



CREDIBILITY EVALUATION FOR BLIND PROCESSING RESULTS OF BPSK SIGNALS BY USING PHASE SPECTRAL ENTROPY

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Abstract- A credibility test method based on the features of frequency domain entropy of a phase is proposed to evaluate the blind processing results of a BPSK signal. Initially, a reference signal was constructed depending on the certain identified modulation results. By analyzing the differences of the phase of the correlation series between the observed signal and the reference signal, a reliability test problem for the BPSK signal is performed by calculating the phase spectrum entropy and comparing it with a certain threshold. Simulation results show that the proposed method can be used to verify the reliability of the blind processing results of a BPSK signal at a low signal-to-noise ratio and without a priori knowledge of the signal parameters.

Index terms: blind signal processing; credibility test; phase spectrum entropy.

I. INTRODUCTION

Signal detection, modulation recognition, and parameter estimation are the important operations of signal processing in electronic surveillance and cognitive radio under the condition of lacking a priori information and low signal-to-noise ratio (SNR). These three operations directly affect the results of successive signal processing parts. In electronic surveillance, the results of front-end signal processing will affect the successive signal sorting, locating, tracking, interference, and emitter recognition. In cognitive radio (CR), the reliable results of front-end spectrum sensing and analysis are the premise and foundation of operations such as spectrum sensing and management. Generally, modulation recognition, parameter estimation, and other signal processing results are only blind treatments because of a lack of a priori information in the signal processing domain of electronic surveillance and CR. Judging the accuracy of the processing result has become a new issue in CR and electronic surveillance. The IEEE P1990.6 standard (about CR) [1], reports that a credibility evaluation for modulation recognition of part of a civilian wireless signal sensing device has been considered as an output parameter. Reference [2] shows that the credibility evaluation has been regarded as an independent new operation of modulation recognition in military signal processing systems under conditions of non-cooperation that can be used to judge an unknown signal.

Recently, some researchers analyzed the credibility of signal detection (or spectrum sensing) or modulation recognition, but only a few of them discussed the credibility test about signal blind processing results. References [3–6] analyzed the credibility of the sensing results for each single node to judge whether there are malicious users in cooperation spectrum sensing. This procedure will improve the reliability of the sensing system. However, the researchers analyzed only the binary detection credibility of the primary user signal, and did not analyze the estimation credibility of signal modulation information and subtle parameters. Reference [7] discussed the credibility of a modulation recognition classifier in CR. Half of the difference between the maximum and the secondary output value of a MLP neural network classifier was used to measure the confidence of the classifier. This method requires many training samples, and is difficult to achieve this under non-cooperation conditions. Reference [8] proposed a credibility analysis method based on entropy when BPSK, QPSK, 8PSK, and QAM modulated signals in SISO and MIMO systems were recognized. This method used the differences between likelihood

ratios under different hypotheses to measure the credibility. However, it is also difficult to calculate the likelihood functions without a priori information. Reference [9] proposed a credibility assessment method of signal blind processing based on a lack-of-fit test of linear regression for a BPSK signal. However, the lack-of-fit test for the regression depended on clustering to achieve duplicate samples. Thus, the cluster method and the number of clusters will affect the performance of this method.

This paper first constructed a reference signal, and subsequently calculated the correlations between the reference signal and the observation signal. Then, the phases of spectrums of the correlations were calculated. The credibility assessment of the BPSK signal blind processing results can be obtained by testing the entropy of the phase spectrum. The simulation showed that this method can test the credibility of BPSK signal blind processing at a low signal-to-noise ratio and without a priori knowledge for the signal parameters, and that the algorithm is simple.

II. SIGNAL MODEL

The complex BPSK signal model in a limited observation time can be described as

$$s(t) = Ae^{j(2\pi f_0 t + \theta)} \sum_{k=1}^{N_c} e^{j\pi c_k} \Pi_{T_c}(t - kT_c), 0 \leq t < T \quad (1)$$

where A is the amplitude, f_0 is the carrier, θ is the initial phase, N_c is the number of symbols, T is the observation period, T_c is the duration of the symbol, c_k is the binary k -th symbol, and Π is the gate function defined as

$$\Pi_a(b) = \begin{cases} 1, & 0 \leq b < a \\ 0, & \text{others} \end{cases} \quad (2)$$

The discrete sample sequences of the BPSK signal added noise can be described as

$$x(n) = s(n) + w(n) = Ae^{j(2\pi f_0 nDt + \theta)} \sum_{k=1}^{N_c-1} e^{j\pi c_k} \Pi_{T_c}(nDt - kT_c) + w(n), 0 \leq n < N - 1 \quad (3)$$

where Dt is the sampling interval, and $w(n)$ is the complex zero-mean band-limited white Gaussian noise with a variance $2\sigma^2$ of which the real part and the imaginary part are independent. N is the number of samples, and the signal-to-noise ratio can be defined as $SNR = A^2 / 2\sigma^2$.

