

Retraction

Retracted: Voice Recognition Control System Based on Cloud Computing and IoT Sensors

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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.

References

- [1] X. Song and S. Sun, "Voice Recognition Control System Based on Cloud Computing and IoT Sensors," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 4489452, 7 pages, 2022.

Research Article

Voice Recognition Control System Based on Cloud Computing and IoT Sensors

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In order to meet the increasing demand for accuracy, stability, and response speed of the voice recognition function of smart home products, the author proposes a smart home voice control system scheme based on the use of smart home Internet gateways to complete remote voice control and environmental monitoring tasks. This method firstly tests the existing home appliance network of the smart home voice control system to verify the feasibility of the author's design. Then, the voice recognition task is transferred to the cloud server, and the smart home Internet gateway only needs to perform data upload, command execution, and protocol analysis. Then, the test set tests the speech enhancement algorithm in the Aishell library. Experimental results show that the processing speed of the voice enhancement method designed by the author is much higher than that of DNN-noise classification, and its processing speed can reach 0.179 s, which is more suitable as a voice enhancement method for smart home voice control systems. Using this method for voice recognition control can meet the increasing demands of the voice recognition function of smart home products for accuracy, stability, and response speed and make people's lives more convenient and comfortable.

1. Introduction

With the development of science and technology, the performance of computer hardware has become more and more powerful, and Internet users have become more and more dependent on the Internet of Things; driven by demand, hardware virtualization and distributed computing have become more and more popular; thus, cloud computing was born; at the same time, the concept of big data and the popularization of intelligent equipment and the application of cloud computing has become more and more extensive. The author proposes to construct a control system by combining cloud computing and speech recognition. The combined application of the Internet of Things and cloud computing, the powerful data processing capabilities of cloud computing, and the wide distribution and reasonable application of the Internet of Things can give full play to the advantages of the two and combine cloud computing and the Internet of Things organically. It will also be the future development trend [1, 2].

With the research questions raised, the problem of voice control recognition accuracy has been paid more and more attention. With the increasing popularity of voice control, there are more and more types of voice assistants, but such applications usually use voice recognition technology to recognize and feedback user instructions [3].

Solving the problem in this big environment can enable interaction in multiple dimensions such as scene and speech recognition, which can better optimize people's living environment and make people's lives more convenient and comfortable. The proposal and rapid development of cloud technology and Internet of Things technology provide new ideas and platforms for the study of a new generation of smart home systems.

2. Literature Review

The concept of "Internet of Things" first appeared in Levenson's book "The Road to the Future" and developed the concept of "Internet of Things" [4]. To some extent,

Liliana et al. first proposed the concept of the Internet of Things based on coding devices, RFID technology, and the Internet of Things, while the International Telecommunication Union report highlighted the possibilities of communication in the Internet age. Things can be done in constant online exchange [5]. RFID technology, sensor technology, and smart embedded technology can be used more. Chaudhuri et al. proposed the concept of the first intelligent world, assuming that the new generation of IT technologies can be used in all spheres of life and will be globally connected and create the Internet of Things [6]. Jiang et al. has always attached great importance to system security, and the R&D team puts more energy on the home security system [7]. On this basis, the application of $\times 10$ communication technology has greatly developed the smart home industry. Leading companies in various industries in the United States have launched a round of competition in the field of smart home relying on their product advantages. Apple introduced a third party to its own smart home platform, which greatly improved the compatibility of the smart home system, combined with Apple's advantages in mobile phones, and the smart home operating system was implanted into the Apple mobile phone. A team of a company has developed a home gateway to control smart home appliances and realize the remote control function of smart homes. With the development of cloud computing technology and artificial intelligence, a company has introduced cloud computing technology and artificial intelligence into the home gateway, abandoning complicated operations and allowing the smart home system to complete control actions through voice recognition and gestures. Relying on its advantages in the field of automation, a company has launched a variety of smart home appliances, contributing to the realization of the overall control scheme of smart homes. At the same time, Jiang et al. also made great efforts on the smart home control system, based on the control technology of H+APP, and integrated advanced automatic control technology into the smart home control system [7]. In a company that focuses on chip advantages, it is committed to developing core processors that can meet the requirements of smart homes and has launched Computer Card, which can help users upgrade and convert traditional smart home devices to smart home devices and transitional tasks for the smart home.

