International Journal of Future Generation Communication and Networking
Vol. 9, No. 2 (2016), pp. 1-8
http://dx.doi.org/10.14257/ijfgcn.2016.9.2.01

Based on the Pseudo Code Ranging Network Broadband Spectrum Perception Algorithm

Wei Jun Chen and Jing Ping

School of Software, Anyang Normal University, Anyang 455000, Henan, China
Email: cwj@aynu.edu.cn

Abstract

The research based on the related network broadband spectrum sensing algorithm of pn code ranging. More than the traditional spectrum sensing method based on narrow band as the research basis, through the radio-frequency head band pass filter center frequency change and implementation, therefore, not effective spectrum of broadband usage in real time tracking and perception, therefore, put forward the network broadband spectrum sensing algorithm based on pseudo code ranging. Spectrum resource usage through the main user judgment, build relevant spectrum perception model, according to theory of time serial search for pseudo code capture, until the results reached the preset threshold, enter the pn code tracking, according to the obtained phase difference sequence regulating local phase to achieve two sequences are minimum steady-state phase, implementation pseudo-code tracking, thus complete the perception of broadband spectrum and tracking. The experimental results show that the improved algorithm for network broadband spectrum perception can effectively reduce because of the negative impact of such factors as the channel fading and improve the processing speed and the reliability of perception, to provide data support to improve the utilization rate of spectrum resources, has a great advantage.

Keywords*: pseudo code ranging, the network bandwidth, Spectrum perception*

1. Introduction

With the development of the explosive growth of wireless communication, it has received widely application. The demand for wireless frequency spectrum resource is also increasing. Accuracy spectrum perception is an important factor of wireless frequency spectrum resource and thus becomes a hot issue of research [1-3]. Currently, common spectrum perception methods are the network broadband spectrum perception methods based on the optimal multi-taper spectral estimation [4], singularity detection [5] and compressed perception [6], among which the latter one is used the most frequently [7.8]. The effective perception of the network broadband spectrum makes it possible for perception high frequency spectrum and is quite promising. Relevant research is paid attention to closely by experts and scholars [9.10].

Traditional spectrum perception methods were usually based on narrow band. Actual need cannot be realized, as the perception was not as effective as expected to.

Consequently, this paper proposes a network broadband spectrum perception method, in order to make up for the weakness of traditional methods. The service condition of main users is analyzed. The spectrum perception model is established. Pseudo codes are acquired according to the time-domain serial research theory, until the threshold is reached. Then, local phase sequence is adjusted according to obtained phase difference and pseudo codes are tracked. These are the basic steps of network broadband spectrum perception and tracking. Results show that with the improved algorithm, negative factors such as noises can be wiped out. As a result, the perception is more efficient and reliable, which makes full use of the spectrum resource.

ISSN: 2233-7857 IJFGCN

2. Principles for Network Broadband Spectrum Perception Based Oon Pseudo Code Ranging

Principles for network broadband spectrum perception based on pseudo code ranging can be described as below:

The phase of the carrier wave is adjusted by sending pseudo-random codes. The codes are sent through antenna which receives and reflects the wave. The receiver regains m sequence of the reflected wave and tracks the signal synchronously through adjusting the phase. The distance of the object can be obtained by computing the delay inequality τ between sending and receiving m sequence. To ensure the distance is definite, the period of m sequence should be twice the ranging.

Suppose the maximum ranging is $d_{\max}$, and the period pT of m sequence can be computed by:

$$d_{\max} = \frac{1}{2} cpT \qquad (1)$$

Where $p = 2^n - 1$, and n is used to describe the series of shift register. T is code width. As the period of pseudo-random codes prolongs, the codes are more resistant to interference. Higher accuracy is reached and the ranging is increased.

