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Research Article

Data Transmission Efficiency Optimization Algorithm of Laboratory Equipment Based on Frequency Control

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In order to improve the efficiency and throughput of data transmission of laboratory instruments and equipment and reduce resource consumption, an optimization algorithm of data transmission efficiency of laboratory instruments and equipment based on frequency control is proposed. Firstly, the frequency control method is used to construct the real-time data transmission model of laboratory instruments and equipment, and the optimal equivalent load of instruments and equipment is obtained. Secondly, the filtering time constant is selected through the first-order low-pass filtering control model to obtain the value range of the filtering time constant. Finally, the filter time constant is optimized in real time according to the stabilized power prediction value sequence, the optimization objective function of data transmission efficiency is obtained, and the optimization of data transmission efficiency is realized by solving the objective function. The experimental results show that compared with the traditional algorithm, this algorithm can improve the data transmission efficiency of laboratory instruments and equipment and improve the data throughput and reduce the resource consumption. The data transmission efficiency of this algorithm is always maintained at more than 85%.

1. Introduction

With the development of science and technology, the transmission of analytical laboratory data has gradually developed in the direction of simplicity, high speed, and high efficiency from the initial manual transcription and print output to media copy. In this process, computer network plays a role of technical support [1]. The traditional negative film technology used in SEM laboratory has been gradually eliminated. At present, the new SEM instruments are digital photos, which saves analysts the tedious, time-consuming, and toxic darkroom work [2]. At present, the analysis results submitted to users are mostly realized by CD recording and U disk and other storage media copy. The problems of these methods are that the CD-ROM recording operation of data is troublesome, the service life of the recorder is short and prone to failure, and there are many inconveniences in use [3]; Transferring data through storage media such as USB flash disk is very easy to infect SEM equipment and computer with virus [4]. The types of instruments and equipment in the comprehensive laboratory are complex, the number is huge, and the increase is rapid. Different instruments and equipment have different data processing and storage methods [5]. Among them, electronic universal testing machine equipment is the most widely used and used in materials and other fields. It is an indispensable testing configuration for material mechanics research [6]. In laboratory equipment management, realizing intelligent data acquisition of instruments and equipment is the core work of the laboratory. Therefore, whether to improve the data transmission efficiency of electronic universal testing machine equipment is an important topic faced by laboratory equipment management [7].

2. Research Status

Relevant scholars at home and abroad have made some progress. The analysis results of different research methods adopted by different scholars are shown in Table 1.

Table 1: Research status.

Research methods	Pros and cons analysis
Ren and Chen [8] proposed a transmission optimization method based on the wireless sensor network.	The advantage is that it can shorten the queuing delay of data transmission, while the disadvantage is insufficient throughput.
Ouyang and Cui [9] proposed a transmission optimization method based on quadratic programming.	The advantage is that it can realize the optimization and integration of data transmission efficiency, while the disadvantage is that the resource consumption is high.
Yang et al. [10] proposed a transmission optimization method based on time complexity	The advantage is that it can avoid the problem of data packet loss, while the disadvantage is that the transmission efficiency is low.
Cui et al. [11] proposed a transmission optimization method based on coupled multistable stochastic resonance.	The advantage is that it can effectively filter the noisy signal, but the disadvantage is that the calculation process is cumbersome and time-consuming.
Zhang et al. [12] proposed a transmission optimization method based on three partition state alphabet.	The advantage is that it can enhance the flexibility of data transmission, but the disadvantage is that it needs to use the algorithm frequently, which increases the computational complexity.
Wu [13] proposed a transmission optimization method based on the K-means clustering algorithm	The advantage is that it can enhance the attributes of transmitted data, but the disadvantage is that there are many iterations.
Li et al. [14] proposed a transmission optimization method based on compressed sensing.	The advantage is that it can increase the capacity of the transmission link, while the disadvantage is that it is easy to cause congestion of the transmission network.
Hamzah et al. [15] proposed a transmission optimization method based on greedy function and a particle swarm optimization algorithm.	The advantage is to improve the compatibility of data transmission, while the disadvantage is to increase the transmission distance.
Amjad et al. [16] proposed a transmission optimization method based on the wireless area network.	The advantage is that it can reduce the packet loss probability of data transmission, while the disadvantage is that it reduces the transmission power of data transmission.
Shende and Sonavane [17] proposed a transmission optimization method based on energy aware multicast routing protocol.	The advantage is that it can accurately select the path of data transmission, while the disadvantage is that it reduces the trust of nodes.

