Blind Identification of Sparse Multipath Channels Under the Background of Internet of Things

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Abstract. To improve the ability of blind identification and scheduling of sparse multipath channels in wireless communication networks under the background of Internet of things, a blind identification algorithm for sparse multipath wireless communication based on random sampling interval equalization and BPSK modulation is proposed. The sparse multipath channel model of wireless communication network under the background of Internet of things is constructed, and the multipath characteristics of sparse multipath channel of wireless communication network are analyzed. The BPSK modulation method is used to filter the inter-symbol interference of sparse multipath channel of wireless communication network. Based on the adaptive random sampling interval equalization technique, blind channel identification is designed, and the tap delay line model is used to suppress the multi-path of sparse multipath channel in wireless communication network. The simulation results show that the blind identification of sparse multipath channels in wireless communication networks is well balanced and the bit error rate (BER) is reduced.

Keywords: Internet of things · Sparse multipath channel · Blind identification · Communication

1 Introduction

The Internet of things is a smart object with the ability of online real-time, comprehensive and accurate positioning perception, the ability of "unobstructed" large data comparison and query, and the ability of daily management and emergency response with super intelligence beyond the individual's brain. Therefore, wireless communication networks can use the advantages of the Internet of things to blindly identify and schedule sparse multipath channels. Under the background of Internet of things, the sparse multipath channel of wireless communication network is easy to be interfered by the spectrum of the network, it is easy to appear multi-path effect. The attenuation of signal energy is large, so it is necessary to develop and store reasonable information resources in the spectrum. Transmission and utilization can realize blind identification scheduling of sparse multipath channel in wireless communication network, improve the fidelity of big data communication transmission. And study the blind identification scheduling model of sparse multipath channel in wireless communication network

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under the background of Internet of things [1]. The sparse multipath channel and spectrum of the wireless communication network are effectively managed and controlled, and the error-free control of the sparse multipath channel of the Internet of things is carried out with joint feature recognition and blind channel identification design, so as to improve the efficiency and intelligence of Internet of things communication and resource transmission control [2].

The invention relates to a sparse multi-path channel blind identification and scheduling technique of a wireless communication network under the background of internet of things. In the background of internet of things, the sparse multi-path channel of the wireless communication network is affected by the interference of the electromagnetic medium. The multi-path effect of the channel output, the inter-code interference is easily generated, the communication channel is unbalanced, the channel blind identification design and the scheduling are needed, and the fidelity of the large-data output is improved [3]. Conventionally, a blind identification algorithm for a sparse multi-path channel of a wireless communication network mainly comprises a decision feedback blind identification algorithm, an LMS blind identification algorithm, a diversity blind identification algorithm and the like, the output symbol modulation is carried out in combination with the adaptive modulation and demodulation technology. The channel spread spectrum scheduling is carried out by adopting a spread spectrum technology, the anti-interference and the robustness of the channel scheduling are improved, a certain research result is obtained. The invention provides a blind identification algorithm based on a judgment feedback self-coherent matching object-to-internet communication blind identification algorithm, which consists of a feed-forward filter and a feedback filter, But the method cannot effectively inhibit the impulse response interference in the background of the electromagnetic radiation and the internet of things, so that the anti-interference capability of the channel blind identification and scheduling is not strong; the channel blind identification algorithm based on the combination of the PTRM and the DS is proposed in the reference [4], the blind identification design of the internet of things communication in the background of internet of things is carried out, the inter-code interference suppression model is adopted for multi-path filtering and channel anti-interference processing, the PTRM direct-expanding simulation communication system is constructed. In the three cases of PTRM, the Internet of Things communication system is studied, the error rate of three blind identification scheduling models under different signal-to-noise ratios and different processing gains is analyzed, and the blind identification and scheduling capability of the sparse multi-path channel of the wireless communication network is improved. But the method has the problem that the computational expense is too large and the complexity is high; in the reference [5], a sparse multi-path channel blind identification algorithm based on a wireless communication network under the object of networking background based on a direct sequence spread spectrum is proposed, and a self-correlation matched filter is designed. By direct sequence spread spectrum method, the channel blind identification of the Internet of things communication in the Internet of things is realized, the blind identification effect of the communication channel is good, and the error bit rate of the communication is low. But with the increase of the impact strength of the large data, the impact resistance of the channel is not good, and it needs to be improved [6].