According to the characteristics of m sequence, code width T has something to do with the ranging accuracy. When T is reduced, the ranking is more accurate. When the ranging is large, the period of pseudo-random codes prolongs, and the time τ for slipping acquisition method is: l

$$\tau = \frac{pT}{2} \qquad (2)$$

During the spectrum perception, it is suggested to design rapid codes with rapid acquisition plans, as shown in Figure 1.

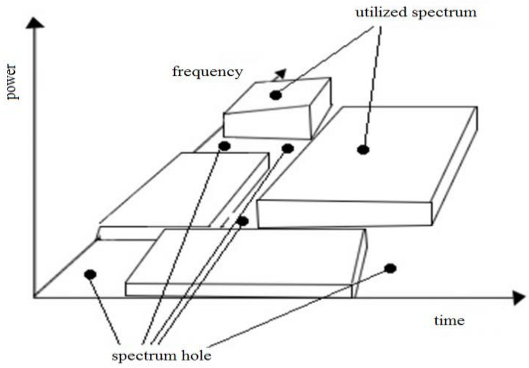


Figure 1. Production of Rapid Code

From the abovementioned principles, the network broadband spectrum perception is realized with high accuracy and reliability.

3. Improved Algorithm of Network Broadband Spectrum Perception Based on Pseudo Code Ranging

Traditional spectrum perception methods were usually based on narrow band, which was realized by changing the center frequency of the band-pass filter. However, it fails to track and sense the service condition of network broadband spectrum.

3.1 Construction of Spectrum Perception Model

The perception is to track and locate accurately the underutilized spectrum resources that haven't been used by main users in the network broadband. Cognitive users can take the use of such underutilized resources and drop out when main users are using it. Cognitive users constantly search for underutilized resources. The service condition of the spectrum can be expressed as in Figure 2.

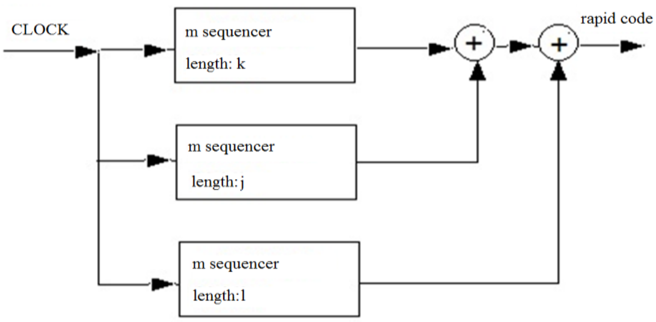


Figure 2. State of the Spectrum Resources

During the perception, cognitive users judge the service condition of the licensed spectrum through the signals sent by main users, and confirm whether there are underutilized resources. The modeling is to verify the dualism hypothesis.

Suppose H_0 is used to describe the situation where there are no main users. H_1 is used to describe the situation where there are main users. Then, the network broadband spectrum perception can be described as below:

$$r(t) = \begin{cases} \omega(t), H_0 \\ s(t) + \omega(t), H_1 \end{cases} \tag{3}$$

Where $r(t)$ is the signal received by cognitive users $s(t)$ is the signal sent by main users $\omega(t)$ is used to describe white Gaussian noise which averages at 0.

According to relevant testing methods, $r(t)$ is dealt with and the statistical decision Y. According to the threshold λ, the service condition of spectrum utilization by main users is judged:

$$\begin{cases} Y < \lambda, H_0 \\ Y \geq \lambda, H_1 \end{cases} \tag{4}$$

3.2 Pseudo Code Acquisition

According to time-domain series search principle, the codes are acquired as below:

The signals sent by main users are received by the receiver. They are transformed to the medium-frequency signal at the front-end:

$$S(i) = \sqrt{2P}D(i)PN(i-i) * \cos \left[(w_o - w_d)iT_s + \phi\right] + n(i) \quad (5)$$

Where P is the received signal power. $PN(i-i_s)$ is the pseudo code. w_o is the frequency of the carrier wave. φ is the original phase. $n(i)$ is the superposition of all noises.