III. ALGORITHM DESCRIPTION

The blind processing of the BPSK signal consists of modulation recognition, carrier estimation, code-width estimation, decoding. The premise of decoding correctly lies in correctly recognizing the modulation mode and correctly estimating the other signal parameters (such as carrier frequency and code width). Therefore, the credibility evaluation for blind processing results of the BPSK signal can be described as the following hypothesis test:

H_0 : Both the modulation recognition and the decoding results are correct;

H_1 : The modulation recognition result is incorrect or the decoding result contains at least a single bit error. (4)

A. Feature Analysis

Assuming H_0 , the identification result of the BPSK modulation mode is correct, and there are no decoding errors. The estimations of the carrier, the length of code, code width, and initial phase are, respectively, $\hat{f}_0, \hat{c}_k, N_c, \hat{T}_c, \hat{\theta}$, the reference signal can be structured as

$$y_0(n) = e^{j(2\pi\hat{f}_0 n D t + \theta)} \sum_{k=1}^{\hat{N}_c} e^{j\pi\hat{c}_k} P_{\hat{T}_c}(n D t - k \hat{T}_c), 0 \leq n \leq N - 1 \quad (5)$$

The correlations between the observed signal $x(n)$ and reference signal $y_0(n)$ can be given as

$$z(n) = x(n)y_0(n) = s_0(n) + w_0(n), 0 \leq n \leq N - 1 \quad (6)$$

where

$$s_0(n) = A e^{j(2\pi D f_0 n D t + D \theta)} \sum_{k=1}^{\hat{N}_c} e^{-j\pi\hat{c}_k} P_{\hat{T}_c}[n D t - (k - 1)\hat{T}_c] \sum_{k=1}^{N_c} e^{j\pi c_k} P_{T_c}[n D t - (k - 1)T_c] \quad (7)$$

where $Df = f_0 - \hat{f}_0$ is the frequency estimation error, and $w_0(n) = w(n)y_0(n)$ is the noise part of equation (6). Under hypothesis H_0 , if $N_c = \hat{N}_c$, $D T_c = T_c - \hat{T}_c \rightarrow 0$, $Df = f_0 - \hat{f}_0 \rightarrow 0$, and the SNRs are moderate, we can obtain

$$z_0(n) = s_0(n) + w_0(n)$$

where $s_0(n) = A e^{j(2\pi D f_0 n D t + D d(t) + \theta)}$. Generally, $D d(t)$ is the equivalent error owing to estimation errors of other parameters such as the code width and initial phase. It can be ignored.

Rewrite $w_0(n)$ as $w_0(n) = b_n e^{j\varphi_n}$, where b_n and φ_n are the modulus and angle of $w_0(n)$, respectively.

Because the real part and the imaginary part follow a Gauss distribution, then b_n follows a

Rayleigh distribution, and φ_{b_n} is a random phase in the range of $[-\pi, \pi)$. Let $a_n = A$ and $\varphi_{a_n} = 2\pi\Delta f n \Delta t + \Delta d(t) + \theta$. It follows that

$$z(n) = s_0(n) + w_0(n) = a_n e^{j\varphi_{a_n}} + b_n e^{j\varphi_{b_n}} \quad (8)$$

This can be further derived as

$$\begin{aligned} z(n) &= a_n e^{j\varphi_{a_n}} + b_n e^{j\varphi_{b_n}} \\ &= a_n e^{j\varphi_{a_n}} \left[1 + \frac{b_n}{a_n} e^{j\phi_n} \right] = a_n e^{j\varphi_{a_n}} \left[1 + \frac{b_n}{a_n} \cos \phi_n + j \frac{b_n}{a_n} \sin \phi_n \right] = a_n e^{j(\varphi_{a_n} + \beta_n)} \sqrt{\left(1 + \frac{b_n}{a_n} \cos \phi_n \right)^2 + \left(\frac{b_n}{a_n} \sin \phi_n \right)^2} \end{aligned} \quad (9)$$

where $\phi_n = \varphi_{b_n} - \varphi_{a_n}$, $\beta_n = \arctan \frac{b_n / a_n \sin \phi_n}{(1 + b_n / a_n \cos \phi_n)}$. The phase of $z(n)$ can be obtained by

$$\rho_n = \varphi_{a_n} + \beta_n = 2\pi\Delta f n \Delta t + \Delta d(n) + \theta + \beta_n \quad (10)$$

Considering the assumption of H_0 , $\Delta f \rightarrow 0, \Delta d(n) \rightarrow 0$, so $\rho_n \approx \theta + \beta_n$. This can be regarded as the deterministic initial phase perturbed by a random component. Figure 1(a) shows the instantaneous phase curve of correlation series $z_0(n)$ when H_0 is assumed. Its probability density can be written as

$$p(\rho_n | \theta, H_0) = \frac{e^{-\gamma}}{2\pi} + \sqrt{\frac{\gamma}{\pi}} \cos(\rho_n - \theta) e^{-\gamma \sin^2(\rho_n - \theta)} Q[-\sqrt{2\gamma} \cos(\rho_n - \theta)] \quad (11)$$

where $|\rho_n - \theta| < \pi$, $\gamma = \frac{A^2}{2\sigma^2}$, and $Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^\infty e^{-\frac{1}{2}y^2} dy$. Figure 2(a) shows a statistical histogram

of the instantaneous phase sequence after removing the direct current part under H_0 assumption.

