Hindawi
Mobile Information Systems
Volume 2022, Article ID 4393305, 11 pages
https://doi.org/10.1155/2022/4393305

Research Article

WSNs-Based Data Transmission Bandwidth Allocation Method for Smart Campus Communication Network in Colleges and Universities

Dun Guo [1] **and Liping Xia** [2]

[1]*Network and Informational Management, Jiangxi Institute of Fashion Technology, Nanchang 330201, Jiangxi, China*
[2]*Dean's Office, Jiangxi Institute of Fashion Technology, Nanchang 330201, Jiangxi, China*

Correspondence should be addressed to Dun Guo; gd@jift.edu.cn

Received 30 June 2022; Revised 21 July 2022; Accepted 13 August 2022; Published 31 August 2022

Academic Editor: Le Sun

Real-time reliability allocation of communication channels is carried out in the environment of limited bandwidth and strong interference, so as to improve the anti-interference ability and communication quality of data transmission in WSNs of smart campus communication in colleges and universities. A real-time adaptive allocation algorithm of data transmission bandwidth in WSNs of smart campus communication in colleges and universities based on Porter's interval equalization and channel error compensation is proposed. We construct the data transmission channel model of WSNs of smart campus communication in colleges and universities, carry out the optimal distribution interval balance control of the data time series of smart campus communication network according to the attenuation of the data transmission bandwidth of the communication network, adopt the band-limited multipath channel balance control method to suppress the interference in the data transmission channel of smart campus communication WSNs in colleges and universities, and realize the frequency spectrum suppression of data transmission of smart campus communication WSNs in colleges and universities. Time-varying channel and delay spread equalization method are adopted for channel equalization scheduling, and combined with channel error compensation, real-time adaptive allocation of data transmission bandwidth in WSNs of smart campus communication in colleges and universities is realized. The simulation results show that the reliability of data transmission bandwidth allocation in WSNs for smart campus communication in colleges and universities is good, the real-time channel allocation ability and channel balance are improved, the error rate of data transmission in smart campus communication network in colleges and universities is low, and the data transmission quality of smart campus communication network in colleges and universities is improved.

1. Introduction

With the rapid development of smart campus communication network technology and hybrid network communication technology, the capacity and flux of smart campus communication network channel in colleges and universities are constantly increasing. Through smart campus communication network in colleges and universities, big data information transmission and big bit stream signal output can be realized, and the real-time interaction and transmission ability of network information can be improved. WSNs data transmission channel is an important communication way to realize multimedia bit sequence stream transmission. The communication network of smart campus in colleges and universities is based on optical fiber network communication and wireless sensor network communication, which integrates wired communication and wireless communication [1]. The communication network of smart campus in colleges and universities has the advantages of large transmission bandwidth and low bit error rate and is widely used in military and civil communication. The communication network channels of smart campus in colleges and universities are easily influenced by the interference of communication network environment and electromagnetic interference, which leads to the poor ability of independent distribution and channel balance of communication network channels of smart campus in colleges and universities. Therefore, it is necessary to allocate the real-time reliability of the WSNs data transmission channel of university smart campus communication and establish a balanced allocation model of university smart campus communication network channel. By building a model to improve the communication quality, therefore, it is of great significance to study the data transmission bandwidth allocation method of university smart campus communication network in the optimal design of communication and information system [2].

The principle of data transmission bandwidth allocation in WSNs of smart campus communication in colleges and universities is to carry out channel equalization control and link forwarding control, to carry out error compensation control according to Porter interval sampling rate of smart campus communication network channels, to establish frequency-domain equalization and time-domain equalization models by combining signal characteristic spectrum analysis at the receiving end and output end of smart campus communication network channels, and to carry out adaptive modulation by combining time-frequency analysis method. To realize the real-time reliability allocation of communication channels in the smart campus communication network of colleges and universities, we reduce the error code of communication output [3, 4]. According to the above principles, related literature works have studied the real-time reliability allocation algorithm of data transmission channels in the smart campus communication WSN of colleges and universities and achieved certain research results. Reference [5] proposed a WSN data transmission algorithm based on stable scheduling retransmission mechanism. Firstly, aiming at the channel orthogonality in the signal preforming process of WSN, using the signal orthogonality between signal sequences, a data transmission stability scheme is designed to improve the channel antinoise ability in the signal preforming process, so as to effectively avoid the channel collision phenomenon Then, based on the retransmission law of WSN nodes during data transmission, combined with the orthogonal characteristics of the channel in the signal preforming process, the signal gain is processed and the retransmission threshold is constructed. Through this threshold, the data retransmission performance can be effectively improved, the network data transmission quality can be stabilized, and the probability of network congestion events can be reduced. However, this method is easily affected by the phase deflection in the channel allocation, which leads to the deviation and distortion of the channel allocation of the output university smart campus communication network, and the overall anti-interference ability of the communication system is not good. Reference [6] proposed a fast dynamic subchannel allocation method for optical fiber communication networks. Based on the optical fiber communication network model, the interference degree of the optical fiber communication network is calculated. Using the interference diagram of the optical fiber communication network subchannel, the actual capacity of the optical fiber communication network service through the link in the forwarding process is defined, the subchannel status of the optical fiber communication network is evaluated, and the multipath channel model of the optical fiber communication network subchannel is established to avoid time-varying subchannels of the optical fiber communication network; by calculating the impulse response of the subchannel of the optical fiber communication network, the output bit sequence after spread spectrum processing is obtained, and the subchannel allocation model of the optical fiber communication network is constructed. By determining the optimal strategy matrix of the subchannel allocation of the optical fiber communication network, the utility function of the optical fiber communication signal transmission is obtained. According to the influence of node interference and subchannel quality on the transmission quality of the optical fiber communication network, the subchannel allocation of the optical fiber communication network is realized. The above method has the problems of high computation overhead and high bit error of communication output. The above method also has some problems such as excessive calculation overhead and high error code of communication output [7–10].