Due to the problems of low transmission efficiency, low data throughput and high resource consumption in the traditional data transmission algorithm of laboratory instruments and equipment, the reliability of the transmission of laboratory instruments and equipment is seriously reduced, resulting in the reduction of data availability and interference to the experimental results. Therefore, it is necessary to study a new data transmission efficiency optimization algorithm for laboratory instruments and equipment. In this study, frequency control technology is used to optimize the data transmission efficiency of laboratory instruments and equipment. The overall research technical scheme of the algorithm is as follows:

(1) In order to effectively improve the data transmission efficiency, the frequency control method is used to construct the real-time data transmission model of laboratory equipment, and the optimal equivalent load of laboratory equipment is obtained.

(2) Based on the real-time transmission model constructed above and the best equivalent load results obtained, the filter time constant is selected through the first-order low-pass filter control model to obtain the value range of the filter time constant.

(3) According to the range of the filter time constant, the filter time constant is optimized in real time by using the smoothed power prediction value sequence, and the optimization objective function of the data transmission efficiency of laboratory equipment is constructed. The optimization of data transmission efficiency can be performed by solving the objective function.

(4) Experimental verification, data transmission efficiency, data throughput, and resource consumption are the experimental comparison indicators, and the performance of the proposed algorithm is compared and verified.

3. Construction of the Real-Time Data Transmission Model of Laboratory Instruments and Equipment

Frequency control is the most commonly used method to suppress the fluctuation of transmission power of instruments and equipment at present. In order to improve the stability of real-time transmission of data of laboratory instruments and equipment, a real-time transmission model of filter time constant is constructed based on frequency control. The model takes the maximum data transmission throughput used to stabilize fluctuations as the optimization goal and takes the stabilization control index and energy storage power and capacity limits as constraints [18]. Then, an optimization method of data transmission efficiency of laboratory instruments and equipment based on real-time optimization of filter time constant is proposed, and the feedback control of energy storage state and the coordination strategy of two-time scale indicators are introduced. Finally, the optimization effect of data transmission efficiency of laboratory instruments and equipment based on this method is analyzed.

Frequency control is one of the most commonly used methods to control the transmitted power fluctuation of instruments and equipment. The data transmission power P_w of experimental instruments and equipment is obtained after the desired leveled power $P_{O,EXP}$ through the first-order low-pass filtering. The difference between $P_{O,EXP}$ and P_w is the power instruction $P_{ESS,C}$ that needs to be compensated for the data transmission of laboratory instruments and equipment. $P_{ESS,C}$ is positive indicating forward transmission. The sum of the actual output power P_{ESS} of laboratory instruments and wind power P_w is the total power P_O of wind power and energy storage after stabilization. At this point, the first-order low-pass filtering control model is expressed as [19]

$$P_{O,EXP}(s) = \frac{1}{1 + T_f \cdot s} \cdot P_w(s). \quad (1)$$

In the actual wind power and energy storage control system, the frequency control algorithm is usually based on the discrete system. According to 1, the frequency control transfer function [20] can be obtained as follows:

$$P_{ESS,C} = P_{O,EXP}(s) - P_w(s). \quad (2)$$

By discretizing equations (1) and (2), the recursive equation can be obtained as follows [21]:

$$P^t_{O,EXP}(s) = \frac{T}{T_f + \Delta t} \cdot P^{t-\Delta t}_{O,EXP} + \frac{T}{T_f + \Delta t} \cdot P^t_{W,} \quad (3)$$

$$P_{ESS,C} = P^t_{O,EXP} - P^t_W, \quad (4)$$

where t is the current moment, and Δt represents the calculation step size. At the same time, according to the actual output power P_{ESS} of the laboratory instrument, the optimal equivalent load of the laboratory instrument can be calculated. At time t, we get

$$REL^t = REL^0 - \sum_{\tau=0}^{t} P^t_{ESS} \cdot \Delta t, \quad (5)$$

where REL^0 is the optimal equivalent load at the initial moment. Equations (3)–(5) constitute the basic model applied to the data transmission frequency control of laboratory instruments.

4. Optimization of Data Transmission Efficiency of Laboratory Instruments and Equipment

4.1. Selection of Filtering Time Constant. The time constant T_f is the key parameter of the first-order low-pass filtering control, and its size directly affects the effect of suppressing fluctuations and the required energy storage capacity and power. The data transmission efficiency of laboratory instruments and equipment is controlled by the first-order low-pass filtering control model. The larger the T_f is, the smoother the power after stabilization is obtained, but the more energy storage capacity and power are needed [22]. At present, the cost of data transmission of laboratory instruments and equipment is still relatively high, so how to optimize and select the appropriate time constant T_f, therefore, reducing the demand of energy storage capacity and power through scheduling technology while meeting the proposed fluctuation suppression index has become the key technical problem of fluctuation suppression control [23–25]. At the same time, the minimum data transmission capacity and minimum energy storage power required to suppress the fluctuation of data transmission efficiency of laboratory instruments and equipment within a period T are

$$\begin{aligned} C_{ESS,D} &= \max_{t\in[0,T]} \mathrm{REL}^t - \min_{t\in[0,T]} \mathrm{REL}^t, \\ P_{ESS,D} &= \max_{t\in[0,T]} \left|P^t_{ESS}\right|. \end{aligned} \quad (6)$$