There are probably two cases when H_1 is assumed:

(1) H_{1A} : Modulation recognition is correct, but there exists incorrectly decoding because of the large estimation error of the parameters.

Figure 1(b) shows the instantaneous phase curve of correlation series $z_0(n)$ when the BPSK is correctly identified while there is 1 bit error decoding. From the figure, we can find that the phase of correlation series $z_0(n)$ will jump in the error decoding interval because of the error accumulation in parameter estimation, while the phase sequences show random characters in correctly decoded intervals. So the entire phase sequences r_n do not satisfy the probability distribution of formula (9). Figure 2(b) shows the statistic histogram of phase sequences r_n in this case. The figure shows that the statistic histogram under H_0 is significantly different from

that under H_1 . When H_{1A} is assumed, the statistic histogram is heavier in the left tail. If the number of decoding errors increases, the phase jump will increase, and the phase probability distribution curve will show a greater difference from that under the hypothesis H_0 .

(2) H_{1B} : Modulation recognition is incorrect

If the bandwidth of the BPSK signal is small, or the signal is distorted because of interference, the signal may be regarded as a normal signal (NS) or other modulation signal on the receiver side. Assuming the signal is recognized as an NS, the reference signal is structured as a sinusoid $y_1(n) = e^{-j(2\pi\hat{f}_0 n D t)}$, $0 \leq n \leq N - 1$. Then the correlations between the reference signal and the observed signal can be obtained:

$$z_1(n) = x(n)y_1(n) = s_1(n) + w_1(n), 0 \leq n \leq N - 1 \quad (12)$$

where $s_1(n) = A e^{j(2\pi D f n D t + D \varphi(n) + \theta)}$ is the signal part, and $w_1(n)$ is the equivalent complex zero-mean band-limited white Gaussian noise with a variance of $2s^2$. The phase of $z_1(n)$ can be calculated as

$$\rho_n = 2\pi D f n D t + D \varphi(n) + \theta + \beta_n \quad (13)$$

From formula (13), we find that the phase-error function $D \varphi(n) = -\sum_{k=1}^{N_c-1} e^{j\pi c_k} P_{T_c}(n D t - k T_c)$ leads to an obvious phase offset and jump in the curve of the correlation between the reference signal and the original signal because of signal model mismatching. On the other hand, signal model mismatching may lead to errors of carrier frequency estimation increasing, and $2p D f n D t$ will become larger and show slope characteristics. Figure 1(c) shows the instantaneous phase curve of correlations $z_0(n)$ when the BPSK is incorrectly identified as an NS signal. From the figure, we find that in this case the code sequence is equivalent to an all-1 sequence.

The simulated sequence is a 13-bit Barker code, and the first five sequences are all 1, therefore the error mainly arises from carrier estimation. In this case, the phase-error function is 0 in this interval, so the phase sequence is mainly determined by $2p D f n D t$ and appears as a straight line with a slope of $2p D f D t$. The successive 7 bits are all decoded to 1. If the original code is not 1, an error is produced and the jump of phase will occur. Figure 2(c) shows a statistic histogram of the phase sequences in this case. The figure shows that the phase distribution is flat and there are greater differences between the phase probability distributions compared with those under hypothesis H_0 .

In conclusion, under the hypotheses H_0 and H_1 , the instantaneous phase curves of correlation between the reference signal and the original signal are obviously different. Under hypothesis H_0 , the phase of $z_1(n)$ can be regarded as an approximate random series around the initial phase of the observed signal, and whose probability distribution can be described by formula (11). Under hypothesis H_1 , the phase sequence is combined with a random phase component and determined phase component, and the probability distribution cannot be described by formula (11).

