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Retraction

Retracted: Optimal Fitting Method of Nonlinear Simultaneous Equations Considering Structural Tensor Image Modeling

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] S. Zhu, "Optimal Fitting Method of Nonlinear Simultaneous Equations Considering Structural Tensor Image Modeling," *Advances in Multimedia*, vol. 2021, Article ID 6356899, 7 pages, 2021.

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Research Article

Optimal Fitting Method of Nonlinear Simultaneous Equations Considering Structural Tensor Image Modeling

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For the purpose of resolving the phenomenon of network congestion in the process of many-to-one communication in multimedia networks at present, the optimal fitting method of nonlinear simultaneous equations (OFMNSEs) is applied to the multimedia transmission congestion control system in this paper. The rate control and resource scheduling are effectively combined, and a clustering network structure is used to activate the congestion control method in turn based on the cluster header and intracluster-related indexes. Finally, it can be known through the analysis of the simulation results that the OFMNSE algorithm put forward in this paper can improve the congestion issue of the multimedia network transmission process and reduce the packet loss rate of data during the transmission effectively under the condition of different relative cache sizes compared with the conventional algorithm.

1. Introduction

With the rapid development of science and technology and computer network, data information is exchanged more frequently [1, 2]. In addition, users put forward higher standards for network transmission speed, transmission capacity, and service quality. However, in this kind of network data transmission, the service data flow has certain burst and fluctuation in the transmission process, and the network traffic transmission parameters are constantly changing [3, 4]. Even in the data network with perfect structure, the congestion problem of real-time streaming transmission cannot be avoided [5]. Data transmission congestion can easily lead to the reduction of quality of service indicators such as transmission delay and throughput, data loss and delay, and then lead to the collapse of the network, which seriously affects the utilization of other resources such as bandwidth and cache [6, 7]. Therefore, in order to make full use of the available network resources and provide a certain guarantee for the quality of service, the problem of service congestion is an important topic of computer network transmission in the future.

Aiming at the phenomenon of network congestion in the process of many to one communication in the nonlinear simultaneous equation, this paper proposes a multimedia structure tensor image model and uses it in the congestion control of Internet traffic, which can effectively solve the problem of network transmission delay and can also adjust the relevant parameters of the controller according to the change of network load, ensuring the stability of the control system, so as to effectively avoid congestion.

2. Real-Time Streaming Transmission Congestion Control Protocol

2.1. Management Control of Cluster Storage. When congestion occurs at the nodes in the network, if the rate control is started at once, the data transmission speed in the network will be reduced immediately [8, 9]. However, the phenomenon of back pressure will be produced at the upstream node, which can lead to congestion in the whole upstream. Hence, before the rate control is carried out based on the OFMNSE, the cluster storage management control scheme is first used to cache excessive packets within the node and delays the application of the rate control scheme. There are three characteristic nodes in the cluster, that is, the cluster header, the cache node, and the sensor node. Any cluster configuration can be expressed as the following:

$$C_i = h_i + n_{bi} + n_{si}. \quad (1)$$

The start of the cluster is the center of the whole cluster. While it sends data to the control center of the cache node, it is also responsible for forwarding the data to the previous type of the cluster. The sensor node is responsible for sensing the work and forwarding the data to the cluster. The cache node is where the whole cluster stores data temporarily. In general, the cluster header is required to calculate the cache space of the whole cluster in each time period t.

$$RB_c = \left(RB_h + \sum_{b_i \in C} RB_{b_i} \right) t, \quad \forall h, b_i \in C. \quad (2)$$

Firstly, the cluster sends a query broadcast to each cache node number in the cluster and each cache node in the cluster per unit time. The details are shown in Figure 1. Whether the cache node in the cluster returns the capacity can be determined based on the cache node number in the list of cache nodes at the cluster header. It is assumed that the time when the cache node sends back the cache capacity to the cluster header is x, and there are n cache nodes in the cluster. The starting time is $tn1$, the return time is $t + x$, the return time of n_2 is $t + 2x$, and so on, and the return time corresponding to n_i is $t + ix$. In addition, for the purpose of managing the traffic, the net network traffic should be calculated as well. The calculation formula is as follows:

$$NS_{c_i} = \left(r_{sh} + \sum_{k \in U_i} r_{k,i} - \sum_{j \in D_i} r_{i,j} \right) t. \quad (3)$$