Aiming at the problems of excessive computational overhead of data transmission bandwidth allocation in communication network and high error code of communication output, this paper proposes a method of data transmission bandwidth allocation in the university smart campus communication network based on WSNs. Based on the construction of communication channel model and the time series filtering analysis of university smart campus communication network data, the real-time adaptive allocation of WSNs data transmission bandwidth is realized through time-varying channel and delay spread equalization. Finally, the simulation test shows the superior performance of this method in realizing the real-time adaptive allocation of data transmission bandwidth in WSNs of smart campus communication in colleges and universities.

2. Communication Channel Model and Time Series Filtering Analysis of Communication Network Data in Smart Campus

With the rapid development of mobile Internet, cloud computing, Internet of Things, and other new technologies in recent years, the trend of ICT integration has brought new business models. Traditional campuses can no longer meet the needs of educational informatization. Smart campuses based on cloud computing will gradually replace the existing campus environment. Based on the previous research on various educational informatization application models, a comprehensive smart campus model integrating various information “islands” will emerge as the times require.

2.1. Construction of the WSNs Channel Model for Smart Campus Communication in Colleges and Universities. WSNs (wireless sensor networks) refer to a network composed of a large number of sensor communication nodes with limited sensing, processing, and computing capabilities.

These nodes are developed at low cost and small size and can be deployed randomly in the monitoring area to provide dense perception close to physical phenomena, process and convey this information, and coordinate actions with other nodes. In order to realize the real-time adaptive allocation of data transmission bandwidth in WSNs of smart campus communication in colleges and universities, firstly, a communication channel model is constructed, and the fading channel is used to design the time-domain allocation and frequency-domain equalization of communication channels [11]. The specific operation process is shown in Figure 1.

Equalization is divided into frequency-domain equalization and time-domain equalization. Time-domain equalization is to directly consider the time response, so that the impulse response of the whole system, including the equalizer, meets the condition of no intersymbol interference. Equalization in frequency domain is to make the total transmission function of the whole system, including the equalizer, meeting the lossless transmission condition from the consideration of frequency response. The actual baseband transmission system cannot fully meet the conditions of transmission without intersymbol interference, because the crosstalk of baseband transmission system is inevitable. When the crosstalk is serious, the transmission function of the system must be corrected to make it meet or approach the requirement of no intersymbol crosstalk. Inserting an adjustable filter in the baseband system can compensate the amplitude-frequency and phase-frequency characteristics of the whole system, thus reducing the influence of intersymbol interference. The time-varying multipath characteristics of WSNs channel of smart campus communication in colleges and universities are described mathematically. Taking discrete multipath as an example, the received signal can be described by

$$x(t) = \mathrm{Re}\left\{a_n(t)e^{-j2\pi f_c \tau_n(t)} s_l\left(t-\tau_n(t)\right)e^{-j2\pi f_c t}\right\}. \tag{1}$$

In formula (1), $a_n(t)$ is the signal sampling amplitude of WSNs, s_l is the bandwidth of WSNs, $e^{-j2\pi f_c t}$ is the delay extension of WSNs, $\tau_n(t)$ is the multipath extension of WSNs, and $e^{-j2\pi f_c \tau_n(t)}$ is the spread spectrum parameter. In the equivalent low communication channel, the time-varying impulse response of WSNs can be described by

$$c(\tau,t) = \sum_n a_n(t)e^{-j2\pi f_c \tau_n(t)} \delta\left(t-\tau_n(t)\right). \tag{2}$$

In formula (2), $a_n(t)$ is the attenuation factor of the WSN receiving the smart campus communication in the nth path, $\tau_n(t)$ is the propagation delay of the nth path, f_c is the modulation frequency, and $s_l(t)$ is the information to be transmitted by the WSN of smart campus communication in colleges and universities [12].

When a very narrow pulse signal is sent from the output of the smart campus communication WSN in colleges and universities, for example, $S_0(t) = a_0\delta(t)$, when it reaches the receiver, because there are many different propagation paths with different path lengths, which limit the symbol rate, the channel with already severely limited bandwidth cannot be fully utilized, and the time for the data of smart campus

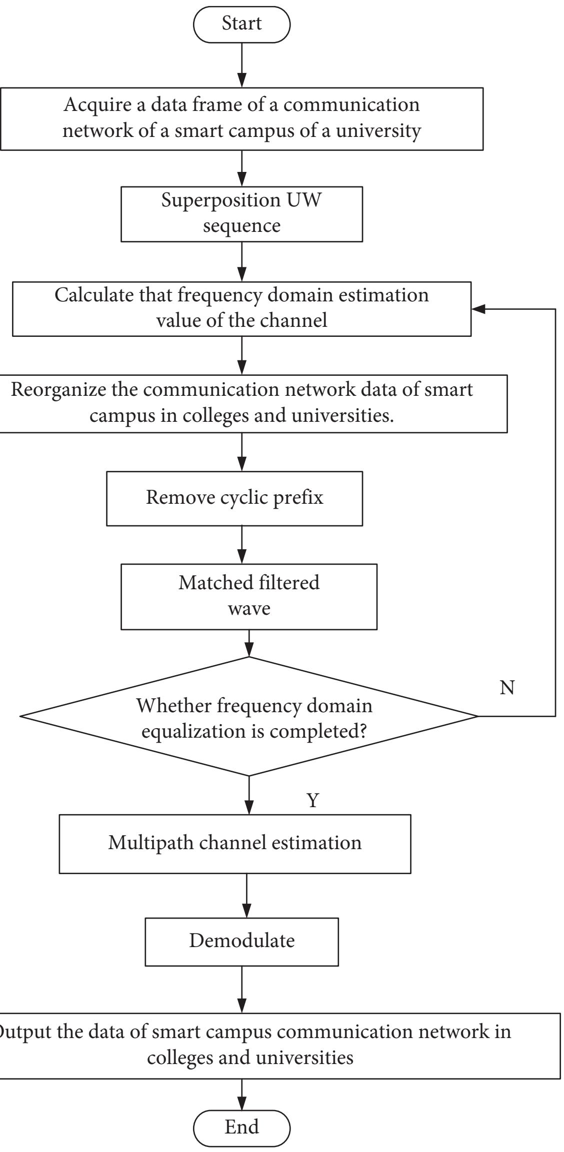

Figure 1: Flow of time-domain allocation and frequency-domain equalization.

communication WSN to reach the receiver along each path is different, so the signal received by the smart campus communication WSN receiver in colleges and universities consists of many pulses with different time delays, which can be expressed by

$$S(t) = a_0 \sum_{i=1}^{N} a_i \delta\left(t-\tau_i\right)e^{jw_c t}. \tag{3}$$

In formula (3), N is the number of paths of the smart campus communication WSN, τ_i and a_i are the delay and attenuation coefficients of the smart campus communication WSN of the first path, and w_c is the carrier frequency of the smart campus communication WSN. According to the above analysis, a bandwidth allocation model of WSNs for smart campus communication in colleges and universities is constructed, as shown in Figure 2.