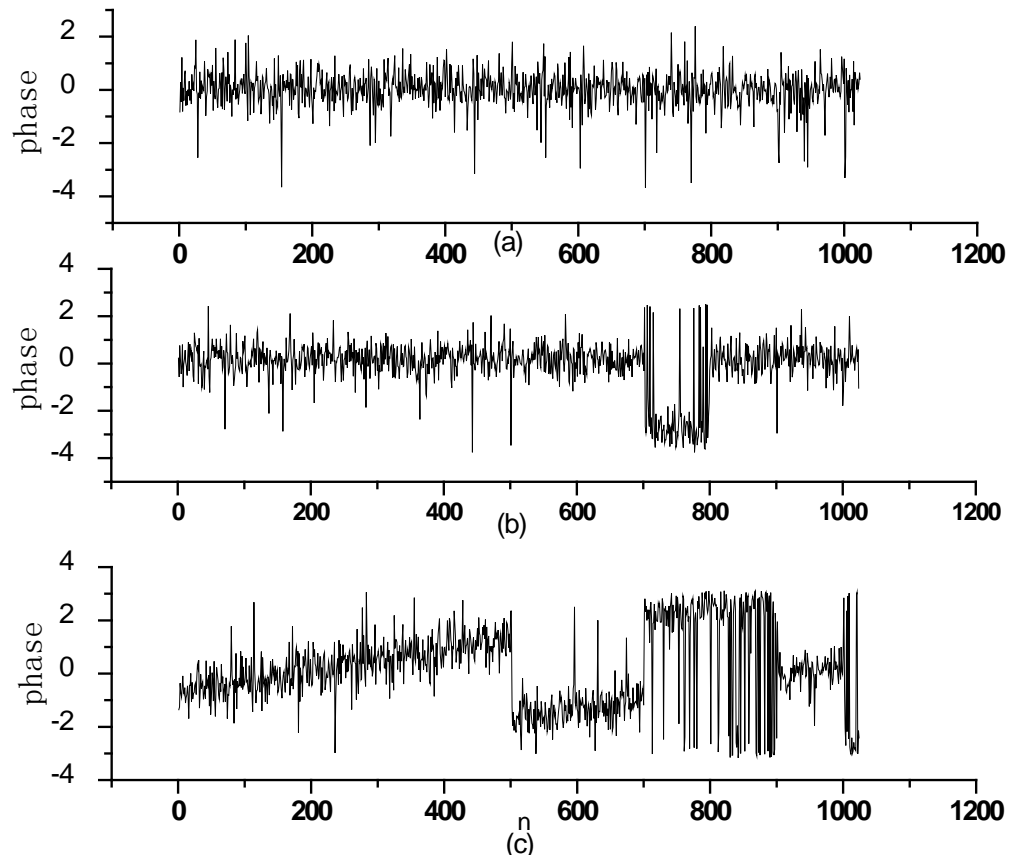


Figure 1. Instantaneous phase curve of correlation series under different hypotheses (13-bit Barker code, SNR is 3 dB)

- (a) BPSK is correctly identified, and there is no decoding error (b) BPSK is correctly identified, but there is one decoding error (c) BPSK is incorrectly identified as NS

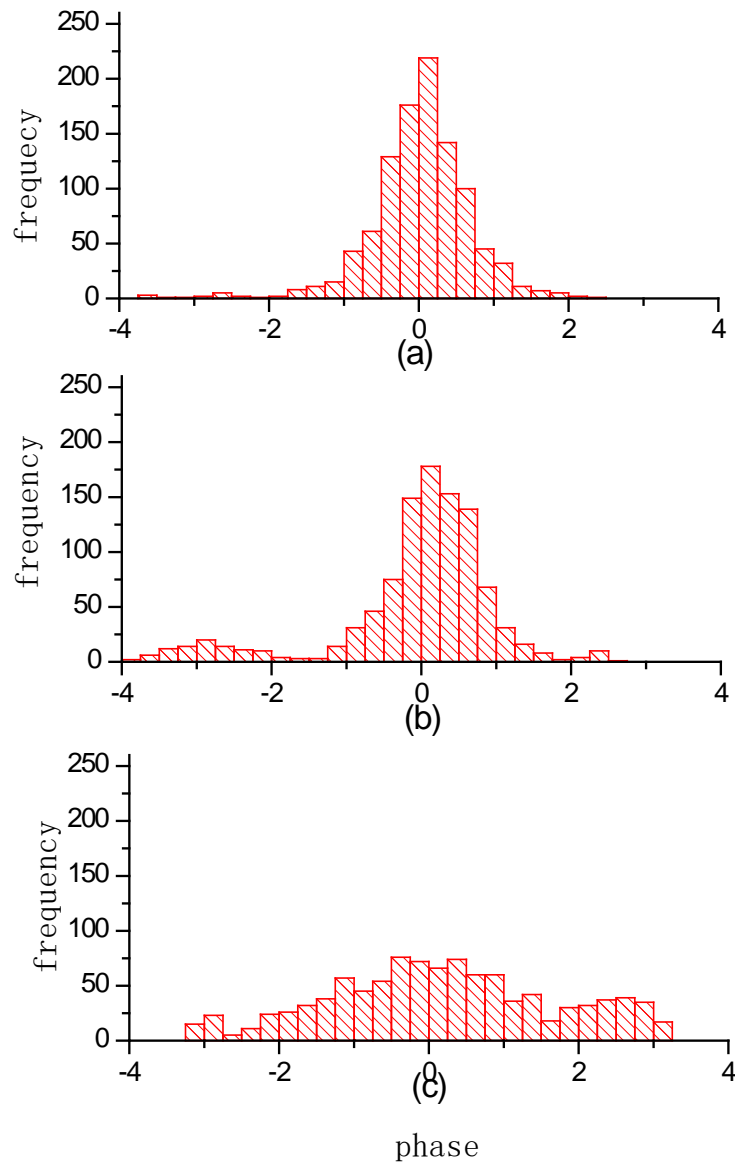


Figure 2. Statistic histogram of correlations phase under different hypotheses (13-bit Barker code, SNR is 3 dB)

- (a) BPSK is correctly identified, and there is no decoding error
- (b) BPSK is correctly identified, but there is one decoding error
- (c) BPSK is incorrectly identified as NS

B. Properties of Phase Spectrum Entropy

From the above analysis, we find that the instantaneous phase curves of the correlation series are different under different hypotheses. The difference mainly demonstrates the randomness of the

phase sequence. Therefore the problem is how to judge whether the phase sequence is random. The phase spectrum entropy can be used as the criterion.