In this paper, the value $CD_h < 0$ is set as a basis for the control method used to start the management of the network storage, and the calculation method indicates that the remaining cache space of the cluster header $CD_h < 0$ is safe. However, $CD_h \geq 0$ indicates that the cache space of the cluster header is insufficient. At this point, it is necessary to start the management control of the network storage. In the cluster storage management control scheme, the scheme of the cluster sending excessive packets to the cache node is distributed in a round-robin manner. In general, a list of cache nodes is established in the cluster header when the cache node sends back its capacity. When the storage management control method in the network is activated, the cluster header will store the node with the most remaining capacity based on the capacity of each cache node provided in the cache. When the storage capacity is above 90%, it will switch to the next cache node for data storage, as shown in Figure 1 and Table 1.

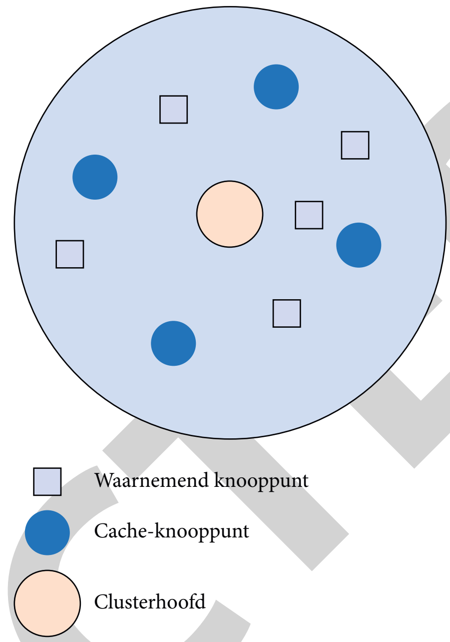

Figure 1: List of cluster headers.

Table 1: Cache capacity of the cluster head in each node state.

Cache node number	Response	State	Cache capacity
1	Yes	A	5
2	Yes	A	4
3	Yes	O	5
4	Yes	O	5

A: work; O: shut down.

2.2. Rate Adjustment. After the cluster storage management control mechanism is started, if the network congestion is not relieved, the OFMNSE algorithm starts the rate adjustment control mechanism in the second phase [10–12]. First, the transfer capacity of C_i from the upstream of the cluster or from cluster C_x to cluster C_i is calculated. Upon the occurrence of congestion, data packets can meet the remaining cache in the cache node. Hence, when congestion occurs, it is necessary to estimate whether the capacity of the cache in the upstream cluster can deal with the volume of data packets that cannot be forwarded. $\beta_i(x)$ is defined as the trend congestion index, and its calculation formula is described as follows:

$$\beta_i(x) = CD_c + R_{x,j} t, \quad \forall x \in U_i. \quad (4)$$

If $\beta_i(x) \leq 0$, it indicates that no congestion will occur within the unit time t; if $\beta_i(x) > 0$, it indicates that congestion will occur within the unit time t. At this time, cluster C_i will give priority to the case of $\beta_i(x) > 0$ in the rate allocation. The sum of $\beta_i(x) > 0$ is added as the total amount of cache capacity required.