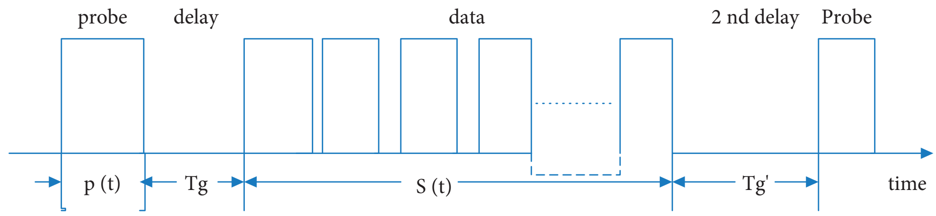

FIGURE 2: Bandwidth allocation model of WSNs for smart campus communication in colleges and universities.

According to the bandwidth allocation model of WSNs for smart campus communication in colleges and universities shown in Figure 1, assuming that the communication channel is a time-broadening channel, the channel of WSNs for smart campus communication in colleges and universities has a limited bandwidth. In the receiver of coherent multipath channel communication, the variance of the real signal received by WSNs for smart campus communication in colleges and universities is defined as

$$\sigma_x^2 = E\left[x^2(t)\right]. \tag{4}$$

In formula (4), $x(t)$ is the signal time series of network transmission. In the WSNs channel of smart campus communication in colleges and universities, the intersymbol interference (ISI) is generally $s_i(t), i = 1, 2, \ldots I$. Because the path lengths of data transmission channels of smart campus communication WSNs in colleges and universities are different, the frequency-domain equalization method is adopted to suppress ISI [13], and the spatial interference model of data transmission channel of smart campus communication WSNs in colleges and universities is constructed. According to the multipath propagation characteristics of communication channels, the channel configuration model is obtained as shown in Figure 3.

2.2. Signal Filtering Detection of WSNs for Smart Campus Communication in Colleges and Universities. A real-time adaptive allocation algorithm of data transmission bandwidth in WSNs of smart campus communication in colleges and universities based on Porter interval equalization and channel error compensation is proposed. The data transmission channel model of WSN in smart campus communication in colleges and universities is constructed, and the optimal distribution interval balance control of data time series in smart campus communication network is carried out according to the attenuation of communication network data transmission bandwidth [14–17]. The symbol transmission rate and measurement error of WSN data transmission channel in smart campus communication in colleges and universities are obtained as follows:

$$S_x = E\left[x^3(t)\right] + \sqrt{\text{sbu}}\left[s\left(t - \tau_0\right)\right]. \tag{5}$$

$$K_x = E\left[x^4(t)\right] - 3E^2\left[x^2(t)\right]b. \tag{6}$$

In formulae (5) and (6), $E[x^3(t)]$ is the attenuation characteristic of the coherent multipath channel, b is the tapped delay line, and the transmission bit sequence is sampled by the tapped interval sampling method. Thus, the data time series model of the smart campus communication network output by the data transmission channel of the smart campus communication WSNs in colleges and universities is obtained, and the instantaneous frequency is estimated according to the time-frequency distribution of the data time series of the smart campus communication network in colleges and universities, thus, accurately simulating the impulse response of the channel. The impulse response of signal $S(t)$ received by WSNs data transmission system of smart campus communication in colleges and universities is as follows:

$$S(t) = a_0 \sum_{i=1}^{N} a_i \delta\left(t - \tau_i\right) e^{jw_c t}. \tag{7}$$

In formula (7), N is the number of data transmission channels in the smart campus communication WSNs, τ_i and a_i are the time delay and frequency attenuation of the data transmission channel in the smart campus communication WSNs, and $e^{jw_c t}$ is the modulation carrier frequency of the data transmission in the smart campus communication WSNs. According to the above impulse response analysis, the input and output model of the communication channel is obtained as shown in Figure 4.

According to the attenuation of communication network data transmission bandwidth, the optimal distribution interval equalization control of communication network data time series in smart campus of colleges and universities is carried out [15–18]. The blind equalization technology is adopted to estimate the time delay and amplitude of communication channels, and a tap delay model is established to suppress the multipath components of channels. It is assumed that WSNs of smart campus of colleges and universities transmits data to each node, and the number of pulse frames of impulse response of channels is b_i frames, and the output time delay in phase offset direction is T_f, and the pulse broadening is

$$T_s = N_f T_f. \tag{8}$$

In formula (8), N_f is the received smart campus communication information code, T_f is the local interference noise on the signal. In digital transmission, the multipath arrival time delay is T_p. By adopting the symbol modulation method, the symbols in the smart campus communication channel are divided into N_c chips, and the tap time interval of the smart campus communication symbols is $R_b < 1/\Delta$, and the multipath delay satisfies

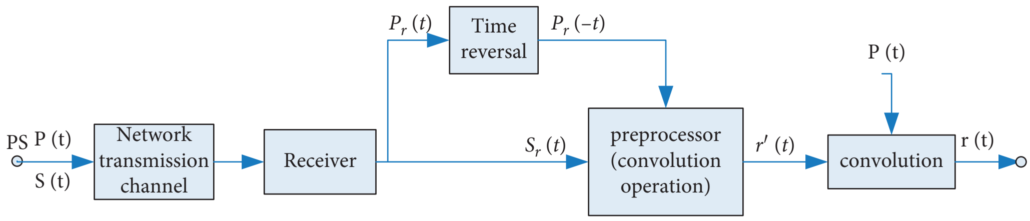

FIGURE 3: Channel configuration model of smart campus communication network in colleges and universities.