Considering the correlation series $z(n)$, the phase spectrum can be achieved by DFT:

$$Z(k) = \sum_{n=0}^{N-1} z(n)W_N^{-nk}, k = 0, 1, \dots, N-1 \quad (14)$$

Figure 3 shows the smoothing filtered phase spectrum of correlation series under different hypotheses. From the figure, we can see that the phase spectrum is a random series under hypothesis H_0 . There are obvious peaks in the phase spectrum, which has a certain bandwidth under hypothesis H_1 because there are aperiodic rectangular-function or ramp-function components in the correlation instantaneous phase sequence.

According to reference [10-11], the module of the phase spectrum $|Z(k)|$ can be divided into L segments. The width of each segment is defined as $W = Z_m / L$, where Z_m indicates the maximum of $|Z(k)|$. k_i is the number of the samples of $|Z(k)|$ which are located in the i th section, and $\sum_{i=1}^L k_i = N$. The probability p_i is defined as $p_i = k_i / N$ and $\sum_{i=1}^L p_i = 1$. Thus the phase spectrum entropy can be calculated by the successive formula:

$$T(Z) = -\sum_{i=1}^L \frac{k_i}{N} \log \frac{k_i}{N} \quad (15)$$

Figure 4 shows a statistic histogram of the correlation series phase spectrum entropy under different hypotheses. From the figure, we find an obvious difference in the respective statistic histograms under different hypotheses. Under hypothesis H_0 , the phase spectrum entropy is greater than 0.8 and is mainly located around 1 with a smaller variance. Under hypothesis H_1 , if the modulation mode is correctly recognized but there is one bit error, only a few phase spectrum entropy values distribute in the interval [0.6, 1.2]. If the modulation mode is incorrectly recognized, most of the phase spectrum entropy values distribute in the interval [0.1, 0.5]. Thus the phase spectrum entropy can be used to distinguish two different hypotheses.

In addition, the mean value of the random noise phase spectrum entropy is rarely affected by noise variance. Figure 5 shows the mean values of the correlation series phase spectrum entropy under different hypotheses with an SNR in the range [-8 dB, 0 dB]. The number of simulations is 1000 in each case. From the figure, we find that the phase spectrum of the correlation series is

random under hypothesis H_0 , and its entropy almost does not change when the SNR changes. By contrast, under hypothesis H_1 , the phase spectrum contains certain varying contents in the two cases, and its entropy decreases when the SNR increases. When the SNR higher than -8 dB, the appearance is obviously different from that for hypothesis H_0 .

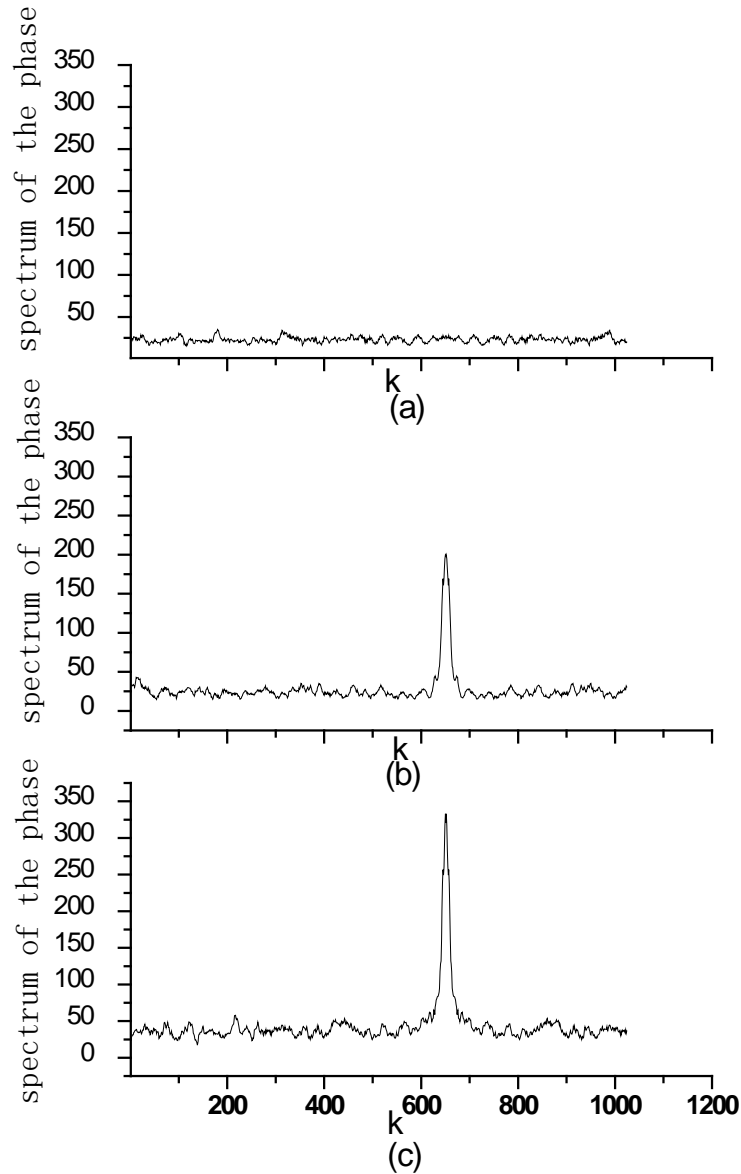


Figure 3. Phase spectrum of correlations under different hypotheses (13-bit Barker code, SNR is 3 dB)