The sum SUM_i of $\beta_i(x)$ can be obtained as follows:

$$\text{SUM}_i = \sum_{X \in U_i} \beta_i(x), \quad \forall \beta_i(x) > 0. \quad (5)$$

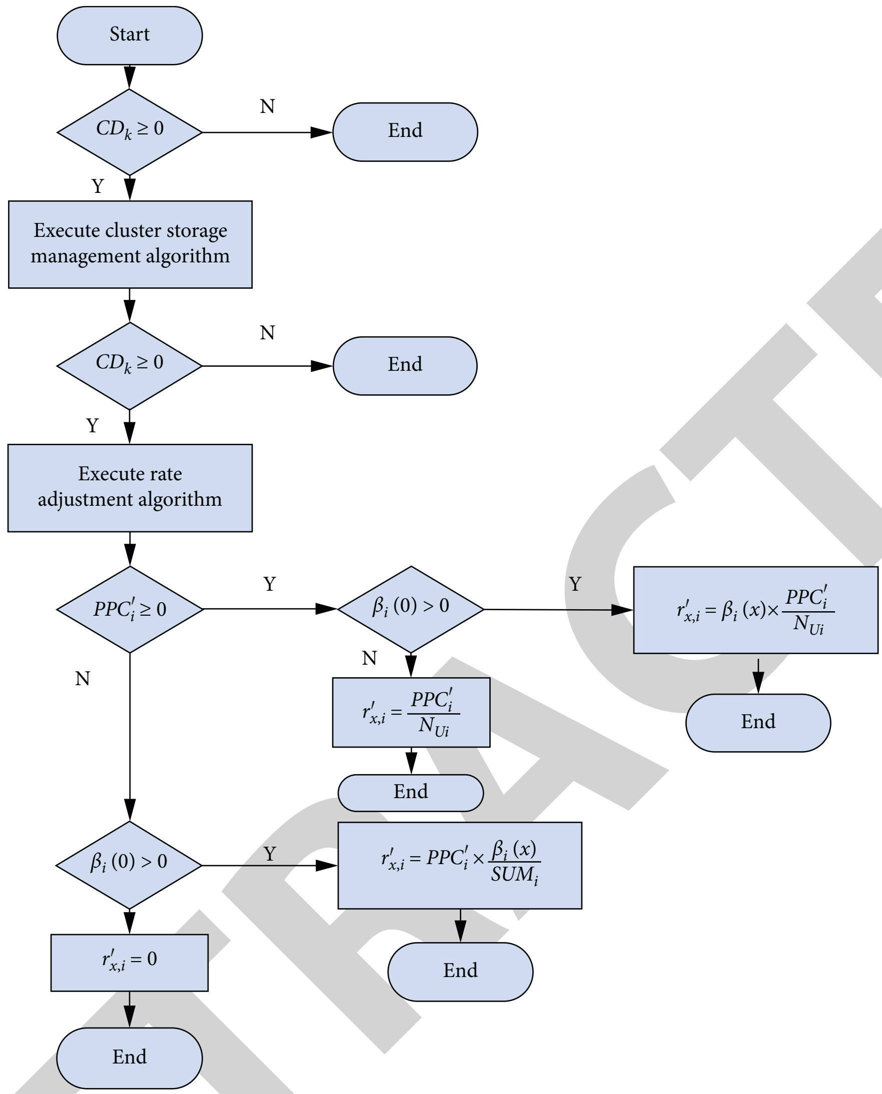

Figure 2: Process flow chart of the OFMNSE algorithm.

The potential capacity PPC_i available in the cluster C_i can be obtained as follows:

Based on the definition of $\beta_i(x)$, in cluster C_i, as the upstream cluster $\beta_i(x) > 0$ that preferentially allocates the first rate of the cluster is adopted, it is the value of PPC_i to be updated, that is, the remaining potential capacity of PPC'_i, is shown as follows:

$$PPC'_i = PPC_i - \mathrm{SUM}_i. \tag{6}$$

If $PPC'_i \geq 0$ stands for the situation where the traffic required by the upstream cluster can be met, and if $PPC'_i < 0$ stands for the situation where the remaining potential capacity of the cluster C_i cannot meet the traffic required by the upstream cluster, then there are two types in the part of rate adjustment which are as follows:

(1) If $PPC'_i \geq 0$,

$$\begin{cases} r'_{x,i} = \beta_i(x) + \dfrac{PPC'_i}{N_{U_i}}, & \text{if } \beta_i(x) > 0, \\ r'_{x,i} = \dfrac{PPC'_i}{N_{U_i}}, & \text{if } \beta_i(x) \leq 0. \end{cases} \tag{7}$$

(2) If $PPC'_i < 0$,

$$\begin{cases} r'_{x,i} = PPC_i \times \dfrac{\beta_i(x)}{\mathrm{SUM}_i}, & \text{if } \beta_i(x) > 0, \\ r'_{s,i} = 0, & \text{if } \beta_i(x) \leq 0. \end{cases} \tag{8}$$

The process flow of the OFMNSE algorithm puts forward in this paper is shown in Figure 2.

3. Process of the Real-Time Streaming Transmission Congestion Control

3.1. Structural Tensor Image Modeling. For system (2), the simple multimedia Optimal Fitting Method of Nonlinear Simultaneous Equations is first used to carry out traffic control as follows:

$$q(n+1) = \mathrm{Sat}_q^0\left\{q(n) - a\left(x(n) - x^0\right) - b(x(n) - x(n-l))\right\}. \tag{9}$$

Here, $q^0 \geq c$. The saturation function in equation (3) is to impose a certain restriction on q, and the lower limit is zero, which can ensure that q is nonnegative; the upper limit q^0 can impose the restriction that the transmission rate of the non-bottleneck link will not to be excessively large. As the deviation near the equilibrium point of the network is very small, the saturated nonlinear characteristics of the difference equation as aforementioned can be removed, and the time shift operator z^{-l} can be introduced to obtain the following after consolidation:

$$\left\{(z-l)^2 + \sum_{j=0}^{D} z^{-(j-l)} l_i\left[a + b\left(1 - z^{-1}\right)\right]\right\} x(z) = \sum_{j=0}^{D} z^{-(j-l)} l_j a x_0 + \left(r^0 - c\right) z, \tag{10}$$

For the convenience of analysis, let a=−b, so that the closed-loop system can be obtained as follows:

$$\begin{aligned}\forall(z) = {} & z^{D+2} - 2z^{D+1} + z^D - bl_0 z^D - bl_1 z^{D-1} \\ & - bl_2 z^{D-2} - \cdots - bl_{D-1} z - bl_D.\end{aligned} \tag{11}$$

In the following section, it is proved that the closed-loop system is stable under certain conditions.

Proof. A function is set as follows:

$$\begin{aligned}\forall(z) = {} & z^{D+2} - 2z^{D+1} + z^D - \xi_0 z^D - \xi_1 z^{D-1} \\ & - \xi_2 z^{D-2} - \cdots - \xi_{D-1} z - \xi_D.\end{aligned} \tag{12}$$

That is, $\forall(z)$ is a ξ function. When $\xi = 0$, the following can be obtained:

$$\forall(z) = z^{D+2} - 2z^{D+1} + z^D = z^D (z-1)^2. \tag{13}$$

Hence, $z_i(0) = 0$, $i = 1, 2, \ldots, D$, $z_{D+1}(0) = z_{D+1}(0) = 1$.

As $\forall(z)$ is a continuous function of ξ, for the following conditions:

$$\begin{gathered}\forall\xi \in (0, \xi), \\ \xi > 0; \\ |z_i(\xi)| < \frac{1}{2}, \\ i = 1, 2, \ldots, D; \\ |z_{D+1}(\xi)| > \frac{1}{2}, \\ |z_{D+2}(\xi)| > \frac{1}{2}.\end{gathered} \tag{14}$$