In order to solve these problems, this paper proposes a blind identification algorithm for sparse multipath wireless communication based on random sampling interval equalization and BPSK modulation. Firstly, the sparse multipath channel model of wireless communication network under the background of Internet of things is constructed. The blind identification scheduling of sparse multipath channel in wireless communication network is realized by combining BPSK modulation and demodulation technology, and the blind identification of channel is improved. Finally, the simulation results show that the proposed method can improve the performance of blind channel identification scheduling and improve the transmission quality of Internet of things (IoT) communication.

2 Network Multipath Channel Model and Channel Characteristic Analysis Under the Background of Internet of Things

2.1 Network Multipath Channel Model Description Under the Background of Internet of Things

In order to realize blind identification scheduling of sparse multipath channel in wireless communication network under the background of Internet of things, it is necessary to construct sparse multipath channel model of wireless communication network under the background of Internet of things, and analyze the input and output characteristics of communication signal. The sparse multipath channel of wireless communication network in the context of Internet of things is an extended channel, which is modelled and demodulated by multi-input multi-output MIMO multi-path channel model [7]. The sparse multipath channel of wireless communication network has two main characteristics: one is that it is easy to appear channel distortion in the background of Internet of things, and the sparse multipath channel of wireless communication network is bandwidth-limited channel. Blind identification technology can be used for blind channel identification scheduling to suppress distortion and improve the blind identification of the channel. Second, the sparse multipath channel of wireless communication network under the background of Internet of things has a larger absorption coefficient for higher frequency signals, which can compensate for the inherent channel distortion in the received signal, and the channel characteristics change with time. Under the condition of limited space, the blind identification scheduling of symbol interval and fractional interval has the adaptability under the condition of strong micro-multipath and strong micro-multipath. Under the background of Internet of things, doppler frequency shift affects carrier tracking and symbol synchronization of IoT communication. A coherent multi-path channel model is used to optimize the sparse multipath channel model of wireless communication network under the background of Internet of things. The channel model is constructed by using a digital communication system with blind identifier [8]. The impulse response of the channel after sampling decision can be expressed as follows:

$$h(t) = \sum_i a_i(t) e^{j\theta_i(t)} \delta(t - iT_S) \quad (1)$$

Where, $\theta_i(t)$ is the phase offset of each path. The blind identifier parameters weights are installed for blind channel identification scheduling, and the modified filter coefficients are used to compensate $\theta_i(t)$ and symbol rate H adaptively. The dynamic compensation technique is used to process the symbol sampling of sparse multipath channel in wireless communication network under the background of Internet of things [9]. The output signal model is reconstructed by using positive and negative signal flipping method:

$$\tilde{y}_k^+ = \begin{cases} y_k^+, & y_k^+ \geq 0 \\ 0, & y_k^+ < 0 \end{cases} \quad (2)$$

$$\tilde{y}_k^- = \begin{cases} y_k^-, & y_k^- \geq 0 \\ 0, & y_k^- < 0 \end{cases} \quad (3)$$

The transverse time domain filter shown in Fig. 1 is used to modulate the communication channel, so that the output time delay of the Internet of things communication system is equal to the slope of the phase-frequency characteristic curve, and the tap weighted control is combined [10]. Each multipath signal is added to the output, and the blind identified communication signal is outputted.

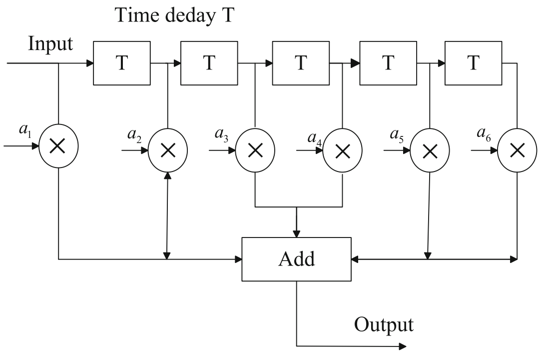

Fig. 1. Structure diagram of transverse time domain filter

In Fig. 1, the big data impact signal is outputted in the multipath channel as follows:

$$x_k = \sum_{n=0}^{N-1} C_n \cdot e^{j2\pi kn/N} \, k = 0, 1, \cdots, N-1 \quad (4)$$

According to the channel difference value of channel impulse between receiving and sending nodes, the complex coefficient is used to simulate the impulse response of the channel accurately. And the instantaneous quantity is used instead of the statistical average to obtain the network multipath channel model under the background of the Internet of things:

$$x_k = \sum_{n=0}^{N/2-1} 2\left(a_n \cos\frac{2\pi kn}{N} - b_n \sin\frac{2\pi kn}{N}\right) \quad k = 0,\ 1, \ldots N-1 \tag{5}$$

In the above formula, a_n denotes the tap interval, and b_n is the time-varying tap coefficient of the blind identifier.