- (a) BPSK is correctly identified, and there is no decoding error
- (b) BPSK is correctly identified, but there is one decoding error
- (c) BPSK is incorrectly identified as NS

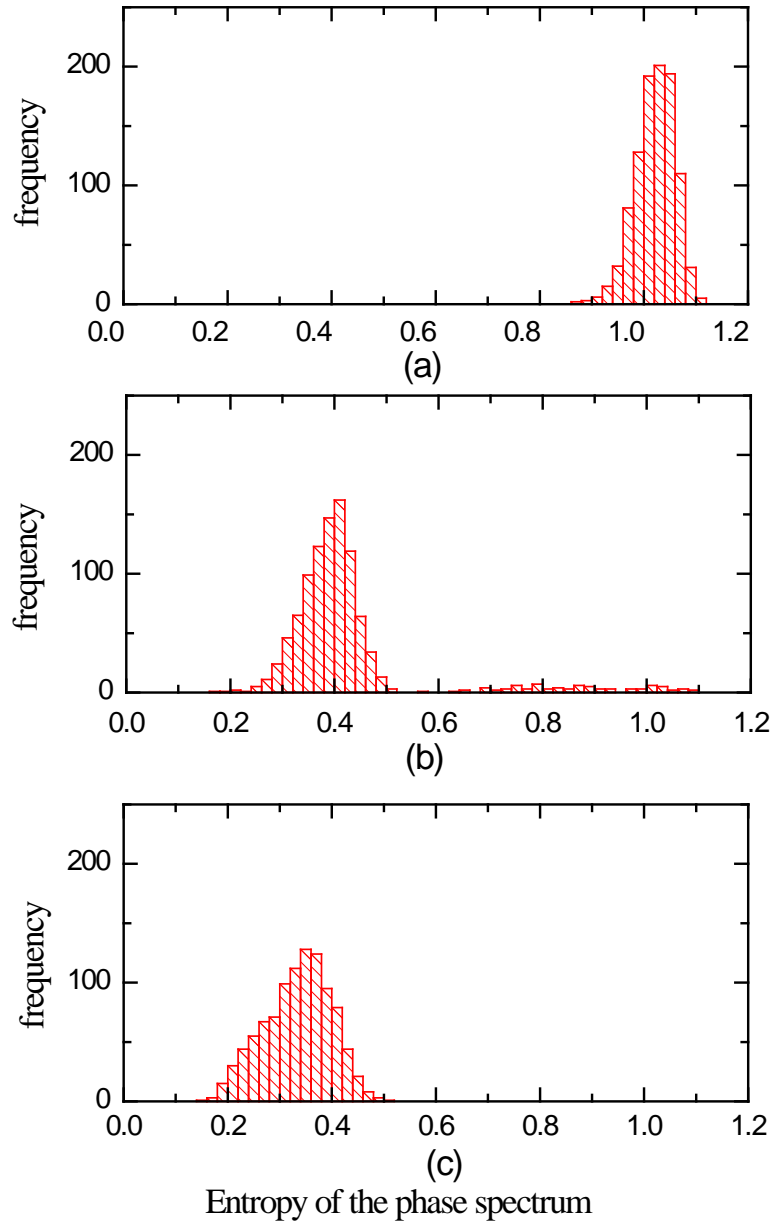


Figure 4. Statistic histograms of the phase spectrum entropy of correlations under different hypotheses (13-bit Barker code, SNR is 3 dB) (a) BPSK is correctly identified, and there is no decoding error (b) BPSK is correctly identified, but there is one decoding error (c) BPSK is incorrectly identified as NS