Based on the current research, the author proposes a smart home voice control system scheme based on the use of smart home Internet gateways to complete remote voice control and environmental monitoring tasks. Using cloud computing technology, speech recognition algorithms with higher recognition efficiency and more suitable for smart homes are applied to smart home voice control, and existing speech recognition algorithms are improved in response to the growing demand for accuracy and response speed of smart home products. Through the above work, a smart home ecosystem is designed to achieve the goal of remote voice control of the smart home system, and finally, a smart home voice control system solution that can be popularized at this stage is constructed [8].

3. Methods

3.1. Overall Scheme Design of Smart Home System. Based on the overall framework design of the smart home, the author designs and proposes a smart home voice control system scheme that uses the smart home Internet gateway to complete remote voice control and environmental monitoring tasks. The smart home voice control system created by the author can use the smart home internet gateway to exchange information, receive information about the environment, transmit information through Internet of Things technology and cloud computing, and perform remote operations [9]. Smart home voice control and environment monitoring system is generally divided into four layers: the application layer, the transport layer, the control layer, and the perception layer.

3.1.1. Smart Home IoT Networking Solution Selection. The author designed a smart home Internet gateway at the transport layer to complete the networking of the Internet of Things within the smart home; in the selection of the networking mode of the smart home Internet of Things, the author compared several currently more mature communication methods, and the specific situation of several communication methods is shown in Table 1.

At present, ZigBee communication is widely used in the field of smart home. ZigBee is a low-speed personal area network IEEE802.15.4, which is suitable for electronic devices with relatively short transmission distances and no high transmission rate requirements. However, the anti-interference ability of ZigBee is low, and encountering obstacles in transmission will affect the transmission distance, and to enhance the ability of transmission to penetrate obstacles, it is necessary to increase the power amplifier circuit, which means the increase of power consumption [10]. In contrast, Wi-Fi has better penetration and faster communication. Since the smart home voice control system is a distributed system, it needs to meet the requirements of high coverage, stable communication, simple connection operation, and multinode expansion, and the author finally chose Wi-Fi communication for the networking of the internal Internet of Things and adopts the basic network structure of Wi-Fi communication. Set the Wi-Fi module on the smart home Internet gateway as the AP access point, set the Wi-Fi module on each secondary controller as the STA site, and complete the task of the smart home Internet gateway executing the device transmission command to the next level.

3.2. Secondary Controller Software Design. A second controller is a simple design to fulfill commands of a smart home voice control system, many devices in the home are controlled by a second controller, and the second controller has different hardware and software designs [11]. Based on the type of home equipment connected to the secondary controller, the author developed software for integrating infrared control devices, switches, and control panel buttons [12].

3.2.1. Network Realization of Infrared Control Equipment. The most common household appliances in family homes are those controlled by a remote control, the author uses an infrared module to control the network of infrared-

TABLE 1: Comparison of various wireless communication technical indicators.

Way of communication	Infrared	Bluetooth	Wi-Fi	ZigBee
Working frequency	820 nm (wavelength)	2.4 GHz	5.2 GHz	868/915 MHz/2.4 GHz
Coverable distance/m	6	11	25	200
Transmission rate/(Mb/s)	1.521/4/16	1	54	0.25
Power consumption/mW	15	100	100	3
Transfer method	One-on-one	One-to-many	One-to-many	One-to-many
Maximum number of nodes	2	5	255	65000

