Load balancing transmission technology of network communication based on phase spectrum compensation

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Abstract: In order to improve the load balance scheduling transmission ability of multi-frequency network communication in high-order nonlinear system, load balance design is needed. A load balance transmission method of multi-frequency network communication in high-order nonlinear system based on phase spectrum compensation is proposed. The time domain model of high-order nonlinear system multi-frequency network communication load is constructed by multi-frequency modulation phase spectrum compensation method. The feature detection of high-order nonlinear system multi-frequency network communication load is realized by high-order statistical feature connection identification and communication load balancing method. The autocorrelation constraint parameters of high-order nonlinear system multi-frequency network communication load are analyzed. The multi-dimensional array networking structure model of high-order nonlinear system multi-frequency network communication load is constructed by spatial spectral density analysis method. Combined with phase spectrum compensation and signal detection methods, the extracted high-order nonlinear system multi-frequency network communication load spectrum features are adaptively scheduled and filtered. In the wireless communication networking environment, load balance transmission of communication load in multi-frequency network of high-order nonlinear system is realized. The simulation results show that this method has better balance and lower error rate in multi-frequency network communication load balancing transmission, which improves the accuracy of multi-frequency network communication load balancing scheduling in high-order nonlinear systems.

1. Introduction

With the development of electronic countermeasures and communication technology, the high-order nonlinear system multi-frequency network communication technology is adopted to realize signal transmission and control, and improve the accuracy of data and signal transmission[1]. In the high-order nonlinear system multi-frequency network communication network, due to the influence of environmental interference of signal transmission and other factors, the high-order nonlinear system multi-frequency network communication load balance transmission ability is not good, and the network channel transmission balance is not good. It is necessary to construct an optimized load balancing transmission model of high-order nonlinear system multi-frequency network communication, so as to improve the output stability of high-order nonlinear system multi-frequency network communication, the related load balancing transmission methods of high-order nonlinear system multi-frequency network communication is studied, it has great significance in network communication and signal detection and identification[2].
In order to improve the transmission speed and detection and identification ability of high-order nonlinear system multi-frequency network communication load, it is necessary to construct an optimized transmission model of high-order nonlinear system multi-frequency network communication load balance, adopt spatial undersampling technology to classify and sample the high-order nonlinear system multi-frequency network communication load, and combine with automatic prediction model to cluster the high-order nonlinear system multi-frequency network communication load characteristics. There are mainly fuzzy C-means clustering method, spectral detection method, fusion beamforming method, etc[3]. The information fusion clustering analysis model of high-order nonlinear system multi-frequency network communication load balancing transmission is constructed, and the high-order nonlinear system multi-frequency network communication load balancing transmission is realized through associated information fusion and feature clustering[4]. However, the accuracy of load balancing transmission of multi-frequency network communication in high-order nonlinear systems by traditional methods is not high. Therefore, this paper proposes a load balancing transmission method for multi-frequency network communication in high-order nonlinear systems based on phase spectrum compensation. Firstly, the signal model is constructed, and the time domain model of high-order nonlinear system multi-frequency network communication load is constructed by using multi-frequency modulation phase spectrum compensation method. The feature detection of high-order nonlinear system multi-frequency network communication load is realized by using high-order statistical feature connection identification and communication load balancing method, and the autocorrelation constraint parameters of high-order nonlinear system multi-frequency network communication load are analyzed. Then, through spatial spectral density analysis method, a multi-dimensional array networking structure model of high-order nonlinear system multi-frequency network communication load is constructed, and phase spectrum compensation and signal detection methods are combined to carry out adaptive scheduling and filtering detection on the extracted spectral characteristics of high-order nonlinear system multi-frequency network communication load. In the wireless communication networking environment, load balance transmission of communication load in multi-frequency network of high-order nonlinear system is realized. Finally, the simulation test and analysis show the superior performance of this method in improving the load balancing transmission capacity of multi-frequency network communication in high-order nonlinear system.