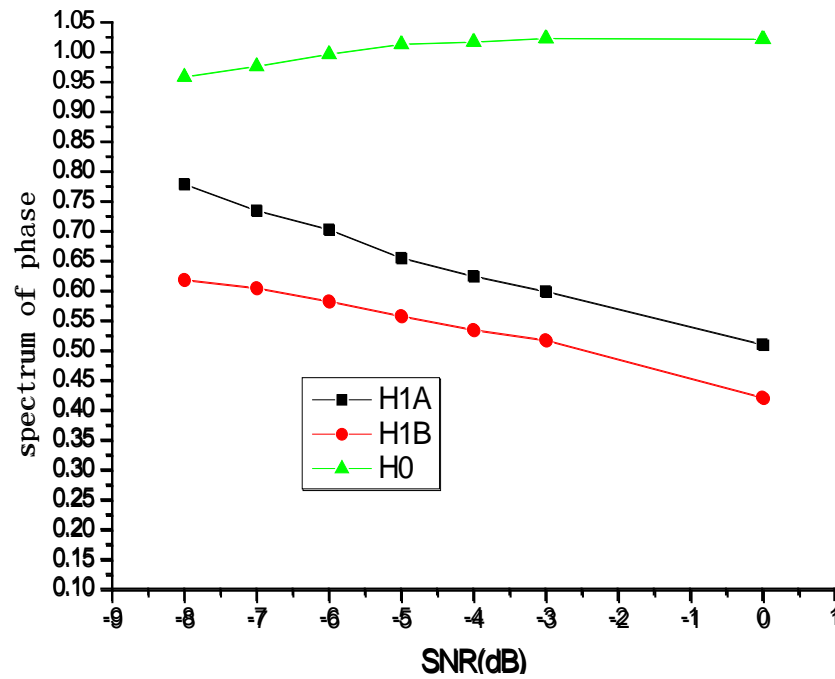


Figure 5. Mean values of phase spectrum entropy of correlations under different hypotheses

C. Algorithm Description

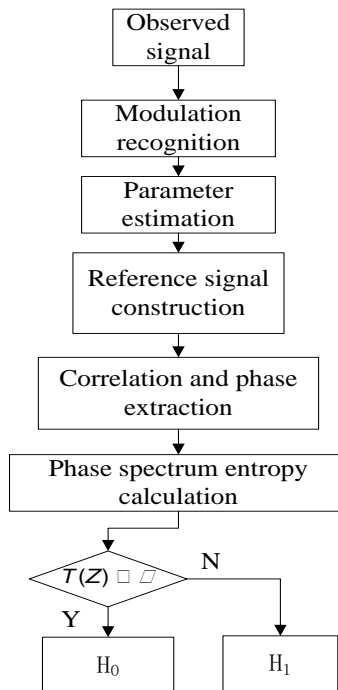


Figure 6. Algorithm procedure

The algorithm flow proposed by this paper is shown in Figure 6. The key steps are described as follows:

- (1) Parameter estimation and reference signal construction: Recognize the modulation type, then estimate the corresponding parameters and construct the reference signal.
- (2) Feature extraction: Extract the phase of the correlation series between the reference signal and the received signal, and then calculate the phase spectrum entropy after removing the mean.
- (3) Judgment: If $T(Z) > l$, H_0 is chosen; otherwise H_1 is chosen. l is a threshold.

IV. PERFORMANCE SIMULATION AND ANALYSIS

Assume the received signal $x(n)$ is the BPSK signal polluted by additive white Gaussian noise, the carrier is 29.081 MHz, the symbol width is 1 μ s, the code series is [1, 1111, 0011, 0101] (which is a 13-bit Barker code), the sampling frequency $f_s = 100\text{MHz}$, and the sample length is 1300.

Experiment 1: Suppose 3000 processing results satisfy the H_0 hypothesis (the modulation recognition is correct and there are no decoding errors), 2000 processing results satisfy hypothesis H_1 (the numbers of H_{1A} and H_{1B} are 1000 respectively). Then the credibility of 5000 processing results is detected by this method.

Experiment 2: Co-Simulation. The intrapulse modulation recognition algorithm used the method in references [12,13], and the parameter estimation algorithm used the method in reference [14]. A total of 5000 simulations were executed.

Table 1 and Table 2 list the performance statistics of the reliability test for the BPSK signal blind processing result under the conditions of experiment 1 and experiment 2, respectively. In the tables, n_{00} indicates the number of times that H_0 is correctly recognized as H_0 , n_{01} indicates the number of times that H_0 is incorrectly recognized as H_1 , n_{10} indicates the number of times that H_1 is incorrectly recognized as H_0 , and n_{11} indicates the number of times when H_1 is correctly recognized as H_1 . $P_e = (n_{10} + n_{01}) / 5000$ is considered to be the estimated probabilities of the two errors. Here the first error means that H_0 is incorrectly recognized as H_1 , and the second error

means that H_1 is incorrectly recognized as H_0 . $P_d = n_{11} / (n_{11} + n_{10})$ is used to measure the algorithm discrimination ability.

