Data Mining-based Traffic Anomaly Detection Method of Communication Network

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Abstract: In the full-duplex heterogeneous optical communication network, the traffic anomaly detection algorithm of the full-duplex heterogeneous optical communication network in S-band and X-band is constructed to improve the traffic output stability of the communication network, and the stability control method of traffic anomaly detection of the communication network based on data mining is proposed. The identification model of flow state parameters of full-duplex heterogeneous optical communication network in different frequency bands is constructed, the channel equalization control of full-duplex heterogeneous optical communication network is carried out by means of nonlinear system control, the flow monitoring model of full-duplex heterogeneous optical communication network with single-channel tracking in S and X frequency bands is established in combination with steady-state error compensation design, the fuzzy compensation method is adopted in combination with nonlinear stability analysis method, full-duplex heterogeneous optical communication network control and analysis of uncertain disturbance characteristics, Realize the channel balance control in the process of communication network traffic anomaly detection. According to the full-duplex heterogeneous optical communication network traffic state parameters, combined with the performance of input and output state parameters, realize the full-duplex heterogeneous optical communication network traffic anomaly detection and analysis. The test shows that the output stability of full-duplex heterogeneous optical communication network traffic detection with this method is good, and the error compensation ability is strong, which improves the output balance of communication network.

1. Introduction

With the continuous expansion of the scale of the full-duplex heterogeneous optical communication network and the development of optical communication technology, people pay great attention to the detection of the traffic anomaly of the full-duplex heterogeneous optical communication network[1]. The analysis and control model of the traffic anomaly characteristics of the full-duplex heterogeneous optical communication network is established, and the flow output self-tracking control system based on state parameter identification is adopted by combining the phased-air array radar communication and adaptive control technology. To improve the stability and adaptability of the full-duplex heterogeneous optical communication network traffic output, the full-duplex heterogeneous optical communication network system has two ways: single-channel tracking and dual-channel tracking [,now the mainstream is single-channel, using the method of single-channel self-tracking control to analyze the stability of the full-duplex heterogeneous optical communication network traffic state characteristics under different tracking modes and interference conditions, so as to improve the ability of analyzing and controlling the traffic abnormal characteristics of the full-duplex heterogeneous optical communication network, and the related research on the analysis method of the traffic abnormal characteristics of the full-duplex heterogeneous optical communication network has attracted great attention[2].

The detection of full-duplex heterogeneous optical communication network traffic anomaly is

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based on the analysis of state stability parameters of S and X frequency bands of full-duplex heterogeneous optical communication network. The identification model of full-duplex heterogeneous optical communication network traffic anomaly state parameters is constructed[3], the spatial grid distribution model of full-duplex heterogeneous optical communication network traffic anomaly is constructed by nonlinear system control method, and the adaptive single-channel state tracking gradient grid hierarchical control method is adopted. Realize the self-tracking and steady-state parameter adjustment of the traffic anomaly of the full-duplex heterogeneous optical communication network, establish the spatial parameter identification model of the single-channel full-duplex heterogeneous optical communication network self-tracking, and realize the analysis of the traffic anomaly characteristics of the full-duplex heterogeneous optical communication network[4]. This paper proposes a state stability control method of the S and X frequency bands of the full-duplex heterogeneous optical communication network based on the single-channel self-tracking. Firstly, the identification model of self-tracking state parameters of full-duplex heterogeneous optical communication network in different frequency bands is constructed, and then the steady-state error compensation design is carried out by means of nonlinear system control, and the channel stability analysis model of single-channel tracking in S and X frequency bands is established. Combined with nonlinear uncertain disturbance compensation method[5], the abnormal characteristics of full-duplex heterogeneous optical communication network traffic are analyzed. Finally, the simulation test analysis shows the superior performance of this method in improving the abnormal characteristics analysis and control ability of full-duplex heterogeneous optical communication network traffic.