2.2 Inter-symbol Interference Filtering for Sparse Multipath Channels in Wireless Communication Networks

The BPSK modulation method is used to filter the inter-symbol interference (ISI) in sparse multipath channels of wireless communication networks, and the blind channel identification design is carried out with adaptive random sampling interval equalization technique [11]. The channel bandwidth of IoT communication network is obtained under the background of Internet of things:

$$T_s = N_f T_f \tag{6}$$

After the multipath propagation of the channel, the time delay of the sparse multipath channel receiver of the wireless communication network under the background of the Internet of things is obtained as follows:

$$x(t) = \sum_{m=1}^{M} \sum_{k=1}^{K(m)} w_{nk} s(t - T_m - \tau_{mk}) + v(t) \tag{7}$$

In the equation, w_{mk} is the superposition of multiple components with phase offset, and $v(t)$ is noise. According to the channel characteristic range, the interference filtering is carried out, and the adaptive cascade filtering model is used to suppress the interference. The filtering function is expressed as follows:

$$x(t) = \sum_{j=1}^{N_S} \sum_{m=1}^{M} \sum_{k=1}^{K(m)} q_j w_{mk} p(t - jT_s - T_m - \tau_{mk}) + v(t) \tag{8}$$

Where, q_j is the instantaneous impulse response of the channel in a short time, the data training sequence is represented as a_j, and the tap delay model of blind identifier is c_j. The channel output code stream after inter-symbol interference filtering is obtained by suppressing the inter-level interference:

$$T(n) = \sum_{i} R(n,\, i) + T(n+1) \tag{9}$$

While n = 0, T(0) = T(1), while n = N, $\mathrm{T(n)} = \sum_{\mathrm{i}} \mathrm{R(n,\, i)}$, according to the above analysis, the proposed method is used to filter the inter-symbol interference of the sparse multipath channel in the wireless communication network, which can effectively suppress the interference term and improve the effective transmission ability of the signal in the channel.

3 Optimal Implementation of Blind Channel Identification Algorithm

3.1 Multipath Suppression in Sparse Multipath Channels

In this paper, a blind identification algorithm for sparse multipath wireless communication based on random sampling interval equalization and BPSK modulation is proposed. The BPSK modulation method is used to filter the inter-symbol interference of sparse multipath channels in wireless communication networks. The fading signal $Y(n)$ is determined by the output signal $d(n)$ of coherent multi-path channel, the tap coefficient of blind identifier is adjusted. And the adaptive weighting is carried out to construct the channel model of Internet of things communication under the background of Internet of things. The blind channel identification design is also carried out [12]. The satisfaction function for the throughput of the Internet of things communication nodes is shown in the following formula:

$$U_{v_i} = \beta_{v_i} \times \log\left(1 + \partial_{v_i} \times \sum_{j=1}^{K} S_{v_i} e_j^T \frac{R_{C_j}}{n_{C_j}}\right),\ v_i \in v,\ C_j \in C \tag{10}$$

Under the constraint of network utility maximization, the probability formula for obtaining optimal channel matching using channel allocation strategy is expressed as follows:

$$p(i,j) = p(i)p(j) = \frac{\frac{\rho^i}{i!}}{\sum_{i=0}^{n}\frac{\rho^i}{i!}} \frac{\frac{\rho^i}{j!}}{\sum_{j=0}^{n}\frac{\rho^i}{j!}},\ i,j = 0,\ 1,\ldots,\ n \tag{11}$$

Taking the throughput maximization of node interface receiving data as the objective function, the multipath characteristic parameters of sparse multipath channel transmission in wireless communication network are constructed under the background of Internet of things. The $C_0 = C_{N/2} = 0,\ C_{N-n} = C_n^*,\ n = 0,\ 1,\ 2\cdots N/2-1$, tap delay linear model for blind identification scheduling is adopted, the tap delay function is:

$$s_{PPM}(t) = \sum_{i=-\infty}^{\infty} \sum_{j=0}^{N_p-1} p\left(t - iT_s - jT_p - c_j T_c - a_i \varepsilon\right) \tag{12}$$

$$s_{PAM}(t) = \sum_{j=-\infty}^{\infty} d_j p(t - jT_s) \tag{13}$$

Assuming that the step-size transformation factor is $\mu \big/ 1 + \mu \|e(n)\|^2$, the steady-state error of blind identification scheduling of sparse multipath channels in wireless communication networks satisfies $T_p = N_p T_c$. a_i is the channel system parameter and ε is the modulation time offset constant under the tap linear blind identification model. The time function of multipath suppression for sparse multipath channels in wireless communication networks is T_c. The sparse multipath channel multipath suppression in wireless communication network is designed by tap delay linear model, and the modulation function of output channel is obtained as follows:

$$U_{v_i} = \beta_{v_i} \times \log(1 + \partial_{v_i} \times \sum_{j=1}^{K} S_{v_i} e_j^T \frac{R_{C_j}}{n_{C_j}}),\ v_i \in v,\ C_j \in C \tag{14}$$