Table 1. Statistical performance for experiment 1

$SNR(dB)$	λ	n_{00}	n_{01}	n_{11}	n_{10}	P_e	P_d
3	0.8	1000	0	3857	143	0.0286	0.96425
	0.85	1000	0	3871	129	0.0258	0.96775
	0.9	999	1	3898	102	0.0206	0.9745
0	0.8	1000	0	3626	374	0.0748	0.9065
	0.85	999	1	3670	330	0.0662	0.9175
	0.9	996	4	3732	268	0.0544	0.933
-3	0.8	1000	0	3490	510	0.102	0.8725
	0.85	996	4	3555	445	0.0898	0.88875
	0.9	996	4	3580	420	0.0848	0.895
-4	0.8	997	3	3488	512	0.103	0.872
	0.85	992	8	3504	496	0.1008	0.876
	0.9	984	16	3537	463	0.0958	0.88425
-5	0.8	987	13	3428	572	0.117	0.857
	0.85	988	12	3511	489	0.1002	0.87775
	0.9	963	37	3545	455	0.0984	0.88625
-6	0.8	952	48	3150	850	0.1796	0.7875
	0.85	944	56	3341	659	0.143	0.83525
	0.9	923	77	3450	550	0.1254	0.8625
-7	0.8	910	90	2739	1261	0.2702	0.68475
	0.85	869	131	2993	1007	0.2276	0.74825
	0.9	832	168	3229	771	0.1878	0.80725
-8	0.8	934	66	2166	1834	0.38	0.5415
	0.85	849	151	2586	1414	0.313	0.6465
	0.9	747	253	2894	1106	0.2718	0.7235

Under the conditions of experiment 1, any modulation recognition methods can be used. From Table 1, we find that the statistical performance of the inspection method based on phase spectrum entropy proposed by this paper depends on the SNR and the threshold value. When the threshold is determined, two type error probabilities decrease and false detection probability increases with the ascents of SNR.

When the threshold is certain, two type error probabilities decrease, the ratio of error detection increases as the SNR increases. When the threshold is 0.9 and the SNR is greater than -5 dB, two type error probabilities are less than 9%, and the ratio of error detection is higher than 88%. The performance of the credibility evaluation will worsen when the SNR is less than -5 dB. The threshold will affect the detection performance when the SNR is certain. When the threshold is higher, two type error probabilities are lower and the detection probability is higher. However, two type error probabilities will not become lower at the same time. In practice, the threshold is usually approximately 0.9.

Table 2. Statistical performance for experiment 2

$SNR(dB)$	λ	n_{00}	n_{01}	n_{11}	n_{10}	P_e	P_d
3	0.8	5000	0	0	0	0	/
	0.85	5000	0	0	0	0	/
	0.9	4983	17	0	0	0.0034	/
0	0.8	5000	0	0	0	0	/
	0.85	5000	0	0	0	0	/
	0.9	4987	13	0	0	0.0026	/
-3	0.8	4990	8	1	1	0.0018	0.5
	0.85	4984	14	1	1	0.003	0.5
	0.9	4973	25	1	1	0.0052	0.5
-4	0.8	4964	33	2	1	0.0068	0.667
	0.85	4948	49	2	1	0.01	0.667
	0.9	4907	90	2	1	0.0182	0.667
-5	0.8	4830	87	70	13	0.02	0.843
	0.85	4800	117	70	13	0.026	0.843
	0.9	4751	166	71	12	0.0356	0.855

-6	0.8	3915	112	810	163	0.055	0.832
	0.85	3868	159	828	145	0.0608	0.851
	0.9	3811	216	837	136	0.0704	0.86
-7	0.8	2006	74	2312	608	0.1364	0.792
	0.85	1980	100	2460	460	0.112	0.842
	0.9	1943	137	2503	417	0.1108	0.857
-8	0.8	597	18	2959	1426	0.2888	0.675
	0.85	587	28	3442	943	0.1942	0.785
	0.9	573	42	3673	712	0.1508	0.838

From Table 2, under experiment 2, the algorithm proposed by this article can effectively conduct a reliability test of BPSK blind signal processing when the SNR and the threshold are moderate. If the SNR is not less than 0 dB, the algorithm can detect more than 4983 cases from 5000 simulations where the modulation mode can be correctly recognized and there is no decode error, and two type error probabilities are very small. When the SNR is in the range of [-3 dB, -4 dB], the errors of modulation recognition and decoding will increase as the SNR decreases. When the SNR is in the range of [-5 dB, -6 dB], the errors of modulation recognition and decoding will further increase as the SNR decreases, while most of them can be identified by the algorithm proposed in this article. For example, suppose the SNR is -5 dB and the threshold λ is 0.85. There are 85 errors of modulation recognition and decoding. When 71 errors can be identified, the ratio of error detection is higher than 84.3%. However, two type error probabilities will increase as the SNR decreases. When the SNR is less than -7 dB, the performance of the BPSK blind signal processing method will dramatically worsen. Thus the errors of modulation recognition and decoding will further increase. Even in this case, if the threshold λ is 0.9, the ratio of error detection is higher than 83.8%.

From the simulation results, we find that the credibility test method for blind processing results of a BPSK signal has a preferable capacity for error detection under conditions with a small SNR. This method needs no *a priori* information of the signal and has low probabilities of two type errors.

V. CONCLUSION

By investigating the credibility of blind processing results for a BPSK signal, the phase of correlations between the reference signal and observed signal was obtained. The characteristics of phase spectrum entropy are used to assess the credibility of blind signal processing results. The simulation shows that the method can effectively assess the credibility of blind processing results for a BPSK signal. This method needs no *a priori* information and is simple and effective. The method can improve the reliability and the validity of blind processing results for radar and cognitive radio signals, which are valuable in the theoretical and practical domains.

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