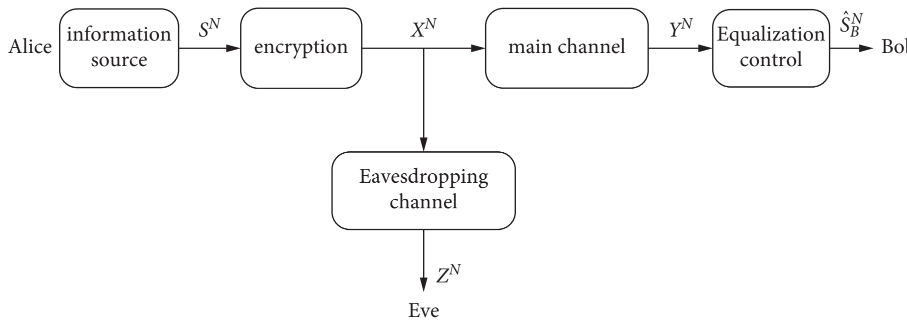

FIGURE 4: Input-output model of smart campus channel in colleges and universities.

$$T_c = \mathrm{ent}\left(\frac{T_f}{N_c}\right). \tag{9}$$

In formula (9), N_c is the autocorrelation of the impulse response function of the communication channel in the smart campus of colleges and universities. It can be seen that at the communication output end of the smart campus of colleges and universities, the phase offset of the received signal is generated through the balanced distribution of channels, thus, compensating the channel imbalance and improving the communication quality of the smart campus of colleges and universities [19–23].

2.3. Band-Limited Multipath Channel Equalization Control. On the basis of constructing the data transmission channel model of WSNs of smart campus communication in colleges and universities, the optimal distribution interval balance control of data time series of smart campus communication network in colleges and universities is carried out according to the attenuation of communication network data transmission bandwidth, and the output sampled data time series model of smart campus communication network in colleges and universities is obtained as follows:

$$s(t) = \sum_i b_j \sum_{j=0}^{N_f-1} p\left(t - iT_s - jT_f - c_j T_c\right). \tag{10}$$

In formula (10), b_j is the interference item of the data in the smart campus communication network of colleges and universities, c_j is the time sampling interval, and T_s is the convolution of signal components and noise. Assuming that the frequency-domain impulse response in the data transmission channel of the smart campus communication WSNs of colleges and universities is $h(n)$, the nonlinear equalization parameter is $y(n)$, the spread loss in the frequency domain is $n(n)$, and the output signal of the equalization system is $\tilde{x}(n)$, the intersymbol interference is suppressed by the matched filter shown in Figure 5 at a limited symbol rate.

After the information is detected and judged, the output data spectrum characteristics of WSNs data transmission of smart campus communication in colleges and universities are as follows:

$$\mathrm{computation}\left(n_j\right) = \left(E_{\mathrm{elec}} + E_{\mathrm{DF}}\right)l\delta + E_{Tx\left(l,d_j\right)}. \tag{11}$$

In formula (11), E_{elec} is the superposition component of the same time and the same phase, E_{DF} is the attenuation loss of multipath propagation, $E_{Tx(l,d_j)}$ is the channel impulse characteristic of WSNs transmission in smart campus communication in colleges and universities, ε_{fs} is the frequency spectrum parameter, l is the fuzzy information sequence, d_j is the multipath component of the detection signal. By adjusting the tap coefficient of WSNs data transmission system in smart campus communication in colleges and universities, the blind equalization method is adopted to suppress the interference, and combining with the FIR filter model, the structural form of the matched filter is obtained as follows:

$$H(z) = Am \cdot \frac{1 + 2z^{-1} + z^{-2}}{\left(1 - \rho e^{j\phi} z^{-1}\right)\left(1 - \rho e^{-j\phi} z^{-1}\right)}. \tag{12}$$

In formula (12), z is the transfer function, amplitude, and intersymbol interference of the smart campus communication WSN, and m is the least square (RLS) estimation pole of the communication channel is located. Using the linear equilibrium adjustment method and the adaptive gradient

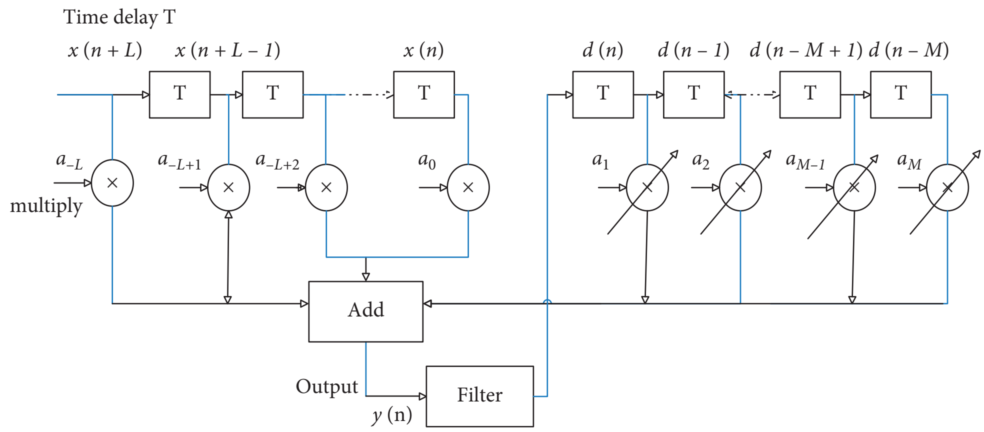

Figure 5: Band-limited multipath channel equalization controller.

algorithm, the real signal $x(n)$ input to the smart campus communication WSN communication channel is

$$x(n) = A\cos(0.3\pi n + \varphi) + v(n). \tag{13}$$

In formula (13), φ is the phase, and $v(n)$ is the intersymbol interference caused by the expansion $[-\pi, \pi)$ of WSNs of smart campus communication in colleges and universities. The adaptive equalization phase is a standard normal distribution among them. The time-frequency joint estimation method is adopted to realize signal filtering, improved the anti-interference ability of communication output, and made the channel allocation reach a stable state.