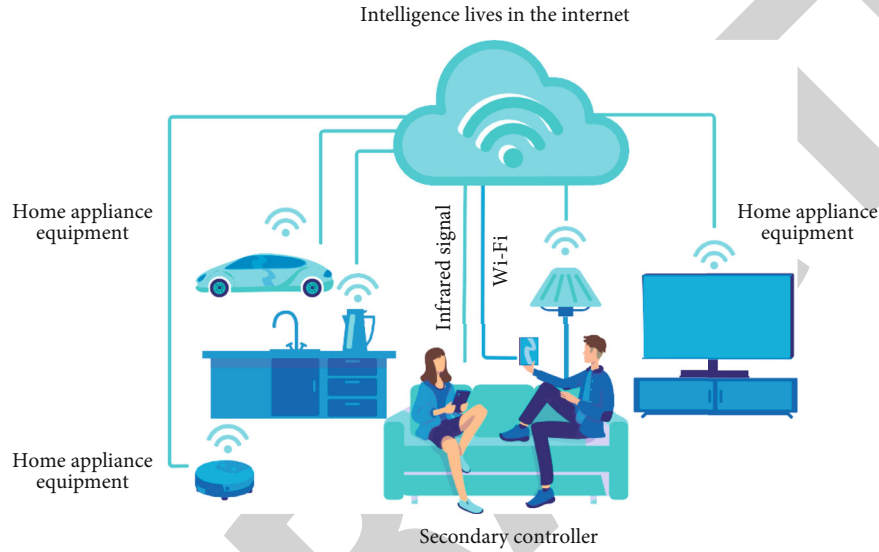


FIGURE 1: Infrared signal control equipment access scheme.

controlled home appliances and realizes remote control through the infrared signal emitted by the infrared module, and the infrared device access scheme is shown in Figure 1.

After receiving the instructions from the Internet gateway, the infrared control module parses the instructions and converts them into control instructions that the controlled device can receive and execute to control the home appliances [13]. After completing the control action, the controller module will send a feedback message to the smart home Internet gateway and enter the standby state. When the device controlled by the secondary controller is an infrared remote control device, the secondary controller is equipped with an infrared module and a storage module. At this time, the secondary controller has two modes of learning and control. When using the infrared control module for the first time, the secondary controller needs to be adjusted to the learning mode to learn the infrared control signal, and the infrared control signal will be received and decoded by the infrared receiving device and stored in the storage module for backup. After the learning is completed, various control tasks can be performed by calling the infrared control signals stored in the storage module [14]. The software flow chart of the secondary controller is shown in Figure 2.

3.2.2. The Realization of Environmental Information Collection. The smart home voice control system designed by the author not only completes the remote voice control

of household appliances but also automatically collects and uploads the environmental data inside the smart home and displays it on the user's web page interface. In each room of the home, at least one secondary controller will be equipped with a sensor module to collect the environmental data of each room of the home. The environmental data collected by the author include temperature, humidity, and light intensity [15]. When the user is at home, the smart home system will compare the collected environmental information with the threshold set by the user in advance. When the threshold is exceeded, the system will automatically turn on the air conditioner, humidifier, or curtains, so that the indoor environment has been stabilized in a comfortable state [16]. The flow chart of automatic improvement of home environment is shown in Figure 3.

After completing the speech recognition task, the cloud service platform will transmit the recognition result to the smart home hardware platform for execution. The smart home voice control system designed by the author connects the secondary controller to the network through the smart home Internet gateway; after the cloud server platform recognizes the voice command, the command information is packaged, and through TCP/IP protocol transmission, the smart home Internet gateway analyzes the protocol to identify useful information after receiving the data packet and sends specific control instructions to