Since the theoretical value range of filtering time constant T_f is $[0, +\infty)$, it is difficult to optimize the calculation. Therefore, it is assumed that

$$\alpha = \frac{T_f}{T_f + \Delta t}. \quad (7)$$

The value range of variable α is [0, 1]. By substituting equation (7) into equation (3), we can get

$$P^t_{O,EXP}(\alpha) = \alpha \cdot P^{t-\Delta t}_{O,EXP}(\alpha) + (1-\alpha) \cdot P^t_W, \quad (8)$$

$$P^t_{ESS,C}(\alpha) = P^{t-\Delta t}_{O,EXP}(\alpha) + P^t_W. \quad (9)$$

Therefore, for a fixed calculation step Δt, optimizing the variable α is equivalent to optimizing the time constant T_f. And a increases monotonously with the increase of T_f, so the larger α is, the smoother the power is. In order to ensure a certain smooth effect, usually set $\alpha \in [\alpha_{\min}, 1]$, $\alpha_{\min} > 0$.

4.2. Optimization of Transmission Efficiency. The size of filtering time constant is closely related to the effect of wave stabilization and the energy storage power and capacity required for wave stabilization. Therefore, this section proposes a real-time optimization method of filtering time constant to obtain the optimal time constant, so as to use the least data transmission capacity of laboratory equipment to stabilize the wind power fluctuation in the next period to meet the proposed fluctuation suppression index f. In this method, α is taken as a single optimization variable, the minimum energy storage capacity is taken as the optimization objective, and the fluctuation suppression index is taken as the constraint condition. Next, we will take the 1-minute period as an example.

Assuming that the predicted value sequence of data transmission power of laboratory equipment in the next 1-minute period is $P^{t+k\cdot\Delta t}_{W,P}$ ($k = 1, 2, \ldots, n$, if $\Delta t = 10s, n = 6$), the predicted value sequence $P^{t+k\cdot\Delta t}_{O,P}(\alpha)(k = 1, 2, \ldots, n)$ of stabilized power and the predicted value sequence $P^{t+k\cdot\Delta t}_{ESS,P}(\alpha)(k = 1, 2, \ldots, n)$ of data transmission power of laboratory

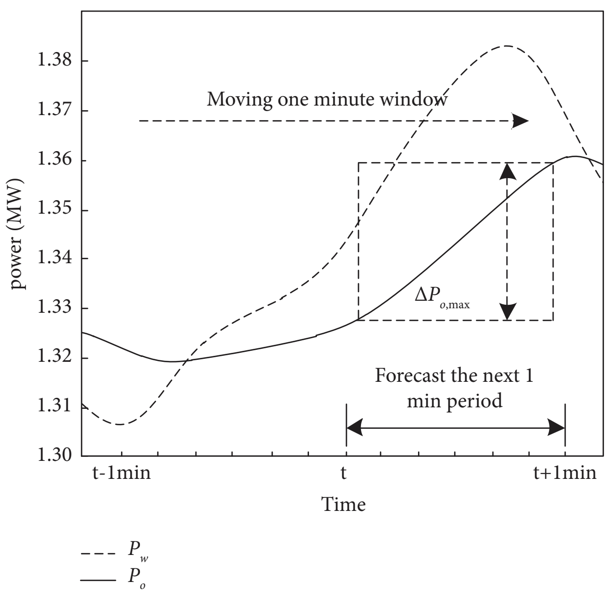

FIGURE 1: Calculation diagram of maximum fluctuation in the next minute.

equipment in the next 1-minute period can be calculated by equations (8) and (9).

$\Delta P_{O,\max}(\alpha)$ is defined as the maximum fluctuation of power in the next minute. Since the fluctuation suppression index needs to be satisfied at any time, $\Delta P_{O,\max}(\alpha)$ is not only related to the power fluctuation in the next minute, but also related to the power fluctuation that has occurred in the previous minute. The calculation method of $\Delta P_{O,\max}(\alpha)$ is shown in Figure 1, that is to calculate the maximum fluctuation of any one minute period in the time window within one minute before and after the time t (the total length is two minutes).