3. Optimization of Data Transmission Bandwidth Allocation in WSNs of Smart Campus Communication in Colleges and Universities

3.1. Time-Varying Channel and Delay Spread Equalization. Time varying channel: wireless communication uses electromagnetic waves to transmit signals in the air, which is very different from the traditional limited transmission environment (such as overhead open line, coaxial cable, optical fiber, waveguide, etc.,). The propagation process of electromagnetic waves is much more complex and the propagation characteristics are relatively poor. The transmitter sends a signal, which is modulated and propagated in space to the receiver. In this process, the signal will not only be lost with the increase of propagation distance, but also be affected by a variety of obstacles or complex terrain to cause "shadow fading," and the signal will pass through multipoint reflection, refraction, and scattering to form multiple path components to reach the receiver. They are superimposed on each other, which may weaken or enhance the signal. Therefore, the received signal amplitude will change dramatically, that is, there will be serious fading. This kind of fading will reduce the available useful signal power and increase the influence of interference, resulting in distortion, waveform broadening, waveform overlap and distortion of the received signal of the receiver, and even a large number of errors in the output of the demodulator of the communication system, so that the communication cannot be realized at all. In wireless communication under high carrier frequency and high-speed mobile environment, one or all of the transmitter and receiver and the surrounding objects are moving rapidly. The increase of Doppler spread leads to the decrease of the channel coherence time, resulting in the signal duration greater than the channel coherence time. Wireless channel has gradually evolved into a time-frequency dual selective fading channel, which is affected by frequency selective fading caused by multipath delay spread and time selective fading caused by Doppler frequency shift. In time-varying channels, the channel impulse response on each transmission path changes rapidly with time.

On the basis of constructing the data transmission channel model of WSNs of smart campus communication in colleges and universities, the optimal distribution interval equilibrium control and filtering analysis of data time series of smart campus communication network in colleges and universities are carried out according to the attenuation of data transmission bandwidth of smart campus communication network, and the optimal design of data transmission bandwidth allocation algorithm of smart campus communication WSNs in colleges and universities is carried out. In this paper, a real-time adaptive allocation algorithm of data transmission bandwidth in WSNs of smart campus communication in colleges and universities based on Porter interval equalization and channel error compensation is proposed. According to the attenuation of data transmission bandwidth in smart campus communication network in colleges and universities, the joint probability density estimation of channel weighting vector and output signal frequency is obtained. In the time-frequency distribution area of smart campus communication channel in colleges and universities, the error of communication transmission channel in smart campus in colleges and universities is obtained by spectrum separation method:

$$\varepsilon(k) = d(k) - W^T X(k) = d(k) - X^T(k) W. \tag{14}$$

In formula (14), $d(k)$ is the communication channel equalization control parameter of smart campus in colleges and universities, W is the sidelobe parameter of smart campus communication in colleges and universities, and $X(k)$ is the modulation component of the multipath smart campus communication signal. The time-varying channel and the delay spread equalizer are designed to compensate the minimum mean square error, and the estimated error square of WSNs data transmission channel of smart campus communication in colleges and universities at a certain moment is

$$\varepsilon^2(k) = d^2(k) - 2\, d(k)X^T(k)W + W^T X(k)X^T(k)W. \tag{15}$$

After taking the mathematical expectation on both sides of the formula, channel allocation is carried out by combining Wigner-Ville distribution and wavelet transform. Under the balanced control of time-varying channel and delay spread, the modulation mean square error of communication channel is

$$E\{\varepsilon^2(k)\} = E\{d^2(k)\} - 2E\{d(k)X^T(k)\}W + W^T E\{X(k)X^T(k)\}W. \tag{16}$$

The interference suppression in the data transmission channel of the smart campus communication WSN in colleges and universities is carried out on the continuous sliding window, and the spectrum suppression of the data transmission in the smart campus communication WSN in colleges and universities is realized, and the cross-correlation function between the time-varying channel and the balanced output of delay spread is obtained:

$$R_{x\,d}^T = E\{d(k)X^T(k)\}. \tag{17}$$

$$R_{xx} = E\{X(k)X^T(k)\}. \tag{18}$$

In formula (18), $X(k)$ is the output result of decision demodulation. By windowing, the time width of the communication channel is reserved to achieve the effect of frequency-domain balance of data transmission in WSNs of smart campus communication in colleges and universities. At this time, the energy density spectrum of the output signal satisfies

$$\eta_k^w(\omega) = E\left(T_k^w | T_k^w > \xi_k^w(\omega)\right), \quad k \in R_w, w \in W. \tag{19}$$

In formula (19), T_k^w is the process parameter of time-varying channel, and $\xi_k^w(\omega)$ is the data transmission bandwidth of WSNs for smart campus communication in colleges and universities. When the window function $h(t)$ is determined, the time-varying channel and delay spread are controlled in combination with the time-varying resolution of frequency domain, and the estimated result of instantaneous energy spectrum of communication channel is as follows:

$$\xi_k^w(\omega) = \min\{\xi | \Pr(T_k^w \le \xi) \ge \omega\} = E(T_k^w) + \gamma_k^w(\omega). \tag{20}$$

In formula (20), ξ is the decision threshold of data transmission bandwidth allocation in WSNs of smart campus communication in colleges and universities, and $\gamma_k^w(\omega)$ is the characteristic parameter of spatial focus. Through the above design, coherent superposition is carried out in time and frequency to realize the equalization of communication channels.