2. Model building and parameter analysis

2.1. Model building

I In order to realize the abnormal detection of single-channel full-duplex heterogeneous optical communication network traffic, the angle measurement and parameter analysis method in the moving platform coordinate system is adopted to construct the full-duplex heterogeneous optical communication network traffic planning model in the carrier coordinate system, the constrained slip angle parameter adjustment in the process of abnormal characteristics of single-channel full-duplex heterogeneous optical communication network traffic is carried out based on the kinematics analysis method, and the full-duplex heterogeneous optical communication network traffic optimization and ambiguity detection method are combined. Control the convergence in carrier coordinate system[6], use DSP to design tracking filtering and positioning, and get the parameter adaptive optimization model of DDC digital down-conversion and filtering processing. According to the construction of the full-duplex heterogeneous optical communication network traffic anomaly parameter model, the active single-channel state tracking analysis model of the full-duplex heterogeneous optical communication network traffic anomaly is constructed, and the channel offset control of the single-channel full-duplex heterogeneous optical communication network is realized by adopting the adaptive single-channel state tracking gradient grid hierarchical control method, and the optimization formula of the full-duplex heterogeneous optical communication network traffic anomaly parameter is obtained:

$$K = -g'(o_{dq}) \frac{\partial \left(\sum_{j=1}^{t} z_{dj} a_{jq} \right)}{\partial z_{kj}} \quad (1)$$

Wherein, $g'(o_{dq})$ is the offset correction coefficient of the abnormal traffic movement of the full-duplex heterogeneous optical communication network, z_{dj} is the spectral information parameter of the abnormal traffic distribution of the full-duplex heterogeneous optical communication network, a_{jq} is the decision threshold, and z_{kj} is the attitude change parameter. Assuming that a_{jq} is an abnormal parameter of full-duplex heterogeneous optical communication network traffic and a beam directivity parameter at a certain moment, the transmission parameter of beam directivity estimation information is obtained, and the antenna motion range of full-duplex heterogeneous optical communication network traffic distribution is as follows:

$$X(R) = X(n) - y_c(-1)^{i+1} \tag{2}$$

Among them, $X(n)$ is the offset of antenna receiving gain, y_c is the parameter of two-dimensional active phased array, and i is the number of tests. Therefore, a self-tracking state parameter identification model of traffic anomaly in full-duplex heterogeneous optical communication network is constructed[7].

2.2. Control constraint parameter analysis

The positive definite function of is constructed, and the traffic anomaly controller of the full-duplex heterogeneous optical communication network is adopted to establish the self-tracking state stability control model of single-channel LEO satellite under the guidance of periodic interconnection[8]. On the basis of path optimization and convergence control in the process of active single-channel state tracking control, the objective function of stable optimization of the traffic anomaly state of the full-duplex heterogeneous optical communication network is obtained as follows:

$$A = (a_{ij})_{n\times n} \tag{3}$$

Wherein, a_{ij} is the abnormal state variable of full-duplex heterogeneous optical communication network traffic, *n* is the inertial joint control parameter, and the adaptive learning weight of full-duplex heterogeneous optical communication network traffic tracking control is defined as:

$$p_{ij} = \frac{a_{ij}}{\sum a_{ij}} \tag{4}$$

In which a_{ij} is the individual state parameter of the full-duplex heterogeneous optical communication network traffic distribution, the fitness parameter of the full-duplex heterogeneous optical communication network traffic is $\boldsymbol{A} = \begin{bmatrix} 1 & 0.6 \\ -0.4 & 0.5 \end{bmatrix}$, and the individual feature distribution is optimized according to the full-duplex heterogeneous optical communication network traffic parameter to obtain the spatial feature quantity of the full-duplex heterogeneous optical communication network traffic abnormal state distribution. The one-dimensional spatial subsystem distribution function of the full-duplex heterogeneous optical communication network traffic abnormal tracking is described as $X_i(t) = (x_{i1}(t), x_{i2}(t), \ldots, x_{iD}(t))$, The distribution list vector of the full-duplex heterogeneous optical communication network traffic represented by $(X_1(0), X_2(0), \ldots, X_N(0))$ constitutes the null space, and the output steady-state aggregation degree is expressed as, according to the above analysis, the constraint parameter model of the stability control of the full-duplex heterogeneous optical communication network traffic abnormal state is established[9].