2. Signal model and feature analysis

2.1. High-order nonlinear system multi-frequency network communication load model
In order to realize the balanced transmission of high-order nonlinear system multi-frequency network communication load, multi-dimensional sensors are used to collect the high-order nonlinear system multi-frequency network communication load, and bus scheduling is carried out on the collected high-order nonlinear system multi-frequency network communication network signals. In the multi-dimensional array networking protocol, a balanced scheduling identification model of high-order nonlinear system multi-frequency network communication load is constructed[5], and through data bus structure analysis, the high-order nonlinear system multi-frequency network communication load detection and software structure design are carried out, and the overall structure model of high-order nonlinear system multi-frequency network communication load balanced transmission is obtained as shown in Figure 1.
Fig. 1 Overall structure model of load balancing transmission in multi-frequency network communication

According to the overall structure model of balanced transmission of high-order nonlinear system multi-frequency network communication load shown in Figure 1, the time-domain discrete information expression of high-order nonlinear system multi-frequency network communication load is obtained by tracking carrier information at the receiving end:

\[
    z(t) = s(t) + js(t) = \frac{4\pi}{E_s} \int_{-\infty}^{\infty} (t-t_0)^2 |x(t)|^2 dt = s(t) + jH[s(t)]
\]  

In the above formula, \(a(t)\) is called the detection amplitude of multi-frequency network communication load of high-order nonlinear system, sometimes also called envelope; \(z(t)\) is called time dispersion (time standard deviation), and \(\phi(t)\) is the fuzzy transfer function of the communication load of multi-frequency network in high-order nonlinear system.

Using the method of non-stationary time-varying signal feature detection, the signal transmission control of high-order nonlinear system multi-frequency network communication network is carried out, and the time domain distribution model of high-order nonlinear system multi-frequency network communication load is obtained as \(v_{a,m} \in [1, n]\). The transmitting end adds a pulse with a long duration before the signal forehead, which can be written as:

\[
    H(t) = \int_{-\infty}^{\infty} f_2 \arg[Z(f)] df \int_{-\infty}^{\infty} f_2 \exp[j2\pi\phi(t)] dt d\phi
\]  

Wherein, \(b(\tau, \phi)\) is the output spread function of multi-frequency network communication load of high-order nonlinear system, \(\tilde{f}(t)\) is the group delay of frequency domain signal, \(\tau\) is the characteristic spread bandwidth of signal acquisition, \(\phi\) is the fuzzy function of multi-frequency network communication load of high-order nonlinear system. Combined with the function transmission control of integrated system, the multi-frequency network communication load model of high-order nonlinear system is constructed[6].

2.2. Analysis of communication load characteristics of multi-frequency network

The multi-frequency modulation phase spectrum compensation method is used to construct the time domain model of high-order nonlinear system multi-frequency network communication load[7], and the feature detection of high-order nonlinear system multi-frequency network communication load is realized by high-order statistical feature connection identification and communication load balancing method, and the down-modulation carrier amplitude of high-order nonlinear system multi-frequency network communication load is obtained as follows:

\[
    y(t) = \int_{a,b} \rho(a,b) - \frac{1}{2\pi} \frac{d}{df} \arg[Z(f)] \frac{dab}{a^2}
\]
In the above formula, \( f(t) \) is the frequency domain estimated value of high-order nonlinear system multi-frequency network communication load, \( p(a, b) \) is the signal weighting function of zero phase, \( a \) is the slope of its phase characteristic, and \( b \) is the frequency shift parameter of high-order nonlinear system multi-frequency network communication load.

The expression of time broadening function of multi-frequency network communication load of high-order nonlinear system is:

\[
K(u) = Z(f) = A(f) e^{i\theta(f)}
\]

According to the one-to-one mapping relationship between signal and its spectrum, the spectral density separation formula of communication load of high-order nonlinear system multi-frequency network can be expressed as:

\[
Y(u) = \frac{1}{2\pi} \int_{-\infty}^{\infty} S(f) e^{2\pi j f u} df
\]

Based on random power spectral density detection, the dynamic compression model of high-order nonlinear system multi-frequency network communication load is constructed, and the pulse peak span of high-order nonlinear system multi-frequency network communication load is obtained as follows:

\[
f = x(s(t)g(u-t)z_{m}) - x(\min_{x=m} z_{m})
\]