3.2. Real-Time Adaptive Allocation of Data Transmission Bandwidth in WSNs of Smart Campus Communication in Colleges and Universities. The link spread spectrum method is used to recombine the multipath signals of the communication channel transmission link model, and the convolution form is used to overlap and superimpose the channels to suppress the multipath influence. Under the condition of linear grouping, the decision function of data transmission bandwidth allocation of WSNs for smart campus communication in colleges and universities is constructed as follows:

$$\begin{cases} H_0\colon x'(t) = w(t) \\ H_1\colon \sqrt{E}\, s'(t) + w(t) \end{cases} \quad 0 \le t \le T, \tag{21}$$

where,

$$x'(t) = x(t) * h_w(t), \tag{22}$$

$$s'(t) = s(t) * h_w(t). \tag{23}$$

In formulae (21)–(23), $x(t)$ is the multimultipath signal reconstructed by the WSNs of smart campus communication in colleges and universities, $h_w(t)$ is the strength of pseudo-intersymbol interference, $s(t)$ is the output of demodulator, and $h_w(t)$ is the time-frequency parameter of the signal reconstructed by the WSNs of smart campus communication in colleges and universities. According to the relationship between the frequency and time of the communication channel, whitening treatment is carried out, and the association rule feature quantity between the frequency and the base feature quantity of the WSNs output signal of smart campus communication in colleges and universities is described as follows:

$$\lambda^n\left(d_{\gamma_0}\right) = \int_{-\infty}^{+\infty} f(t) d_{\gamma_0}^*(t)\mathrm{d}t. \tag{24}$$

In formula (24), $f(t)$ is the time-varying parameter of the WSNs of smart campus communication in colleges and universities, and $d_{\gamma_0}^*(t)$ is the performance parameter of time compression. In order to improve the frequency resolution of channel allocation, the channel error compensation of WSNs of smart campus communication in colleges and universities is adopted to adaptively optimize the channel allocation. When the output spectrum characteristic quantity satisfies

$$\left|\langle f, d_{\gamma_0}\rangle\right| \ge a \sup_{\gamma\in\Gamma}\left|\langle f, d_\gamma\rangle\right|. \tag{25}$$

In formula (25), a is the instantaneous frequency of the smart campus communication WSN in colleges and universities, and d_γ is the relative stationarity parameter of the frequency spectrum in the smart campus communication WSN in colleges and universities. Then, the oscillation amplitude of channel allocation is

Table 1: Configuration parameters of data transmission bandwidth of WSNs for smart campus communication in colleges and universities.

Bandwidth/dB	Impulse response/dB	Attenuation coefficient	Expansion loss/dB
10	12.005	0.874	0.353
20	12.028	0.419	0.399
30	12.028	0.575	0.387
40	12.059	0.630	0.382
50	12.053	0.770	0.345
60	12.064	0.784	0.392
70	12.024	0.123	0.364
80	12.017	1.070	0.381
90	12.072	0.651	0.325
100	12.011	0.508	0.359

$$a(t) = \sum_{n=0}^{\infty} a_n g_a(t - nT_a). \tag{26}$$

In formula (26), a_n is the phase-frequency characteristic parameter, g_a is the autocorrelation parameter, T_a is the time delay, and t is the time-frequency sequence. Based on Doppler expansion with a fixed scale factor, the Fourier transform of the transmission signal model in the WSNs channel of smart campus communication in colleges and universities is obtained. Based on the above Fourier transform, the multipath recombination of channels is carried out to obtain the output extended sequence $x' = \sum_{v=1}^{V} b_v \bullet \mathrm{IFFT}\{X_v\} = \sum_{v=1}^{V} b_v x_v$. Based on scalable and translational wavelet transform, the characteristic quantity of bandwidth allocation of the recombined WSNs of smart campus communication in colleges and universities is obtained as follows:

$$X' = \sum_{v=1}^{V} b_v X_v. \tag{27}$$

In formula (27), $\{b_v, v = 1, 2, \ldots, V\}$ is the impulse weighting coefficient of the data transmission channel in the WSNs of smart campus communication in colleges and universities. The multiscale characteristics of channel transmission are introduced to allocate the real-time reliability of the channel. When $\tilde{x} = \sum_{v=1}^{V} b_v x_v$ is the smallest, it means that the residual mean square error is the smallest. According to the above analysis, the time-varying channel and delay spread equalization method are adopted to balance the channel scheduling, and the real-time adaptive allocation of data transmission bandwidth in WSNs of smart campus communication in colleges and universities is realized by combining with channel error compensation.

4. Simulation Analysis

In order to test the application performance of this method in realizing the real-time adaptive allocation of data transmission bandwidth and optimizing communication quality in the smart campus communication WSN, a simulation experiment was conducted. The experiment is designed by MATLAB, and the carrier frequency signal of the smart campus communication WSN data transmission is 12 KHz~26 KHz, and the time width of the smart campus communication WSN data transmission is 56 ms LFM signal. The signal-to-noise ratio (SNR) of data transmission interference in WSNs of smart campus communication in colleges and universities is -15 dB, the order of feedforward band-limited multipath channel equalization controller is 12, the order of linear equalizer is 12, and the iteration steps are all 0.01. The iteration steps of channel allocation are 200. See Table 1 for bandwidth configuration parameters.

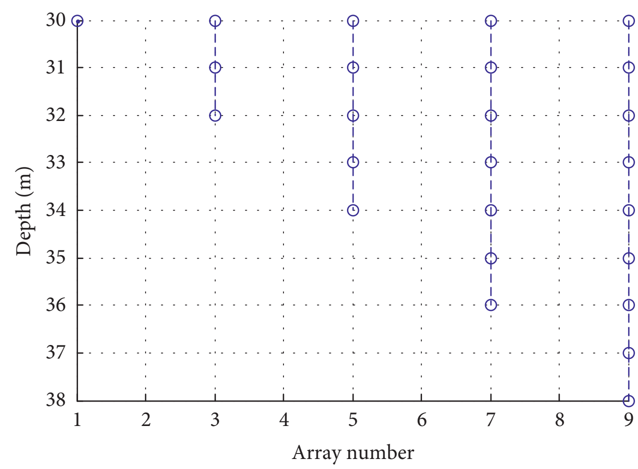

Figure 6: Distribution of WSNs elements in smart campus communication of colleges and universities.

According to the above simulation environment and parameter settings, carry out the simulation of data transmission bandwidth allocation of the smart campus communication WSN in colleges and universities. The array element distribution of the smart campus communication WSN in colleges and universities is shown in Figure 6, and the input signal waveform is shown in Figure 7.

Take the data transmission signal of WSNs of smart campus communication in colleges and universities shown in Figure 6 as the test set, and allocate channels in real time. After channel allocation, the time-domain waveform of the data time series of smart campus communication network in colleges and universities is output to each channel, as shown in Figure 8.

The analysis of Figure 8 shows that the spectrum resolution of the output waveform of WSNs data transmission bandwidth real-time adaptive allocation using this method is better, which indicates that the communication quality is better.