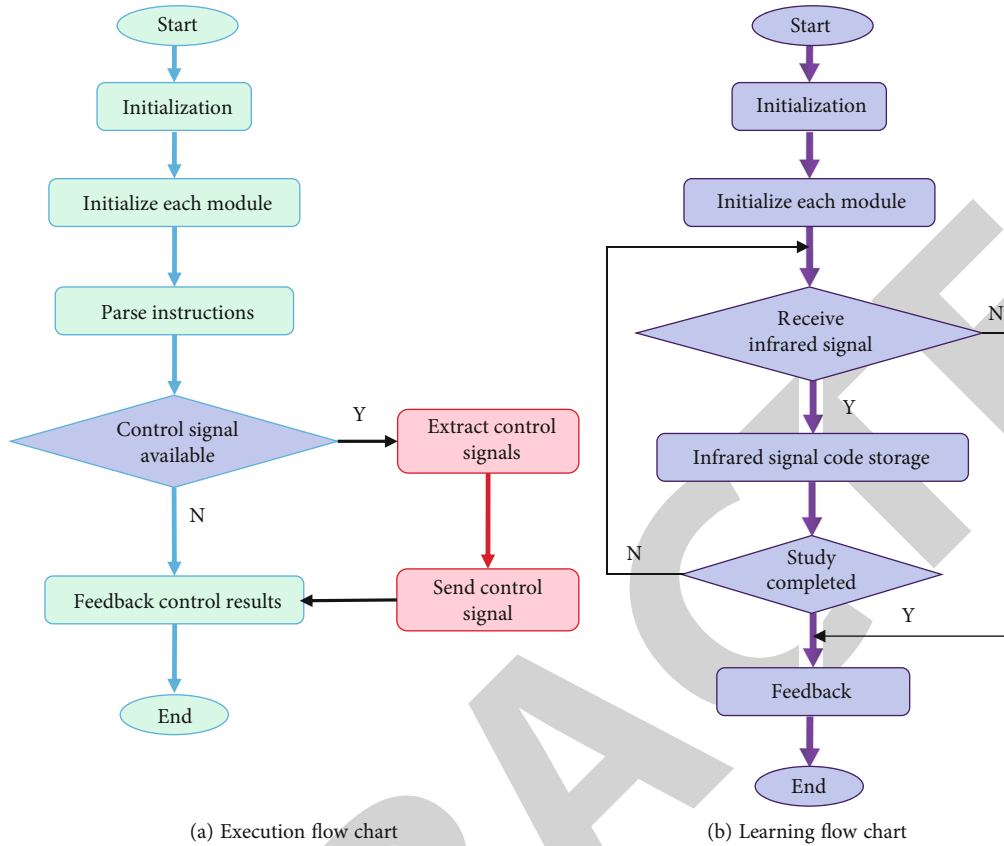


FIGURE 2: Software flow chart of the infrared control module.

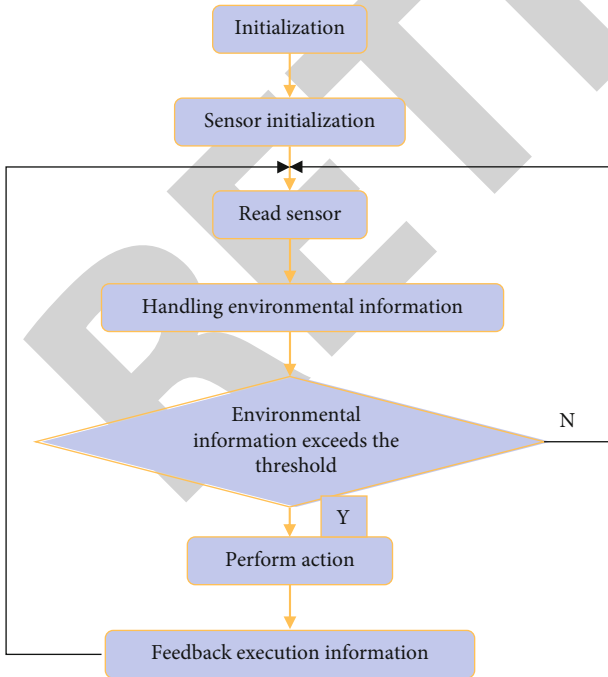


FIGURE 3: Flowchart of automatic improvement of home environment.

the secondary controller to complete the function of remote voice control.