Let the power sequence after stabilization in the first minute be $\Delta P_{O,L}^{t-m\cdot\Delta t}$ $(m = 0, 1, .., n-1)$, then the power after stabilization in the time window $[t - 1\,\text{min}, t + 1\,\text{min}]$ can be expressed as

$$P_{O,WIN}(\alpha) = \left\{\Delta P_{O,L}^{t-m\cdot\Delta t}, \Delta P_{O,P}^{t+k\cdot\Delta t}(\alpha)\right\}. \tag{10}$$

Then the maximum fluctuation $\Delta P_{O,\max}(\alpha)$ of power after stabilization in the next 1 minute can be calculated by the following formula:

$$\Delta P_{O,\max}(\alpha) = \max_{i\in[1,n]}\left\{\max_{j\in[1,n]}\left[P_{O,WIN}^{\tau}(\alpha)\right] - \min_{j\in[1,n]}\left[P_{O,WIN}^{\tau}(\alpha)\right]\right\}. \tag{11}$$

Among them, $s = t - (i - 1 + j)\cdot\Delta t$.

According to equations (10) and (11), the energy storage capacity $C_{ESS,D}(\alpha)$ and energy storage power $P_{ESS,D}(\alpha)$ required in the next 1 minute period can be calculated, both of which are related to variable α. $C_{ESS,D}(\alpha)$ can more clearly reflect the operation process of the energy storage system in a period of time and is closely related to the operation economy and cost calculation of the data transmission efficiency of laboratory instruments and equipment. Therefore, $C_{ESS,D}(\alpha)$ minimum is taken as the objective function of the optimization method, as follows:

$$\max_{\alpha\in[\alpha_{\min},1]} C_{ESS,D}(\alpha). \tag{12}$$

Let $\Delta P_{O,\text{LIM}}$ be the maximum fluctuation limit in the next one minute. If only one minute time scale fluctuation is considered, then the value of $\Delta P_{O,\text{LIM}}$ is set as the one-minute time scale fluctuation suppression index $P_{w,\gamma}$. If two-time scales fluctuation is considered, then $\Delta P_{O,\text{LIM}}$ should be determined by two-time scale index coordination strategy. Therefore, the maximum power fluctuation constraint of laboratory equipment in the real-time optimization method of filtering time constant can be expressed as

$$\Delta P_{O,\max}(\alpha) \le \Delta P_{O,\text{LIM}}. \tag{13}$$

In addition, the maximum charging and discharging power of laboratory equipment is usually determined by the grid connected converter. Setting $P_{ESS,\text{LIM}}$ as the maximum charging and discharging power limit of laboratory equipment, the data transmission power constraints of laboratory equipment are as follows:

$$P_{ESS,D} \le P_{ESS,\text{LIM}}. \tag{14}$$

As mentioned above, equations (12)–(14) are the real-time optimization functions of the filtering time constant. Based on this, the data transmission efficiency of laboratory equipment is optimized.

There are maximum and minimum operations in the objective function and constraint conditions, so the traditional gradient based optimization method is difficult to solve. In addition, the optimization period of the optimization method can be set flexibly, such as 5 minutes, 10 minutes, and so on. Obviously, the optimal operation mode of energy storage can be obtained by optimizing the time constant in a longer period of time. However, due to the uncertainty of the data transmission power of laboratory equipment, it is difficult to accurately predict the transmission power of instrument identification in a long period of time, and the amount of calculation is also larger, so it is not suitable for running in the food time control system. Therefore, this paper takes 1 minute as the optimization period of the filtering time constant optimization model, which corresponds to the time scale of the fluctuation stabilization index proposed by the demonstration project.

Part of the code of the algorithm is shown in Figure 2.

4.3. Optimization Algorithm Steps

(1) eNB obtains data transmission information of laboratory instruments and equipment from DASH proxy or DASH multicast proxy;

(2) eNB collects channel quality information of laboratory data transmission in the cell;

(3) PSNR(P) corresponding to COL of each grade is used as the auxiliary value of temporary decision;

```
class Adam:
    def __init__(self, loss, weights, lr=0.001, beta1=0.9, beta2=0.999, epislon=1e-8):
        self.loss = loss
        self.theta = weights
        self.lr = lr
        self.beta1 = beta1
        self.beta2 = beta2
        self.epislon = epislon
        self.get_gradient = grad(loss)
        self.m = 0
        self.v = 0
        self.t = 0

    def minimize_raw(self):
        self.t += 1
        g = self.get_gradient(self.theta)
        self.m = self.beta1 * self.m + (1 - self.beta1) * g
        self.v = self.beta2 * self.v + (1 - self.beta2) * (g * g)
        self.m_hat = self.m / (1 - self.beta1 ** self.t)
        self.v_hat = self.v / (1 - self.beta2 ** self.t)
        self.theta -= self.lr * self.m_hat / (self.v_hat ** 0.5 + self.epislon)
```

Figure 2: Algorithm code (part).