In which \( a, b \) and \( x(n) \) represent coupling coefficients. For a given bandwidth high-resolution high-order nonlinear system multi-frequency network communication load \( d \) and scale, using the frequency domain representation method of the whole signal, the energy distribution and maximum value \( \max\{E(n,d)\} \) of the high-order nonlinear system multi-frequency network communication load in \( x(n) \) scale are obtained, and the spectral peaks of the high-order nonlinear system multi-frequency network communication load are as follows:

\[
K = \left| \int_{-\infty}^{\infty} [s(u)g^*(u-t) e^{-j2\pi fu} du] \right|^2
\]

Carry out convolution sampling on \( x(t) \) to obtain discrete characteristic components of the high-order nonlinear system multi-frequency network communication load, and the width of the window function of the high-order nonlinear system multi-frequency network communication load is \( h(t) \). According to the above analysis, the characteristic analysis model of multi-frequency network communication load of high-order nonlinear system is constructed[8].

3. Load balance transmission of multi-frequency network communication in high-order nonlinear system

3.1. Load detection of multi-frequency network communication in high-order nonlinear system based on phase spectrum compensation

Autocorrelation constraint parameters of high-order nonlinear system multi-frequency network communication load are analyzed. Under the Internet of Things environment, the output of high-order nonlinear system multi-frequency network communication load is constructed as \( x(t) \) by spatial spectral density analysis method, and the power spectrum at different times is calculated, which obeys uniform distribution in the interval [-T, T]. The node distribution model of high-order nonlinear system multi-frequency network communication load at the receiving end is as follows:

\[
r(t) = g(t) + n(t)
\]
In this formula, \( g(t) \) is the echo information of the high-order nonlinear system multi-frequency network communication network, and FIR filtering method is adopted to separate the interference of the high-order nonlinear system multi-frequency network communication load. It is assumed that the input high-order nonlinear system multi-frequency network communication load is a single frequency signal, where \( \cos 2\pi f_0 t \) is the high-order nonlinear system multi-frequency network communication load frequency. The output beam of the high-order nonlinear system multi-frequency network communication network collected by the first transmission node of the Internet of Things application layer is:

\[
s_n(t) = \cos \left[ 2\pi f_0 [t + \tau_n(\theta)] \right] = s(t)g(u-t)
\]

(10)

Assuming that the non-stationary signal is in the analysis window function \( g(t) \), the correlation terms of load modulation information and noise output of high-order nonlinear system multi-frequency network communication are as follows:

\[
l(t) = \int_{-\infty}^{\infty} s(u+\frac{\tau}{2})s^*(u-\frac{\tau}{2})g(\tau)u\,d\tau\,d\tau
\]

(11)

Get the fuzzy function of the signal:

\[
u_m = \cos \left[ 2\pi f_0 \tau_n(\theta) \right]; v_m = \sin \left[ 2\pi f_0 \tau_n(\theta) \right]
\]

(12)

Based on this, a load transmission model of high-order nonlinear system multi-frequency network communication based on phase spectrum compensation is constructed, as shown in Figure 2.

![Fig. 2 Load transmission model of high-order nonlinear system multi-frequency network communication based on phase spectrum compensation](image)

3.2. Signal feature classification

The multi-dimensional array networking structure model of high-order nonlinear system multi-frequency network communication load is constructed by spatial spectral density analysis method. Combined with spectrum parameter analysis[9], it is obtained that the high-order nonlinear system multi-frequency network communication load received at the Internet of Things terminal is a continuous signal \( y(t) \), and the characteristic component combination form of high-order nonlinear system multi-frequency network communication load is obtained by autocorrelation beamforming.

\[
y(t) = s(t) + n(t) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} W_s(t,v)\,dt\,dv + \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} W_n(t,v)\,dt\,dv
\]

(13)

In the beam center direction, the signal output is looked at the Fourier transform of a certain energy distribution characteristic function, and the output spectrum of the multi-frequency network communication load of the high-order nonlinear system is obtained as follows:

\[
Y_s(u) = F^u \left[ y(t) + \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} W_s(t,v)\,dt\,dv \right] = F^u \left[ s(t) + n(t) \right] = F^u \left[ s(t) \right] + F^u \left[ n(t) \right]
\]

(4)
According to the input load spectrum density of high-order nonlinear system multi-frequency network communication, the echo of high-order nonlinear system multi-frequency network communication network is obtained as follows:

\[ G(n, \tau) = \int_{-\infty}^{\infty} W_n(t, \nu) dt = |X(\nu)|^2 \]  

(15)