By transferring the voice recognition task to the cloud server, the smart home Internet gateway only needs to perform data upload, command execution, and protocol analysis. At the same time, the use of cloud computing technology to liberate computing and storage tasks from embedded systems not only reduces the development cost of embedded devices and saves resources but also improves the accuracy and computing speed of speech recognition.

3.2.3. Network Test of Traditional Household Appliances. In addition to analyzing the infrared protocol signal of the air conditioner, this section also tests the three traditional home networking solutions designed by the author, the infrared control device selects the TV, the physical switch control device selects the electric light, and the key panel control device is a microwave oven. At the same time, the author also tested the temperature and humidity acquisition function of the smart home voice control system. After completing the network monitoring of TV lights, lamps, and microwave ovens, the author tested the communication reliability and quick response of existing household appliances as follows: update the software of the smart home Internet gateway. The Internet gateway sends a total of 100 commands to connected home devices every 5 seconds [17]. After the secondary controller completes the operation and the device responds, it returns information to the smart

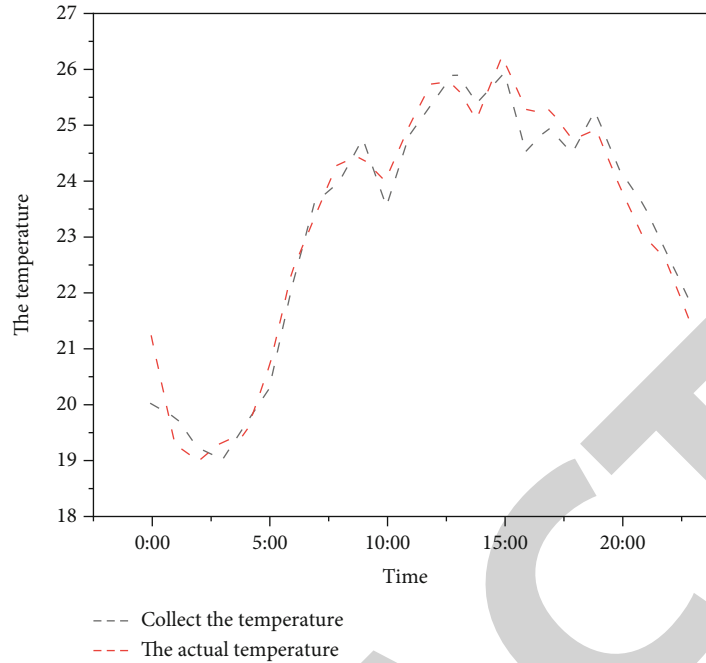


FIGURE 4: Temperature acquisition test.

home Internet gateway and records its response times and response time through the smart home Internet gateway, since there is a direct presence in the smart home Internet gateway and the secondary controller during the response process two transmissions of information; therefore, the author obtains the approximate average response time of the system by dividing the average response time of the smart home Internet gateway by 2.

After completing the network stability test of traditional home appliances, the author also tested the accuracy of environmental information collection [18]. Through the smart home Internet gateway, the sensor reads the sensor every hour, collects and records the temperature of the home for 24 hours, and compares it with the actual values, and the experimental results are shown in Figure 4.

According to the comparison between the indoor temperature within 24 hours collected by the smart home voice control system designed by the author and the actual temperature, it can be seen that the smart home voice control system designed by the author has a high accuracy in collecting environmental data, and it can complete the monitoring function of indoor environmental information.

Through the analysis of the air-conditioning protocol instructions, the connection test of different control types of traditional electrical appliances, and the collection of the temperature in the house, the feasibility of the traditional home appliance network access scheme designed by the author and the reliability of environmental data collection are proved.