As the roots of the characteristic equation are conjugate, $z_{D+1}(\xi)$, $z_{D+2}(\xi)$ has a positive real part. It is assumed that $|z_{D+1}| \geq 1$, then the following can be obtained $|\forall(z)| \geq z_{D+1}^D |z_{D+1} - 1|^2 - |\xi_0 z_{D+1}^D + \xi_1 z_{D+1}^{D-1} + \xi_2 z_{D+1}^{D-2} + \cdots + \xi_{D-1} z_{D+1} + \xi_D|$ is obviously a positive integer with a finite size, which can ensure that the value is taken near the origin. $l_0, l_1, l_2, \ldots, l_D$, $|\forall(z)| > 0$, which is in conflict with the fact that $z_{D+1}(\xi)$ is the root of $\forall(z) = 0$. Hence, $|z_{D+1}(\xi)| < 1$ can be obtained in a similar way. Hence, $|z_{D+1}(\xi)| < 1$ can be obtained: $\forall(z) = z^D \times (z-1)^2 - z^D \times b$ $[l_0 + l_1 z^{-1} + l_2 z^{-2} + \cdots + l_D z^{-D}]$; all the poles in the abovementioned equation are within the unit circle. The aforementioned proof process has demonstrated that taking a value for ξ near the origin can ensure the stability of the control system.

However, due to the delay in system (2), the simple multimedia real-time stream congestion control algorithm that does not include the abovementioned delay link fails to achieve a sound control effect. The simulation experiment indicates that the queue length $x(t)$ and the source end have relatively tremendous fluctuations in the emission rate $q(t)$, and the continuous oscillation time of the system is relatively long. On one hand, the significant vibration of the column has greatly increased the delay jitter from edge-to-edge. At the same time, the occurrence probability of empty queues becomes even higher, and the utilization rate of links is reduced as well.

For this purpose, a delay link is introduced on the basis of the simple multimedia optimal fitting method of nonlinear simultaneous equations described above, and the controller equation is shown in equation (6).

$$\begin{aligned}q(n+1) = \mathrm{Sat}_q^0\Big\{ & q(n) - a\left(x(n) - x^0\right) - b(x(n) \\ & - x(n-l)) - \sum_{k=0}^{iK} \beta_k q(n-k)\Big\}.\end{aligned} \tag{15}$$

where K stands for a nonnegative integer. From the system equation, it can be seen that the maximum delay of $q(n)$ is $q(n-(D-1)$. In addition, K=D is the K tab in the control algorithm. The (D+2)-dimensional system is described by the system equation and the controller equation.

In the analysis of the steady state, the following conditions of the control gain a and β_k shall be met.

$$a > 0,$$
$$\sum_{k=0}^{D-1} \beta_k = 0. \quad (16)$$

The abovementioned section shows the design of the multimedia real-time streaming media congestion control device when the system parameters $L = [l_0, l_1, \ldots, l_D]^T$ are assumed to be fixed values, in which the round-trip delay is equal to the number of bottleneck links in j time slots of l_j. However, in the practical operation of the network, the system parameter l will change dynamically. Hence, the system parameter will change over time. In the design of the controller parameter G, the author can use the least squares identification algorithm with the forgetting factor to identify the system parameters online for the changes of l_j that need to be identified online. □

3.2. Implementation of the Optimal Fitting Method of Nonlinear Simultaneous Equations. The design of the controller for the real-time streaming transmission congestion includes the following steps, and the design can be operated online:

(1) Calculate the estimation $L = [l_0, l_1, \ldots, l_D]^T$ for the number of bottleneck links at the switching node, in which the round-trip delay is equal to the number of bottleneck links in j time slots of l_j

(2) Determine the positions of the D+2 closed-loop poles and identify the characteristic polynomial coefficient vector $F=[f_0, f_1, \ldots, f_{D+1}]^T$

(3) Calculate the controller parameter G based on formula $G(n) = [M(L)] - 1F$, in which $F = (f_1 + 2, f_2 - 1, \ldots, f_3, f_4, \ldots, f_{D+1}, f_{D+2}, 0)^T$

4. Analysis of the Simulation Results

The OFMNSE algorithm put forward in this paper is compared with the scenario of the HCCP algorithm based on the rate control mechanism and that of the conventional algorithm based on the resource scheduling mechanism [13–15]. In the simulations with different transmission rates, the maximum and minimum data rates are set to 11 pps and 3 pps, respectively; the transmission time is 5 pps; the cache capacity is 5 packets; and the simulation time is 300 s. In the circumstances of different cache capacities, the maximum and minimum cache capacities are set to 12 and 6 packets, respectively; the incoming data rate is 11 pps, the stream data rate is 5 pps; and the simulation time is 300 s. The network topological structure in the simulation environment is shown in Figure 3.