(4) The user partition point is selected, that is, all data transmission sequences are sorted in the order of channel quality from small to large, the former users are divided into unicast transmission (Xcan choose 5, 10, 15, . . ., 95100), and the resource consumption (r) under the condition of X% as the partition point is calculated;

(5) Calculate the PSNR: $m = p/r$;

(6) Traverse X in the range of (5, 10, 15, . . ., 95100), calculate m value corresponding to each x value, select the maximum m value and record it as Max-T;

(7) Save the unicast multicast distribution mode corresponding to Max-T;

(8) eNB sends the UE information allocated for multicast transmission (including the channel quality information of UE) and the multicast data transmission resource quota to the DASH multicast proxy;

(9) DASH multicast proxy sorts multicast UES according to the channel quality from small to large and records the minimum min-CQI; The maximum value is max-CQI;

(10) Select the multicast group subdivision granularity s, s can be an integer from 2 to 15 (CQI level is 1 to 15);

(11) The CQI range of multicast UE is divided equally into s parts, which are recorded as 1 to s levels. UE belonging to the same channel quality level are divided into the same group;

(12) The bit rate of s-data transmission is determined for each sub-multicast group, and there is a corresponding relationship between the bit rate and worst CQI in the sub-multicast group;

(13) The transmission rate of each RB has a corresponding relationship with CQI;

(14) The number of RB needed for the video with the corresponding bit rate is calculated according to the size of the data transmission fragment and the data transmission speed of RB, and the RB resource consumption of all multicast levels is added up;

(15) If the number of RB does not reach the upper limit of multicast radio resources, the number of level s is increased by 1, and steps (11) to (14) are repeated until the multicast data transmission resources are consumed, and the optimized device data transmission efficiency is obtained.

5. Experiment

5.1. Experimental Scheme. The connection of experimental instruments is shown in Figure 3.

First of all, the simulation environment is still the SFN domain composed of 19 laboratories. The 19 laboratories form three layers from the inside to the outside. The distance between eNB base stations is 500 meters, and the number of UE is 20, 50, 100, 200, 300, 400, and 500. These seven groups of data are simulated separately. The UE randomly diverges in the SFN domain composed of these 19 laboratories. In terms of video services, we set up 8 video programs to simulate multi video services. The UE is divided into the eight video services on average.

In addition to using the actual collected data, in order to improve the reliability of the experimental results, we also used MySQL database, redis database, and Memcached database.

The simulation parameters are as follows:

Number of laboratories: 19; Laboratory interval: 500 M; Bandwidth: 10 MHz; Carrier frequency: 2 GHz; Channel model: Tu channel model; Base station transmission power: 46 dBm; UE transmission power: 24 dBm; Simulation time: 80 s.

5.2. Experimental Result

5.2.1. Throughput of Laboratory Equipment in the Process of Data Transmission. In order to verify the throughput of this method in the process of data transmission of laboratory

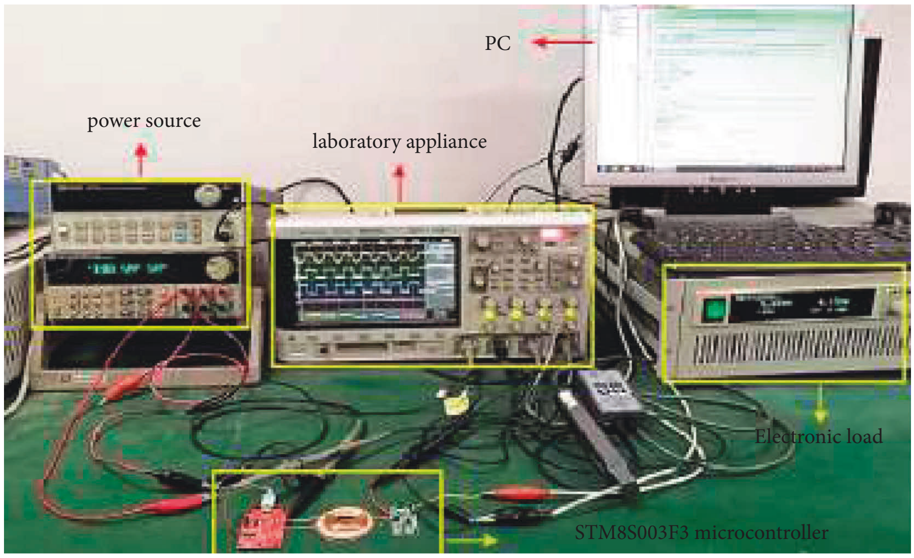

Figure 3: Experimental instruments. Next, we test the data transmission optimization scheme of experimental instruments and equipment proposed in this paper.