Where $n_{C_j} = \sum_{j=1}^{K} S_{v_i} e_j^T$, $e_j^T = (0, \ldots, 1, \ldots, 0)$ denotes the error correction feedback coefficient of the multipath vector v_i given different initial μ values, and $\sum_{j=1}^{K} S_{v_i} e_j^T \frac{R_{C_j}}{n_{C_j}}$ denotes the energy decay term.

3.2 Random Sampling Interval Equalization Channel Scheduling Algorithm

In order to eliminate crosstalk caused by the preceding symbol, the optimal solution of sparse multipath channel sparse table matrix $\boldsymbol{W}$ in wireless communication network under the background of Internet of things is solved as:

$$\boldsymbol{W}_{opt} = \arg \min_{\boldsymbol{W}} \lambda \|(\boldsymbol{X} - \boldsymbol{D}\boldsymbol{W})\boldsymbol{G}\|_F^2 \ \ s.t \ \ \|\boldsymbol{w}_i\|_0 \le k \ \ \forall i \tag{15}$$

A transverse filter is used for forward filtering, and the optimal estimation of output nonlinear filtering is expressed as follows:

$$\boldsymbol{D}_{opt} = \lambda \boldsymbol{X}\boldsymbol{V}^{-1}\boldsymbol{W}^T(\boldsymbol{W}\boldsymbol{V}^{-1}\boldsymbol{W}^T)^{-1} \tag{16}$$

By adaptive spectrum spread, the channel phase shift under the background of Internet of things is obtained as follows:

$$S_{v_i} = \{k(v_1, 1), \ldots, k(v_1, i), \ldots, k(v_1, K)\}, K \leq M, j \in M \tag{17}$$

According to the spectrum of sampled communication signals, the diversity blind identification scheduling is carried out. The competition model for blind identification scheduling of sparse multipath channels in wireless communication networks under the background of Internet of things is shown as follows:

$$\alpha(i, j) = \begin{cases} 0, \; i = 0 \; or \; j = 0 \\ 1, \; n - j < i, \; i \geq j \\ 1, \; n - i < j, \; j \geq i \\ 1 - {}_{n-j}C_i / {}_nC_i, \; n - j \geq i, \; i \geq j \\ 1 - {}_{n-i}C_j / {}_nC_j, \; n - i \geq j, \; j \geq i \end{cases} \tag{18}$$

$\alpha(i, j)$ is used to represent the transmission state of a node in (i, j) state, and the formula $P_C = \sum_{i=0}^{n} \sum_{j=0}^{n} \alpha(i, j) P(i, j)$ is obtained, which is used as the allocation strategy for blind identification scheduling of sparse multipath channels in wireless communication networks under the background of the Internet of things.

4 Simulation Experiment and Performance Analysis

In order to test the blind identification scheduling of sparse multipath channel in wireless communication network under the background of Internet of things, and to improve the transmission quality of Internet of things, the simulation experiment is carried out. The experiment is based on Matlab simulation software. In order to facilitate the simulation, the transmitted data from the Internet of things communication system under the background of the Internet of things in the experiment is simulated by BPSK modulation carrier signal. In order to make it easy to simulate the transmitted data through the simulation environment VisualDSP. In the background of Internet of things, the frequency of communication signal is 14.5 kHz, the carrier signal is a set of sine signals with 24 kHz frequency, the sampling rate of Porter interval is 50 kHz, and the sensitivity of communication signal collector is about −265.7 dB (8 kHz–20 kHz). The LFM signal and BPSK signal are transmitted at the transmitting end of the signal, in which the LFM signal is used to test the multipath of the channel, and the BPSK signal is used to verify the blind identification effect. The bandwidth of the signal is 8 kHz–15 kHz, the frequency interval is $\Delta f = 10\,\text{Hz}$, and the cut-off frequency of the pass band is 5 kHz. According to the above simulation environment and parameter setting, the blind identification scheduling experiment of sparse multipath channel in wireless communication network is carried out. In the experiment, the LFM signal is transmitted at the score transmitter of the Internet of things communication system, as shown in Fig. 2.

