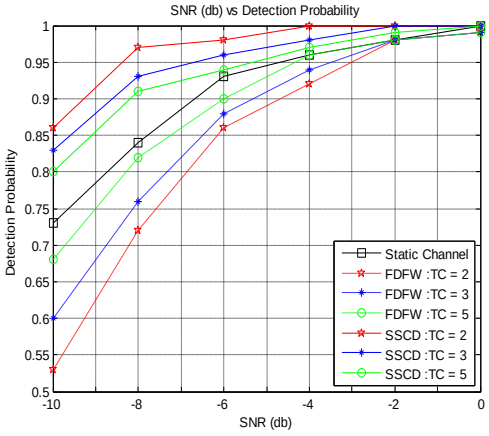
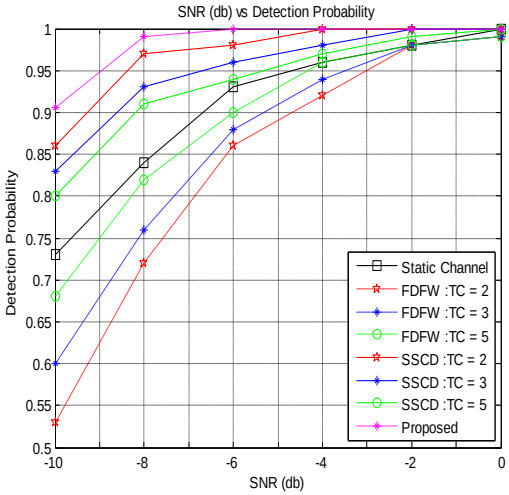


Fig 5 Comparison of traditional works.

The comparison graph of figure 6 renders the comparison of traditional techniques with proposed work on the basis of SNR and detection probability of the work. The comparison is conducted to prove the proficiency of proposed technique over conventional ones.

The fig 6 concludes that the proposed work poses that higher detection probability which is evaluated to 0.9 which is quite higher as compare to the SSCD.



VI. CONCLUSION

It is concluded in this study that the sensitivity of spread spectrum can be enhanced by reducing the effect of the noise from the signals and by performing filtration of the carrier signals which directly improves the signal to noise ratio of the communication system. The proposed work comprised of Matched filters and double threshold value to increase the detection probability. The results proves the proficiency of the proposed work over traditional work i.e. SSCD.

Further enhancements can be done by implementing the spread spectrum sensing mechanism by using intelligent approach such as ANN or FIS to generate more effective and reliable decision regarding the existence of primary users.

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