The packet loss rates in the network when the transmission speed and cache capacity are changed are shown in Figures 4 and 5. Figure 4 indicates that the OFMNSE can slightly improve the packet loss rate of the HCCP. As the cluster is stored in the rate control mechanism based on the OFMNSE, it can delay the start of the rate control and the time when congestion occurs in the upstream cluster, thereby improving the packet loss rate significantly.

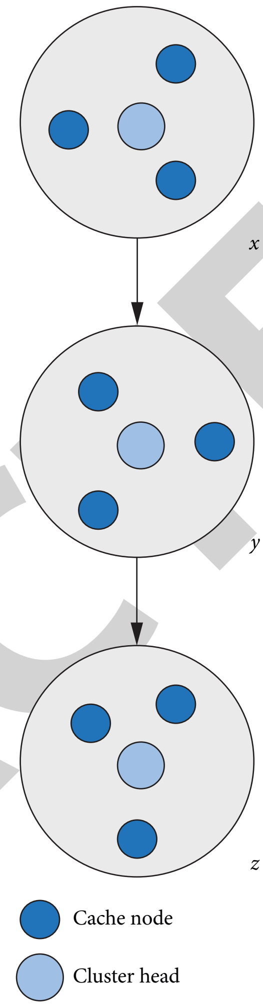

Figure 3: Network topological structure in the simulation environment.

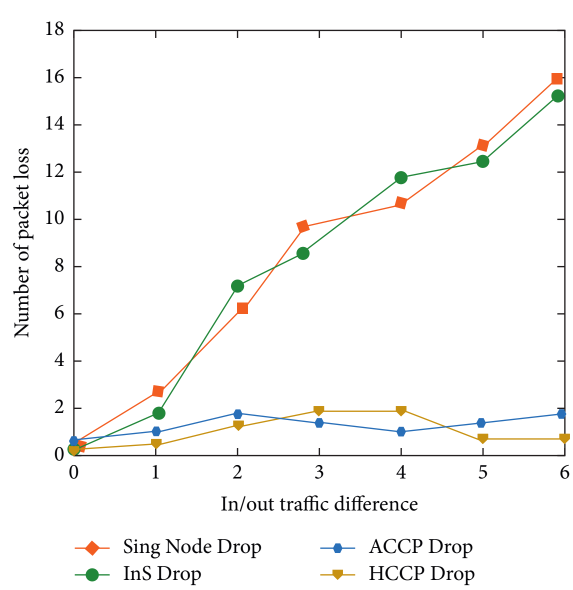

Figure 4: Changes in the transmission rates.

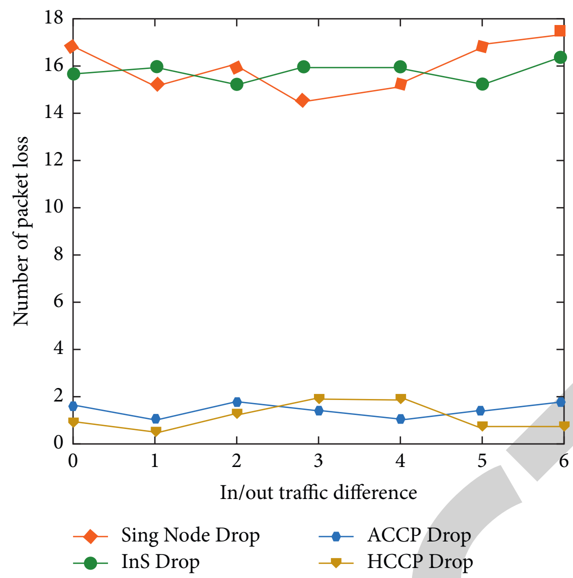

Figure 5: Different situations of the cache capacity.