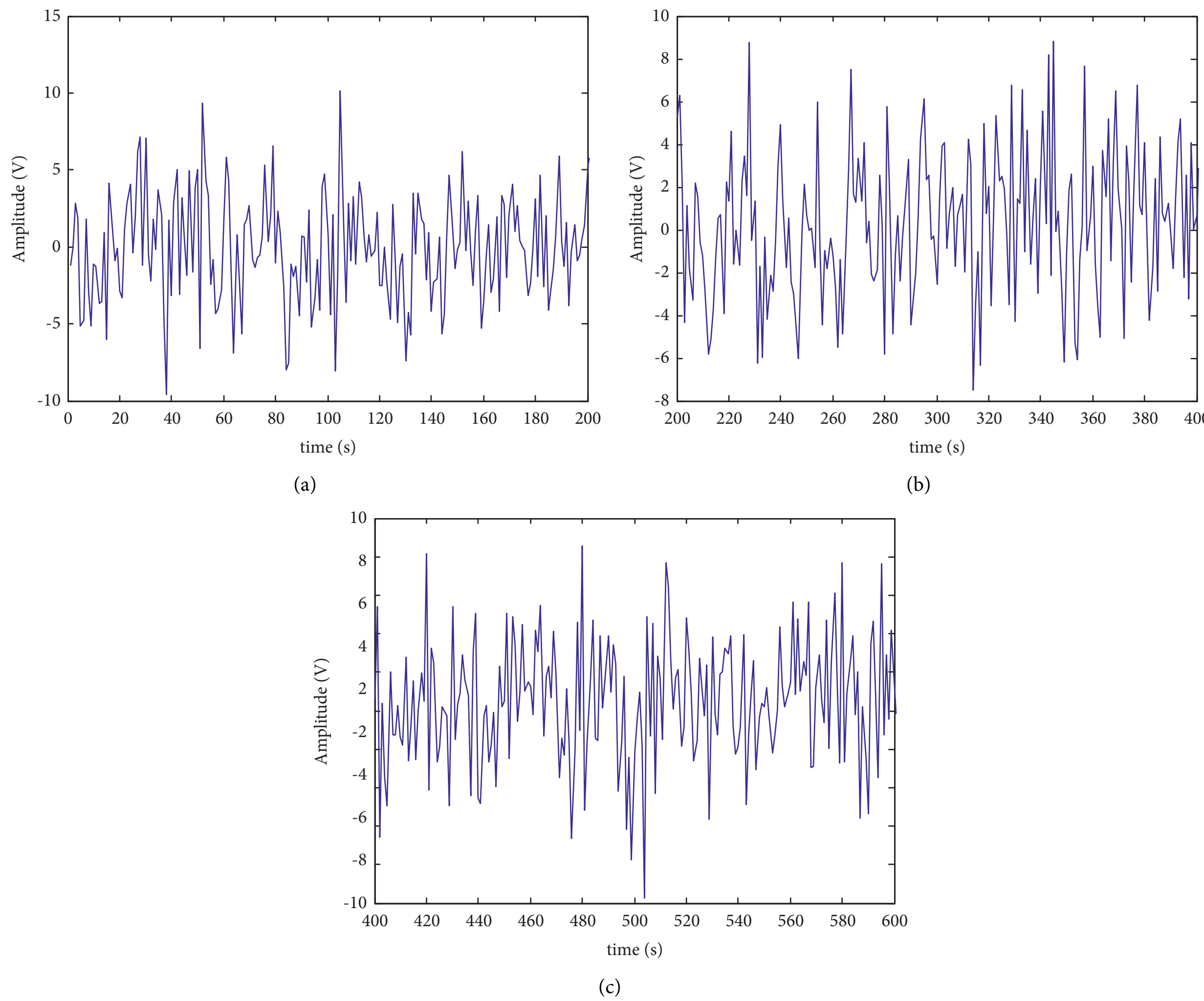

FIGURE 7: Time series waveform of communication network data in smart campus of colleges and universities: (a) sample 1, (b) sample 2, and (c) sample 3.

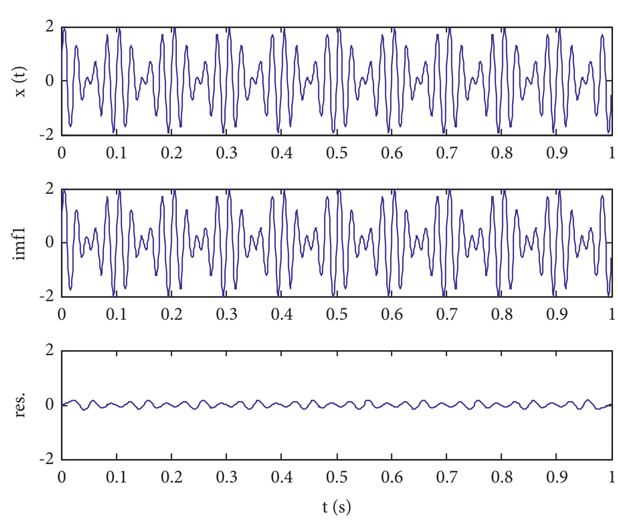

FIGURE 8: Time -domain waveform of transmission bandwidth allocation output of smart campus communication network in colleges and universities.

TABLE 2: Comparison of output bit error rate.

SNR/dB	This method	Reference [5]	Reference [6]
−10	0.034	0.405	0.574
−8	0.024	0.428	0.701
−6	0.016	0.428	0.624
−4	0.012	0.459	0.481
−2	0	0.453	0.894
0	0	0.464	0.665

Test the output bit error rate of different allocation methods, and the comparison results are shown in Table 2.

According to the analysis of Table 2, the bit error rate of the output allocated by this method to the communication channel of the smart campus of colleges and universities is low. Under the signal-to-noise ratio of -10 dB, the output bit error rate is the highest, which is 0.034. The output bit error rates of reference [5, 6] methods are 0.405 and 0.574, respectively, which are higher than the methods in this paper.