3. Traffic anomaly detection of 2 full-duplex heterogeneous optical communication network

3.1. Full duplex heterogeneous optical communication network traffic single channel control

Based on the method of nonlinear system control, the steady-state error compensation is designed, and the channel stability analysis model of single-channel tracking in S and X bands is established[10]. Combined with the method of nonlinear uncertain disturbance compensation, the steady-state characteristic quantity of single-channel control of traffic anomaly in full-duplex heterogeneous optical communication network in S and X bands is $p_i = (p_{i1}, p_{i2}, \ldots, p_{iD})$. According to the full-duplex heterogeneous optical communication network traffic prediction equation, the self-tracking control quantities of the full-duplex heterogeneous optical communication network traffic anomaly is $\boldsymbol{Y}(0, k \mid k) = \boldsymbol{Y}(k \mid k-1)$, and the channel equalization prediction outputs of the full-duplex heterogeneous optical communication network in S and X frequency bands are as follows:

$$\tau_{ij}(t+n)=(1-\rho)\tau_{ij}(t)+\Delta\tau_{ij}(t) \quad (5)$$

Wherein, $\tau_{ij}(t)$ is the target state of full-duplex heterogeneous optical communication network traffic anomaly, $\Delta\tau_{ij}(t)$ is the parameter information fusion matrix of full-duplex heterogeneous optical communication network traffic anomaly control, and ρ represents the fitness function. Under the parallel optimization control algorithm, the reliability factors of nodes with abnormal traffic in full-duplex heterogeneous optical communication network are obtained. Among them, $\overline{l(e_i)}=\frac{\sum_k l(e_{ik})}{d_i}$ is the periodic spatial interconnection inertia parameter of the traffic abnormal distribution of the full-duplex heterogeneous optical communication network, d_i is the location information of the traffic abnormal space of the full-duplex heterogeneous optical communication network, and k is the location accuracy. Therefore, the traffic single-channel control model of full-duplex heterogeneous optical communication network in S and X bands is established[11].

3.2. Anomaly detection optimization of full-duplex heterogeneous optical communication network

Combined with the nonlinear uncertain disturbance compensation method and big data mining, the channel equilibrium control in the process of abnormal detection of communication network traffic is obtained, a more accurate mapping relationship is established, and the abnormal nodes of full-duplex heterogeneous optical communication network traffic are obtained. The compensation of abnormal parameters of full-duplex heterogeneous optical communication network traffic is realized through iteration, and the fractal directivity function of initial weight and threshold path optimization is as follows:

$$R_{I_a}=\max(X_{k,a})-\min(X_{k,a}),\quad 1<k<n \quad (6)$$

Wherein, $X_{k,a}$ represents the distribution value of traffic state information of full-duplex heterogeneous optical communication network, and the optimization control of full-duplex heterogeneous optical communication network traffic detection is extremely poor. Under the uncertainty of initial weights and thresholds, the optimization planning problem of abnormal characteristics of full-duplex heterogeneous optical communication network traffic is described as follows:

$$\min F=(x,y)^2+A \quad (7)$$

Wherein, (x,y) represents the two-dimensional distributed coordinate system and A represents the non-geometric parameter error. By adopting the stability boundary adjustment method, the differential equation for adjusting the flow error of the full-duplex heterogeneous optical communication network is obtained as follows:

$$\begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}=\begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_{m-1} \end{pmatrix}+\begin{pmatrix} e_1 \\ e_2 \\ \vdots \\ e_n \end{pmatrix} \quad (8)$$