Table 2: Comparison results of data transmission throughput.

Data transmission distance/m	Throughput of laboratory equipment in the process of data transmission/kbit		
	Methods in reference [8]	Methods in reference [9]	Method of this paper
50	142	221	342
100	125	212	323
150	111	200	312
200	105	162	300
250	98	154	287
300	96	134	276
350	86	121	265
400	80	112	254
450	77	103	241
500	72	98	234

equipment, the methods of reference [8], reference [9], and this method are used to test the throughput of data transmission, and the results are shown in Table 2.

From the analysis of Table 2, it can be seen that the throughput in the process of data transmission is different under different methods. When the data transmission distance is 100 m, the throughput of the method of reference [8] in the data transmission process of laboratory instruments and equipment is 125 kbit, the throughput of the method of reference [9] in the data transmission process of laboratory instruments and equipment is 212 kbit, and the throughput of the method of this paper in the data transmission process of laboratory instruments and equipment is 323 kbit. Under this transmission distance, the throughput of the algorithm in this paper is increased by 198 kbit and 111 kbit, respectively. When the data transmission distance is 300 m, the throughput of the method of reference [8] in the data transmission process of laboratory instruments and equipment is 96 kbit, the throughput of the method of reference [9] in the data transmission process of laboratory instruments and equipment is 134 kbit, and the throughput of the method of this paper in the data transmission process of laboratory instruments and equipment is 276 kbit. Under this transmission distance, the transmission throughput of the algorithm in this paper is increased by 180 kbit and 142 kbit, respectively. The above experimental results show that the throughput of this method in the process of equipment data transmission is significantly higher than that of other methods, which indicates that this algorithm improves the performance of data transmission of laboratory equipment.

5.2.2. Resource Consumption in the Transmission Process of Laboratory Instruments. In order to analyze the resource consumption of laboratory equipment, the methods of reference [8], reference [9], and the resource consumption of laboratory equipment detected by this method are used, and the results are shown in Figure 4.

By analyzing Figure 4, we can see that the resource consumption of the experimental data transmission process is different under different methods. When the data transmission volume is 100 GB, the resource consumption of the method in reference [8] is 215TTI, the resource

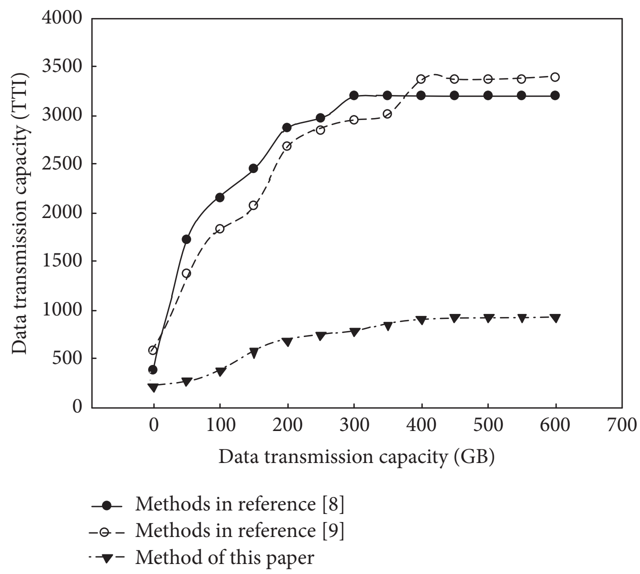

Figure 4: Resource consumption results during data transmission.

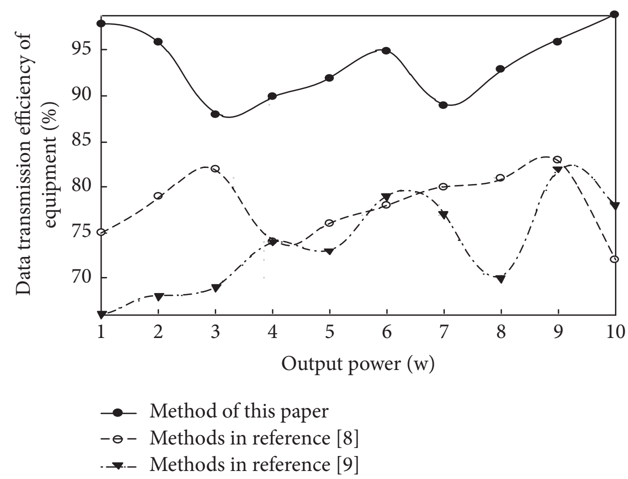

Figure 5: Comparison results of data transmission efficiency.

consumption of the method in reference [9] is 183TTI, and the resource consumption of the method in this paper is 37TTI. Under this data volume, the resource consumption of the algorithm in this paper is reduced by 178TTI and 146TTI, respectively. When the data transmission volume is 500 GB, the resource consumption of the method in reference [8] is 3200TTI, the resource consumption of the method in reference [9] is 3270TTI, and the resource consumption of the method in this paper is 900TTI. Under this data volume, the resource consumption of the method in this paper is reduced by 2300TTI and 2370TTI, respectively. From the above data, it can be seen that the method in this paper can improve the resource consumption in the process of data transmission and optimize the data transmission efficiency of laboratory instruments and equipment.