After the multiple with local pseudo codes and carrier waves, there are two signals I and Q. After integration, they can be expressed as:

$$I(k) = \sqrt{2P}D(k)R\left[\xi(k)\right]^* \sin c\left[T_d \Delta w_d(k)/2\right]^* \cos\varphi(k) \quad (6)$$

$$Q(k) = \sqrt{2P}D(k)R\left[\xi(k)\right]^* \sin c\left[T_d \Delta w_d(k)/2\right]^* \sin\varphi(k) \quad (7)$$

$$\sin c(z) = \sin(z)/z \quad (8)$$

Where $R\left[\xi(k)\right]$ is used to describe local pseudo code and function of received pseudo code. T_d is the integration time.

Computing the quadratic sum and the acquisition decision with the peak value is obtained:

$$P = \max(P_j) = \max\left\{\sqrt{I_j^2(k) + Q_j^2(k)}\right\} \quad (9)$$

If it doesn't reach the threshold, then the pseudo code generator is moved half a code. The process is repeated until the peak value reaches the threshold, which indicates successful phase synchronization. Then, the pseudo codes are tracked.

3.3 Pseudo Code Tracking

After acquisition, there are still errors Δ between local code and the input pseudo code sequence. Thus, we need to track the pseudo code for accuracy purpose.

A typical lead-lag incoherent code tracking modeling is adopted to track the pseudo codes. Phase difference of received and local sequence is obtained. Local phase sequence is adjusted accordingly, so that the stable phase difference between two sequences is the minimum. The tracking model is shown as in Figure 3:

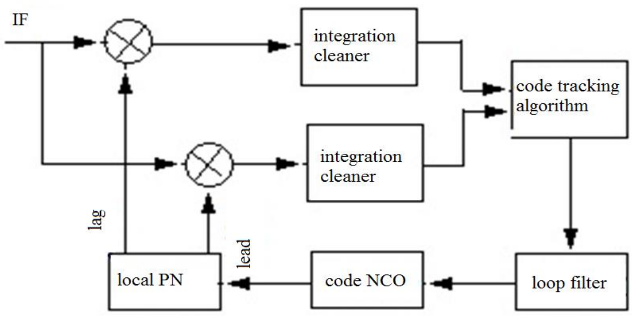


Figure 3. Lead-Lag Incoherent Code Tracking Model

Suppose the curve of $\pm 1/2Tc$ is featured by $DTc/2(\tau)$, thus there is:

$$D_{Tc/2}(\tau)=R(\tau-T_c/2)-R(\tau+T_c/2)=$$
$$\begin{cases}\frac{N+1}{N}\frac{2\tau}{T},|\tau|\le\frac{2T_c}{2}\\ \frac{N+1}{N}\frac{2\tau}{T}(1-\frac{3T_c}{|2\tau|}),\frac{T_c}{2}\le|\tau|\le\frac{3T_c}{2}\\ 0,|\tau|<\frac{3T_C}{2}\end{cases} \quad (10)$$

Where T_c is the code width of the expanded spectrum sequence. $R(\tau)$ is the normalized function of PN.

According to abovementioned method, the network broadband spectrum resource perception is realized and located.

4. Results and Analysis

To verify the efficacy of the improved algorithm, an experiment was conducted.

Relevant parameters are set up as below: the network broadband frequency ranges from 0Hz-80MHz and is divided into 80 equal-interval channels, the width of each is 1MHz. Number them as $h=\{h_1,h_2,...,h_{80}\}$. BPSK modulating signal is adopted to transmit. Under different parameters, the threshold is confirmed as the average value of 100 experiments. White gaussian noise is added.