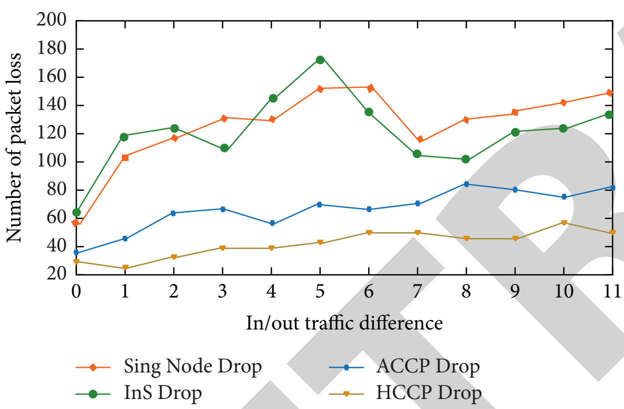

Figure 6: Changes in the throughput.

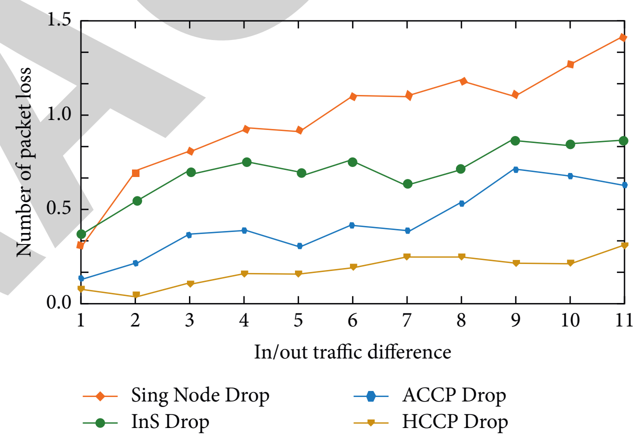

Figure 7: Average end-to-end delay.

From Figure 5, it can be known that compared with the conventional algorithms, the OFMNSE can be used to control the packet loss rate. In Figure 4, increasing the cache capacity can help reduce the packet loss rate through the conventional algorithms. However, due to the failure to control the network service, the packet loss rate of the conventional algorithms is relatively high. As the OFMNSE can impose rate control on cluster storage, network congestion can be controlled more effectively than the conventional algorithms.

From Figure 6, it can be observed that the throughput of OFMNSE is significantly superior to the other algorithms with the increase in the packet transmission rate. In addition, if the packet transmission rate is high (greater than 6 pps), a certain degree of congestion will occur in the network. Since then, the network throughput of HCCP and conventional algorithms has no longer increased and tends to decline further. Although OFMNSE has slowed down the increasing trend, the overall network throughput is increasing. From Figure 7, it can be seen that, with the increase in the transmission rate of the data packet, the transmission delay of the data is gradually increased as well. The OFMNSE algorithm can reduce and slow down the development of the network transmission delay by including the cluster storage mechanism and controlling the transmission rate mechanism.

Description of the simulation result: if the transmission rate is different, the OFMNSE can be used to control the network congestion effectively instead of the INS algorithm and HCCP. In addition, if the cache capacity is different, the OFMNSE can slightly improve network congestion compared with the HC-CSP and can significantly increase the packet loss rate of the conventional algorithms.

5. Conclusions

In this paper, the optimal fitting method of nonlinear Simultaneous equations is applied to the multimedia transmission congestion control, where the rate and the effective scheduling of resources are combined to address the storage nodes in the congestion control mechanism based on the congestion situation of the cluster header and the transmission process in the cluster without including the excessive packet time. When the rate control is suspended, the data flow corresponding to the real-time performance of the adjusted data is regulated to implement the traffic control, with the purpose of reducing network confusion.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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