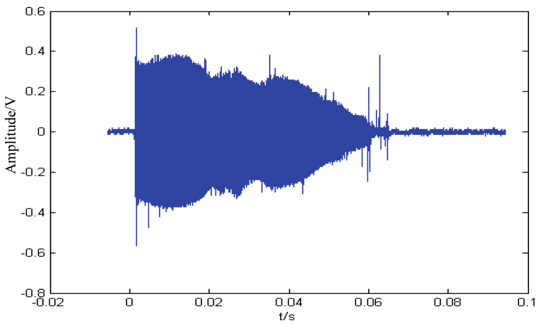

Fig. 2. Output multipath LFM signal from Internet of things communication system

Figure 2 the multipath interference of the transmitted LFM signal leads to poor symbol reception. Therefore, the tap delay line model of the channel is used to suppress the multipath of the sparse multipath channel in the wireless communication network. The blind identification scheduling of sparse multipath channel in wireless communication network is realized by combining BPSK modulation and demodulation technology. The impulse response and cross-correlation of sparse multipath channel of output wireless communication network after multipath suppression are obtained as shown in Fig. 3.

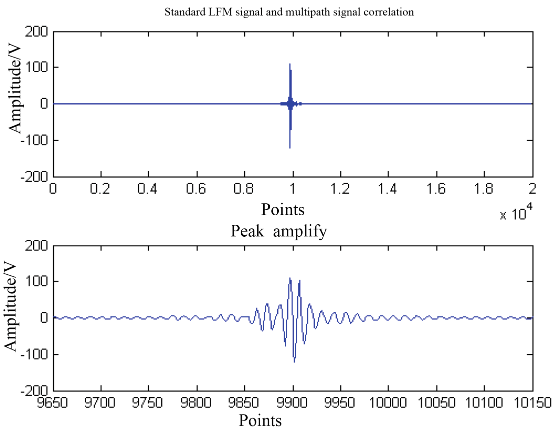

Fig. 3. Channel impulse response and cross-correlation after multipath interference suppression

The results of Fig. 3 show that the blind identification scheduling of sparse multipath channel in wireless communication network using this method has a good impulse response and improves the anti-jamming ability of the channel. As a result, the symbol receiving ability of sparse multipath channel in wireless communication network is improved. Finally, the signals before and after blind channel identification scheduling are compared as shown in Fig. 4.

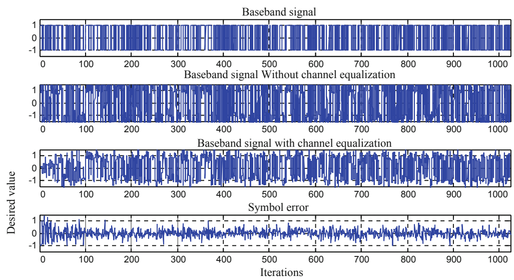

Fig. 4. Baseband signal transmission waveform before and after blind channel identification scheduling

The results of Fig. 4 show that the signal output performance of blind channel identification scheduling using this method is better and the fidelity of symbols is higher. Finally, the method is compared with the traditional method. The interference signal-to-noise ratio of big data is −10–10 dB. Under the same other conditions, the error bit rate of output is tested, and the comparison results are shown in Table 1.

Table 1. Comparison of bit error rates for output streams.

SNR	Proposed method	Traditional method
−10	0.0572	0.1644
−5	0.0431	0.0934
0	0.0312	0.0632
5	0.0006	0.0546
10	0.0001	0.0087

The results of Table 1 show that the proposed method is used for blind identification scheduling of sparse multipath channels in wireless communication networks under the background of Internet of things, and the output bit error rate is low. The robustness and anti-jamming ability of the sparse multipath channel in the wireless communication network are improved, and the robustness of the communication channel is better.

5 Conclusions

In this paper, a blind identification algorithm for sparse multipath wireless communication based on random sampling interval equalization and BPSK modulation is proposed. The sparse multipath channel model of wireless communication network under the background of Internet of things is constructed, and the multipath characteristics of sparse multipath channels in wireless communication networks are analyzed. The BPSK modulation method is used to filter the inter-symbol interference of sparse multipath channel of wireless communication network. Based on the adaptive random sampling interval equalization technique, blind channel identification is designed, and the tap delay line model is used to suppress the multi-path of sparse multipath channel in wireless communication network. The simulation results show that the blind identification of sparse multipath channels in wireless communication networks is well balanced and the BER is reduced. This method has important application value in improving the communication quality of Internet of things.

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