Suppose $h_1=\{h_{1_1},h_{1_2},...,h_{1_\beta}\}$ is the No. of the channel occupied by main users. $D_1=\{D_{1_1},D_{1_2},...,D_{1_\beta}\}$ is the decision of channel h_1. The detection rate of evaluation index is:

$$P_d=\frac{\|D_1\|_0}{\beta} \quad (11)$$

Suppose $h_0=\{h_{0_1},h_{0_2},...,h_{0_\omega}\}$ is the No. current spectrum hole. $D_0=\{D_{0_1},D_{0_2},...,D_{0_\omega}\}$ is the decision of channel h_0. So, the false alarm rate is:

$$P_f = \frac{\|D_0\|_0}{\omega} \quad (12)$$

Both the traditional method and the improved method are adopted to conduct the experiment. The evaluation is according to the performance of the network broadband perception algorithm which is based on pseudo code ranging.

(1) Comparison of perception performance of algorithms under different SNR

The SNR (signal-noise ratio) ranges from -25dB to 25dB. 100 experiments of traditional algorithm and improved algorithm are conducted under each signal-noise ratio. The average of detection rate and the false alarm rate is shown in Figure.4 and 5:

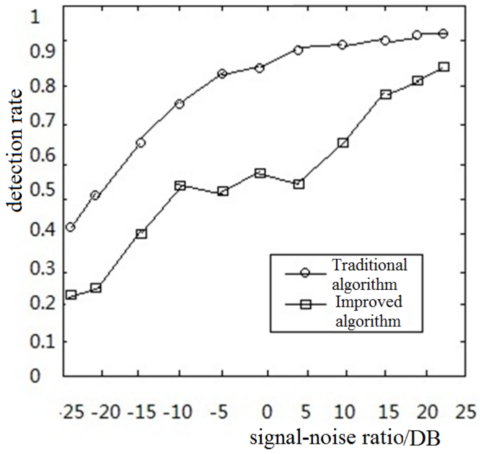


Figure 4. Detection Rate of Two Algorithms under Different Signal-Noise Ratios

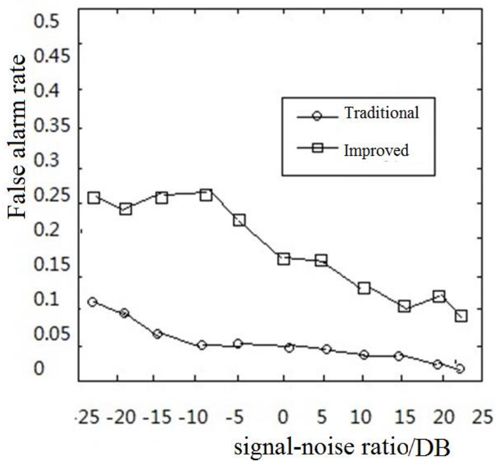


Figure 5. False Alarm Rate of Two Algorithms under Different Signal-Noise Ratios

From Figure 4 and 5, it is seen that when the settings of the network broadband spectrum perception remains unchanged, the detection rate of the algorithm increases versus the signal-noise ratio. And the false alarm rate decreases along with the increase of the signal-noise ratio. Under the same signal-noise ratio, the average detection rate of the improved algorithm is higher than that of the traditional algorithm, and the average false alarm rate is lower than the latter. This indicates that the improved algorithm is more resistant to interference and performs better than the traditional algorithm.

(2) Comparison of time-consuming of two algorithms

To evaluate the efficiency of the improved algorithm, time-consuming is compared, as shown in Figure 6.

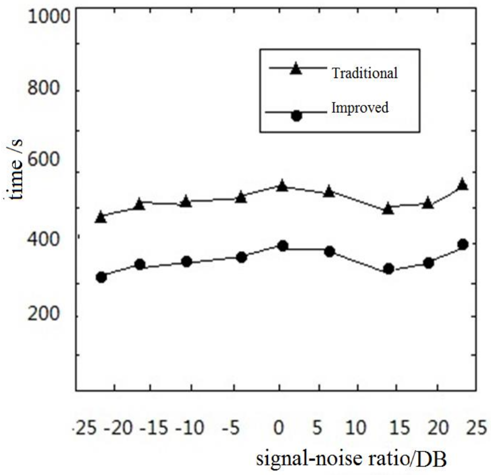


Figure 6. Comparison of Time-Consuming Of Two Algorithms

From Figure 6, it is seen that time-consuming of the algorithm is little influenced by signal-noise ratio. And the improved algorithm consumes less time than the traditional one, indicating that the improved algorithm has higher efficiency than the traditional algorithm in the network broadband spectrum perception.