5.2.3. Data Transmission Efficiency. In order to verify the effectiveness of this method, the methods of reference [8], reference [9], and the transmission efficiency of laboratory equipment under different loads tested by this method are adopted, and the results are shown in Figure 5.

By analyzing Figure 5, it can be seen that the data transmission efficiency of laboratory equipment with different loads is different. When the output power is 2 W, the device data transmission efficiency of the method in reference [8] is 79%, the device data transmission efficiency of the method in reference [9] is 68%, and the device data transmission efficiency of the method in this paper is 96%. Under this output power, the data transmission efficiency of the algorithm in this paper increases by 17% and 28%, respectively. When the output power is 8 W, the device data transmission efficiency of the method in reference [8] is 81%, the device data transmission efficiency of the method in reference [9] is 70%, and the device data transmission efficiency of the method in this paper is 93%. Under this output power, the transmission efficiency of the algorithm in this paper increases by 12% and 23%, respectively. The data transmission efficiency of this paper is always higher than that of reference [8] and reference [9], and the highest equipment data transmission efficiency is as high as 99%, which shows that this method can effectively optimize the data transmission efficiency of laboratory equipment.

From the above experimental results, it can be seen that the effect of the algorithm in this paper is better than the two literature comparison algorithms in terms of transmission throughput, resource consumption, and transmission efficiency. Moreover, from the resource consumption, it can be seen that the complexity of the algorithm in this paper is relatively low, so it consumes less resources. The complexity of the algorithm will be verified in detail in subsequent studies.

6. Conclusion

In order to solve the data transmission efficiency optimization algorithm of laboratory equipment, this paper proposes a data transmission efficiency optimization algorithm of laboratory equipment based on frequency control. The real-time data transmission model of laboratory instruments and equipment is constructed. The filtering time constant of laboratory instruments and equipment is selected through the first-order low-pass filtering control model, and the filtering time constant range is obtained. The objective function of data transmission efficiency optimization of laboratory equipment is obtained by using frequency control to realize the optimization of data transmission efficiency. When the data transmission distance is 300 m, the throughput of the laboratory equipment is 276 kbit. When the data transmission is 500 GB, the resource consumption of this method is 900TTI. When the output power is 8 W, the data transmission efficiency of this method is 93%. This method can significantly improve the data transmission efficiency, improve the resource consumption in the process of data transmission and optimize the data transmission efficiency of laboratory equipment.

Data Availability

There are no available data for this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] A. Moradi, H. Farrokhi, and R. Ghazizade, "Throughput optimization using simultaneous sensing and transmission in energy harvesting cognitive radio networks," *International Journal of Communication Systems*, vol. 32, no. 3, pp. e3850–e3874, 2019.

[2] M. Faheem, R. A. Butt, B. Raza et al., "A multiobjective, lion mating optimization inspired routing protocol for wireless body area sensor network based healthcare applications," *Sensors*, vol. 19, no. 23, pp. 5072–5117, 2019.

[3] M. K. Sahu and S. Patil, "Linear regression based power optimization of wireless sensor network in smart city," *IOP Conference Series: Materials Science and Engineering*, vol. 1085, no. 1, pp. 012005–12011, 2021.

[4] M. K. Pavlova and R. K. Silbereisen, "Age, cumulative (dis) advantage, and subjective well-being in employed and unemployed Germans: a moderated mediation model," *Journal of Occupational Health Psychology*, vol. 17, no. 1, pp. 93–104, 2012.

[5] Z. Z. Hu, S. Yuan, C. Benghi et al., "Geometric optimization of building information models in MEP projects: algorithms and techniques for improving storage, transmission and display," *Automation in Construction*, vol. 107, no. 11, Article ID 102941, 2019.

[6] A. Pushpalatha and G. Kousalya, "A prolonged network life time and reliable data transmission aware optimal sink relocation mechanism," *Cluster Computing*, vol. 22, no. S5, pp. 12049–12058, 2019.

[7] J. Abegunde, H. Xiao, and J. Spring, "A smart game for data transmission and energy consumption in the internet of things," *IEEE Internet of Things Journal*, vol. 13, no. 21, pp. 17–24, 2019.