In which the error term $\mathbf{e}$ satisfies the normal distribution of the flow detection characteristics of the full-duplex heterogeneous optical communication network, and β is the mapping vector between pseudo errors. By using the method of compensation of the flow anomaly characteristics of the full-duplex heterogeneous optical communication network, the flow anomaly detection characteristic values of the full-duplex heterogeneous optical communication network are obtained as follows:

$$\hat{n}=G_n\hat{\varepsilon} \quad (9)$$

Wherein

$$G_n = \begin{pmatrix} r_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & r_{mn} \end{pmatrix} \tag{10}$$

$$r_i = \frac{EA_i}{S_i} \tag{11}$$

Where, E is the weight coefficient of traffic abnormal state distribution of full-duplex heterogeneous optical communication network; S_i is non-geometric parameter error; A_i is the observability index.

To sum up, according to the performance of parameters such as abnormal state of traffic, input and output of full-duplex heterogeneous optical communication network, stability control and feedback tracking error compensation are adopted to realize abnormal detection of traffic and stability analysis and improvement of full-duplex heterogeneous optical communication network[12].

4. Experimental analysis

The simulation experiment verifies that the method proposed in this paper can detect the traffic anomaly of the full-duplex heterogeneous optical communication network, analyzes the state stability of the traffic transmission of the full-duplex heterogeneous optical communication network, and obtains the traffic distribution time series of the full-duplex heterogeneous optical communication network as shown in Figure 1.

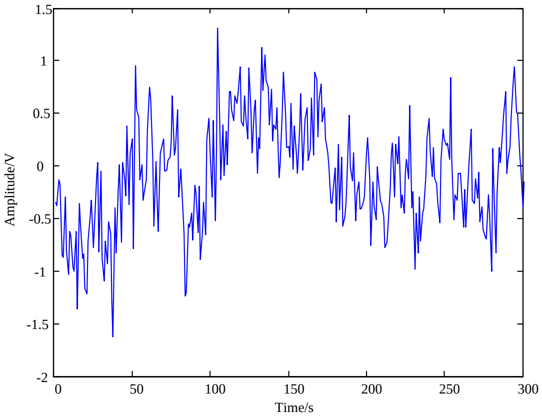

Fig. 1 Time series of traffic distribution in full-duplex heterogeneous optical communication network

Taking Figure 1 as a sample, different detection methods are used to track the traffic anomaly of optical communication network. The tracking methods are divided into extreme value tracking, monopulse tracking, cone scanning tracking, navigation guidance plus inertial navigation guidance tracking and compound tracking, which are divided into different test points. See Table 1 for the coordinate distribution of the test points.

Table 1 Coordinate distribution of test points

Test point	X	Y	Z
monitoring point1	1.1788	36.4893	5.5847
monitoring point2	1.1738	36.9432	7.9078
monitoring point3	1.1397	36.3690	4.2416
monitoring point4	1.1457	36.9406	0.0440
monitoring point5	1.1302	36.7681	6.7103
monitoring point6	1.1476	36.9612	8.4864
monitoring point7	1.1551	36.8427	3.7071
monitoring point8	1.1682	36.8047	8.4558
monitoring point9	1.1213	36.9041	4.0300

monitoring point10	1.1377	36.3210	4.8487
monitoring point11	1.1211	36.7636	6.6897
monitoring point12	1.1263	36.2297	3.6066

According to the coordinate distribution in Table 1, the output frequency of inertial transmission of optical communication network traffic is set to 50KHZ, the positioning accuracy of optical communication network traffic is set to 2cm+1ppm(RMS), the GNSS failure probability distribution is 3%D(D is mileage with odometer) (RMS), the zero bias stability parameter of optical communication network traffic is 6°/hr, the measuring range is set to 6g/16g/50g, and the power supply is+12. The power consumption is less than 3.5 watts. According to the above parameter settings, the stability tests under different tracking modes are carried out to realize abnormal feature detection. The detection results are shown in Figure 2.