5. Conclusion

Traditional spectrum perception methods have much limitation. The perception results are poor and actual needs cannot be realized. Therefore, this paper proposes a network broadband spectrum perception method based on pseudo code ranging. The spectrum perception model is established. Pseudo codes are acquired according to the time-domain serial research theory, until the threshold is reached. Then, local phase sequence is adjusted according to obtained phase difference and pseudo codes are tracked. Results show that the network broadband spectrum perception can achieve satisfying perception result with higher efficiency. The false alarm is avoided to some extent. Such method allows full use of spectrum resources and has great potential.

References

[1] Y.K. Yu, M. Wang, W. Guo, L.H. Ma and Z. Wei, "Study of pseudo-range error influenced by the group delay of intermediate frequency BPF in GNSS", Electronic Measurement Technology, no. 3, **(2014)**, pp. 24-28.

[2] H. Cheng, L. Xie and X. Ni, "Reputation-Based Hierarchically Cooperative Spectrum Sensing Scheme in Cognitive Radio Network", China Communications, vol. 1, **(2014)**, pp. 12-25.

[3] Y.Q. Cui and Z.S. Tian, "Forward Signal Acquisition Algorithm and Simulation in Deep Space PN Ranging", Science Technology and Engineering, vol. 3, **(2014)**, pp. 179-182.

[4] Y.B. Li, G.B. Chang and F. Ye, "Exponential entropy-based spectrum sensing algorithm in cognitive radio", Journal of Jilin University：Eng and Techno Ed, no. 5, **(2014),** pp. 1506-1511.

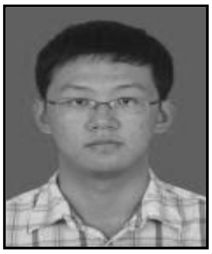
[5] J. Wang, G. Ding, Q. Wu, L. Shen and F. Song, "Spatialtemporal spectrum hole discovery： a hybrid spectrum sensing and geolocation database framework", Chinese Science Bulletin, no. 16, **(2014)**, pp. 1896-1902.

[6] G. Qui and S. Feng, "An Improved Clustering Cooperative Spectrum Sensing Algorithm Based on Minimum Spanning Tree [J]", Telecommunication Engineering, vol. 54, no. 5, **(2014)**, pp. 564-568.

[7] Y.H. Xu and M.S. Lim, "Spectrum sensing using multiple dual polarization antennas for cognitive radio systems in microcell environments [J]", Journal of zhejiang university science, vol. 14, no. 10, **(2013)**, pp. 792-798.

[8] X.H. Zhao ang X.Y. Li, “Spectrum Sensing Algorithm in Cognitive Radio Based on Array Antenna and Covariance Matrix”, Journal of Electronics & Information Technology, vol. 36, no. 7, **(2014)**, pp. 1693-1698.
[9] H. Li, X.Y. Gan, S.Y. Chen and X.X Feng, “Multi-Channel Spectrum Sensing in Cognitive Ad-hoc Networks：An Energy-Efcient Manner”, Journal of Shanghai Jiaotong university, no. 5, **(2013)**, pp. 513-519.
[10] X. Liu, W.Z. Zhong, F.Q. Kong and Q.F. Jing, “Secondary User and Power Allocation in Spectrum Sensing of Multi-Channel Cognitive Radio”, Journal of South China University of Technology: Natural Science Edition, vol. 42, no. 1, **(2014)**, pp. 52-58.

Author



Chen Weijun (1984), School of Software, Anyang Normal University, Anyang 455000, Henan, China