5. Conclusions

In the smart campus communication WSN, it is easy to be affected by the interference of communication network environment and electromagnetic interference, which leads to the poor ability of independent allocation of D bandwidth and channel equalization. It is necessary to allocate the data transmission channels of smart campus communication WSN in real time and establish a channel equalization allocation model to improve the communication quality. This paper proposes a real-time adaptive allocation algorithm of data transmission bandwidth of smart campus communication WSN based on Porter's interval equalization and channel error compensation. We construct the data transmission channel model of WSNs of smart campus communication in colleges and universities, carry out the optimal distribution interval balance control of the data time series of smart campus communication network according to the attenuation of the data transmission bandwidth of the communication network, adopt the band-limited multipath channel balance control method to suppress the interference in the data transmission channel of smart campus communication WSNs in colleges and universities, and realize the frequency spectrum suppression of data transmission of smart campus communication WSNs in colleges and universities. Time-varying channel and delay spread equalization method are adopted for channel equalization scheduling, and combined with channel error compensation, real-time adaptive allocation of data transmission bandwidth in WSNs of smart campus communication in colleges and universities is realized. The research shows that this method can improve the communication quality and reduce the bit error rate of communication output when it is used to allocate the data transmission bandwidth in WSNs of smart campus communication in colleges and universities. This method has a good application prospect in improving the stability of WSNs of smart campus communication in colleges and universities.

Data Availability

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

Acknowledgments

This study was supported by the Science and Technology Project of Jiangxi Provincial Department of Education (Research on the Application of Smart Campus Network Based on GPON in Application-Oriented University) (No. GJJ191081).

References

[1] X. Hong, X. Xu, P. E. N. G. Ao et al., "Key technologies and system architecture evolution of fusion positioning based on 5G mobile communication systems," *Journal of Xiamen University*, vol. 60, no. 3, pp. 571–585, 2021.

[2] Z. Pan, X. Jiagn, and C. Wang, "Research on WSN compressed data collection method based on mobile agent," *Computer Simulation*, vol. 38, no. 4, pp. 315–320, 2021.

[3] D. Wu, W. Shi, and Y. Wang, "Adaptive channel hopping for interference mitigation in wireless sensor networks," *Software Guide*, vol. 19, no. 8, pp. 207–211, 2020.

[4] T. Zhao, "High reliability and low delay wireless communication challenges, basic principles and implementation technologies of the Internet of things," *China New Telecommunications*, vol. 23, no. 17, pp. 33-34, 2021.

[5] T. Wu, "The research on WSN data transmission algorithms based on stable scheduling retransmit mechanism," *System Simulation Technology*, vol. 16, no. 1, pp. 40–45, 2020.

[6] H. Xu, P. Xiao, and X. Huang, "Fast dynamic allocation method of subchannels in optical fiber communication network," *Laser Journal*, vol. 42, no. 11, pp. 128–132, 2021.

[7] R. Yang, "Design and implementation of wireless network in College Campus," *Telecom World*, vol. 27, no. 2, pp. 156-157, 2020.

[8] L. Zhang, C. Liu, and M. Zhagn, "Dynamic channel allocation method of heterogeneous communication network based on convolutional neural network," *Journal of Xi'an Polytechnic University*, vol. 34, no. 1, pp. 124–130, 2020.

[9] X. Liu, "5G communication channel estimation and equalization method," *Communications Technology*, vol. 53, no. 11, pp. 2653–2657, 2020.

[10] L. Hu, "Research on security guarantee of smart campus system under ISO 2.0," *China New Telecommunications*, vol. 23, no. 7, pp. 148–150, 2021.

[11] Y. Li, C. Dong, and K. Niu, "High resolution Wireless channel simulation and localization technique for 6G network," *Journal of Electronics and Information Technology*, vol. 43, no. 1, pp. 13–20, 2021.

[12] Q. Liu, "Wireless sensor network communication based on backscattering and software definition," *Journal of Electronic Measurement and Instrument*, vol. 34, no. 6, pp. 41–47, 2020.

[13] Y. Cui, Z. Zhao, and J. Wu, "A reconfigurable intelligent surface design for wireless communication networks," *Radio and Communications Technology*, vol. 48, no. 3, pp. 475–479, 2022.

[14] L. I. Pu, L. Pan, and R. Ding, "Channel bandwidth adaptive TCP transmission optimization method in wireless high latency environment," *Journal of Chengdu University (Natural Science)*, vol. 40, no. 4, pp. 374–378, 2021.

[15] X. I. Qi, "Design and development of WSN network data management software system," *Information Recording Materials*, vol. 22, no. 9, pp. 120-121, 2021.

[16] X. Tong, "Multi channel communication network data cross layer acquisition timing control," *Computer Simulation*, vol. 38, no. 12, pp. 341–344, 2021.

[17] Li Wu, "HAI jie optical fiber communication network intrusion interference signal location detection simulation," *Computer Simulation*, vol. 37, no. 3, pp. 435–439, 2020.

[18] X. Xie, M. A. Hong, and F. Yang, "Interval fuzzy number time series prediction method based on combination model," *Journal of Fujian Normal University (Philosophy and Social Sciences Edition)*, vol. 37, no. 3, pp. 9–13, 2020.

[19] G. Bai, "Research on the application of 5g mobile communication network architecture in Campus," *Computer Knowledge and Technology*, vol. 17, no. 34, pp. 64-65, 2021.

[20] J. Zhagn and H. Song, "Reconstruction of impulse response function based on correlation function under ambient excitation[J]," *Journal of Vibration and Shock*, vol. 39, no. 10, pp. 220–227, 2020.

[21] P. He and M. He, "Analysis and simulation of order reflection pulse response characteristics in diffuse channel for indoor optical communication," *Optical Communication Technology*, vol. 44, no. 7, pp. 11–14, 2020.

[22] L. I. Qin, W. Li, and Z. Wang, "Optical fiber demodulator based on phase generated carrier technology," *Audio Engineering*, vol. 45, no. 9, pp. 59–63, 2021.

[23] C. Leyang, C Weidong,, T. Yue, Z. Sisi, X. Ruyi, and X. Haoran, "Virtual and reality symbiosis:digital twin (dt) technology and its prospective application in education: also discuss the reconstruction of the ubiquitous intelligence space," *Journal of Distance Education*, vol. 37, no. 5, pp. 3–12, 2019.