Within the frequency distribution range of the high-order nonlinear system multi-frequency network communication load, the time width of the high-order nonlinear system multi-frequency network communication load is calculated by using the signal frequency domain decomposition technology:

\[ T(x) = \frac{4\pi}{E_x} \int_{-\infty}^{\infty} (t - t_m)^2 |x(t)|^2 dt \]  

(16)

According to the time-frequency scalability of the signal, the frequency components of the high-order nonlinear system multi-frequency network communication load are obtained as follows:

\[ P(t) = \frac{4\pi}{E_x} \int_{-\infty}^{\infty} \left( v - v_m \right)^2 dt + \int_{-\infty}^{\infty} W_t(t - s, \nu) W_t(s, \nu) ds \]  

(17)

Blind separation output of multi-frequency network communication load of high-order nonlinear system is:

\[ y_1(t) = A_1(t) \exp \left\{ j2\pi[F(t - t_m)\ln(t - t_m) \\
- F(t - t_m) - F \ln Dt + f_0 t] \right\} \]  

(18)

The harmonic classification output of the output nonlinear system multi-frequency network signal is expressed as:

\[ y_2(t) = A_2(t) \exp \left\{ j2\pi[F(t - t_m)\ln(t - t_m) - F(t - t_m) - F \ln Dt + f_0 t] \right\} \]  

(19)

In this formula, \( f_{e1} \) is the beam domain parameter of multi-frequency network signal of nonlinear system, and \( f_{e2} \) is the cut-off frequency of signal output[10].

Combined with the method of feature decomposition, the dynamic parameter identification model of high-order nonlinear system multi-frequency network communication load is constructed, and the frequency domain feature quantity of high-order nonlinear system multi-frequency network communication load detection output is obtained as follows:

\[ \psi(s, \tau) = \frac{\int_{-\infty}^{\infty} W_s(t, \nu) dt}{\int_{-\infty}^{\infty} W_s(t, \nu) dt} + |x_m(s, \tau)|^2 \]  

(20)

In the formula, \( x_m(s, \tau) = \sqrt{\int_{-\infty}^{\infty} u(t)u^*[s(t - \tau)]dt} \), according to the above algorithm design, realizes the classification, detection and identification of signals.

4. Simulation experiment and result analysis

In order to verify the application performance of this method in realizing the classification, detection and identification of multi-frequency network communication load in high-order nonlinear system, a simulation test is carried out. The balanced scheduling frequency of multi-frequency network communication load in high-order nonlinear system is set to 15.4KHz, the length of signal acquisition is 1024, the length of signal test set is 25, the time and frequency points are (2.3, 3.4), (2.49,2.15), and the local optimal detection frequency between the two time points is 15.
According to the signal time domain distribution in fig. 3, the amplitude response of the signal is shown in fig. 4.

According to the signal detection result in fig. 4, signal equalization transmission is performed, and the equalization transmission result is shown in figure 5.

By analyzing Figure 5, it can be seen that this method can effectively realize the load balance transmission of multi-frequency network communication in high-order nonlinear system, and the signal characteristics are well balanced. Test the accuracy of load balancing transmission of multi-frequency network communication in high-order nonlinear system with different methods, and get the comparison result of root mean square error as shown in Figure 6.

By analyzing the results in Figure 6, it is known that this method has better balance and lower error rate in the load balancing transmission of multi-frequency network communication in high-order nonlinear system, which improves the accuracy of load balancing scheduling of multi-frequency network communication in high-order nonlinear system.

5. Conclusions
An optimized transmission model of multi-frequency network communication load balance in high-order nonlinear system is constructed, and the load balance transmission of multi-frequency network
communication in high-order nonlinear system is carried out by spatial channel balance design and control method. This paper proposes a load balance transmission method of multi-frequency network communication in high-order nonlinear system based on phase spectrum compensation. The balanced scheduling identification model of high-order nonlinear system multi-frequency network communication load is constructed. Through data bus structure analysis, the high-order nonlinear system multi-frequency network communication load detection and software structure design are carried out. Combined with feature decomposition method, the dynamic parameter identification model of high-order nonlinear system multi-frequency network communication load is constructed to realize balanced signal transmission. The research shows that the load balancing transmission of multi-frequency network communication in high-order nonlinear system by this method has better balance and lower root mean square error.

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