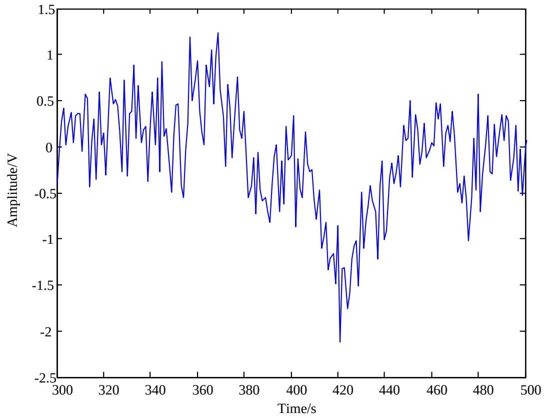

Fig. 2 Abnormal feature detection results

Analysis of Figure 2 shows that this method can effectively locate the traffic anomaly characteristics of full-duplex heterogeneous optical communication network, and test the accuracy of traffic anomaly detection of full-duplex heterogeneous optical communication network by different methods. The comparison results of traffic anomaly detection accuracy of full-duplex heterogeneous optical communication network are shown in Table 2.

Table 2 Stability test results

Iterations	Single channel self-tracking	Single pulse tracking	Conical scanning tracking
100	0.9234	0.6703	0.8363
200	0.9605	0.7044	0.8724
300	0.9105	0.7120	0.8699
400	0.9725	0.7117	0.8207
500	0.9487	0.6588	0.8132
600	0.9138	0.6663	0.8199
700	0.9138	0.6711	0.8537
800	0.9259	0.6533	0.8276
900	0.9478	0.6907	0.7923
1000	0.9697	0.6707	0.8572
1100	0.9732	0.6713	0.8603

From the analysis of Table 2, it is known that the method in this paper has high accuracy in detecting the abnormal characteristics of full-duplex heterogeneous optical communication network traffic, and the stable convergence curve is tested. As shown in Figure 1, it is known from the analysis of Figure 1 that the method in this paper has good convergence in detecting the abnormal characteristics of full-duplex heterogeneous optical communication network traffic.

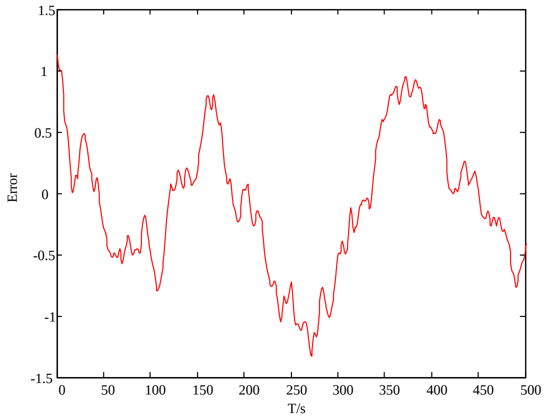

Fig. 2 Convergence test

5. Conclusions

Under different tracking modes and interference conditions, the stability analysis of the traffic state characteristics of the full-duplex heterogeneous optical communication network is carried out, so as to improve the analysis and control ability of the traffic abnormal characteristics of the full-duplex heterogeneous optical communication network, and the stability control method of the abnormal state detection of the communication network traffic based on data mining is proposed. Combining with the nonlinear stability analysis method, the full-duplex heterogeneous optical communication network control and the analysis of uncertain disturbance characteristics, the fuzzy compensation method is adopted. Realize the channel balance control in the process of communication network traffic anomaly detection. According to the full-duplex heterogeneous optical communication network traffic state parameters, combined with the performance of input and output state parameters, realize the full-duplex heterogeneous optical communication network traffic anomaly detection and analysis. The analysis shows that the method in this paper has high accuracy in detecting traffic anomaly in full-duplex heterogeneous optical communication network.

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