[8] X. L. Ren and Y. Chen, "Routing protocol for data transmission delay optimization in wireless sensor networks," *Journal of Computer Applications*, vol. 40, no. 1, pp. 196–201, 2020.

[9] B. C. Ouyang and Y. S. Cui, "Research on information transmission efficiency optimization of distributed database based on quadratic programming," *China Computer & Communication*, vol. 32, no. 18, pp. 147-148, 2020.

[10] D. W. Yang, J. Ma, K. Li, C. Chang, and Y. Gao, "Optimization analysis of wireless network coding packet transmission times based on time complexity," *Electronic Measurement Technology*, vol. 43, no. 1, pp. 37–40, 2020.

[11] H. Cui, Y. Guan, H. Chen, and W. Deng, "A novel advancing signal processing method based on coupled multi-stable stochastic resonance for fault detection," *Applied Sciences*, vol. 11, no. 12, pp. 5385–5394, 2021.

[12] S. M. Zhang, Z. H. Zhang, B. Zhang, Q. Zhang, Z. C. Wen, and X. B. Zhou, "[A study of neurotoxicity of crotonaldehyde in male rats]," *Cognitive Computation*, vol. 39, no. 1, pp. 1–4, 2021.

[13] D. Wu, "A novel K-means clustering algorithm with a noise algorithm for capturing urban hotspots," *Applied Sciences*, vol. 11, no. 6, pp. 459–465, 2021.

[14] C. Li, J. Wang, and M. Li, "Data transmission cross-layer optimization of wireless sensor networks based on compressive sensing," *Control and Decision*, vol. 34, no. 9, pp. 2031–2035, 2019.

[15] H. A. Hamzah, N. Tuah, K. G. Lim, M. K. Tan, and K. T. K. Teo, "Data transmission in wireless sensor network with greedy function and particle swarm optimization," in *Proceedings of the IEEE 7th Conference on Systems, Process and Control (ICSPC)*, IEEE, Melaka, Malaysia, December 2019.

[16] O. Amjad, E. Bedeer, N. Abu Ali, and S. Ikki, "Robust energy efficiency optimization algorithm for health monitoring system with wireless body area networks," *IEEE Communications Letters*, vol. 24, no. 5, pp. 1142–1145, 2020.

[17] D. K. Shende and S. S. Sonavane, "CrowWhale-ETR: CrowWhale optimization algorithm for energy and trust aware multicast routing in WSN for IoT applications," *Wireless Networks*, vol. 26, no. 6, pp. 4011–4029, 2020.

[18] B. Zou, H. Wang, X. Zhou, W. Jiang, and W. Du, "Research on optimization of rendering efficiency of point cloud data of transmission lines in three-dimensional GIS," *Journal of Physics: Conference Series*, vol. 1575, no. 1, pp. 012167–012179, 2020.

[19] T. Vagelos, "User selectable optimization of data transmission compression for electronic devices," *TracFone Wireless*, vol. 16, no. 21, pp. 22–29, 2019.

[20] Z. Zhou, H. Yu, S. Mumtaz, S. Al-Rubaye, A. Tsourdos, and R. Q. Hu, "Power control optimization for large-scale multi-antenna systems," *IEEE Transactions on Wireless Communications*, vol. 19, no. 11, pp. 7339–7352, 2020.

[21] M. Elhoseny and K. Shankar, "Reliable data transmission model for mobile ad hoc network using signcryption technique," *IEEE Transactions on Reliability*, vol. 69, no. 3, pp. 1077–1086, 2020.

[22] H. Amer, H. Al-Kashoash, M. J. Khami, M. Mayfield, and L. Mihaylova, "Non-cooperative game based congestion control for data rate optimization in vehicular Ad hoc networks," *Ad Hoc Networks*, vol. 107, no. 21, Article ID 102181, 2020.

[23] F. Zhao, R. Ma, and L. Wang, "A self-learning discrete jaya algorithm for multiobjective energy-efficient distributed No-idle flow-shop scheduling problem in heterogeneous factory system," *IEEE Transactions on Cybernetics*, vol. 56, no. 14, pp. 1–12, 2021.

[24] F. Zhao, X. He, and L. Wang, "A two-stage cooperative evolutionary algorithm with problem-specific knowledge for energy-efficient scheduling of No-wait flow-shop problem," *IEEE Transactions on Cybernetics*, vol. 51, no. 11, pp. 5291–5303, 2021.

[25] F. Zhao, L. Zhang, J. Cao, and J. Tang, "A cooperative water wave optimization algorithm with reinforcement learning for the distributed assembly no-idle flowshop scheduling problem," *Computers & Industrial Engineering*, vol. 153, no. 10, pp. 1078–1085, 2020.