3.3. Voice Enhancement. In recent years, due to the introduction of deep learning, the effect of speech enhancement has been greatly improved, but most studies on speech enhancement algorithms have ignored the requirements for processing speed; therefore, research and optimization are carried

out from the speech enhancement algorithm. Before the feature extraction of the voice command signal, the collected voice signal needs to be preprocessed. The preprocessing is to process the collected voice commands and improve the accuracy of voice recognition in the subsequent processing.

Some unrelated voice signals may be mixed into the voice command during the collection process, and these voice signals unrelated to control commands may affect the accuracy of voice recognition; therefore, in the process of voice recognition, voice enhancement is essential. Based on the smart home's demand for response speed, in order to improve the speed of speech enhancement without affecting the effect of speech enhancement, the author abandoned the relatively complex computing-based speech enhancement method based on deep learning and chose to use several methods with high reliability, and the more practical speech enhancement methods are studied and analyzed. At present, speech signal enhancement algorithms generally include Wiener filter method, subspace signal path, wavelet separation method, and spectral separation method. The wavelet signal decomposition method has a higher degree of decomposition and initial selection than the signal subspace method. In Wiener filter and spectral separation, the spatial method is computationally intensive; so, the author can do an in-depth study and analysis of spectral subtraction and Wiener filter [19]. The principle of spectrum separation is simple, the more stable and noisy the sample and measurement signal is, the more the user does not speak when entering the command voice, the signal is considered to be the noise contained in this speech, and the best speech signal is received after removing this noise [20]. The speech model of spectral subtraction is shown in Equation (1).

$$y(t) = s(t) + z(t). \quad (1)$$

Among them, $y(t)$ is the speech signal collected, transmitted and sampled, and quantized by the web terminal, $s(t)$ is the noise-free pure speech signal, and $z(t)$ is the additive noise signal.

After Fourier transform, the speech model is analyzed in the frequency domain, see Equation (2):

$$Y(\omega) = S(\omega) + N(\omega). \quad (2)$$

Spectral subtraction assumes that the speech signal and the noise signal are independent of each other, and the power spectrum can be obtained by squaring Equation (2), as shown in Equation (3):

$$|Y(\omega)|^2 = |S(\omega)|^2 + |N(\omega)|^2. \quad (3)$$

Spectral subtraction assumes that the power of the noise remains constant when the person is not speaking and speaking; so, the power spectrum of the pure speech signal of the person speaking can be expressed as the power spectrum of the noise signal minus the power spectrum of the pure noise signal as shown in the formula (4).

$$|S(\omega)|^2 = |Y(\omega)|^2 - |N(\omega)|^2. \quad (4)$$

Finally, the phase information of the noise-containing speech signal $Y(\omega)$ is used to represent the phase of the noise-free pure speech signal, and the speech enhancement signal is obtained after performing the inverse fast Fourier transform on $S(\omega)$. However, the speech signal completed by the traditional spectral subtraction will still have randomly distributed noise, and the speech will be partially distorted, so the author introduces a control coefficient to control the size of the noise power spectrum to improve the spectral subtraction, as shown in Equation (5).

$$|S^*(\omega)| = [|Y(\omega)|^\gamma - \lambda|N(\omega)|^\gamma]^{1/\gamma}. \quad (5)$$

The voice command signal after double filtering by improved spectral subtraction and Wiener filtering can be regarded as a pure voice signal without noise [21].

4. Results and Discussion

The test set comes from the test set of smart home in the Aishell library, 30 different speech signals are selected for testing, and the average length of the selected test speech is 2.7 s. The noise signal comes from public noise, car noise, and white noise in the NoiseX-92 noise library [22]. In the setting of the comparison items, the author chose the more mainstream signal subspace method and DNN-noise classification in speech enhancement to compare with the speech enhancement method designed by the author when the input signal-to-noise ratio is 5 dB, and the test results are shown in Table 2.

The test results prove that the speech enhancement algorithm improved by the author has improved SegSNR under different noise signals compared with the current mainstream signal subspace method and is slightly insufficient compared with the speech enhancement method of the more

TABLE 2: SegSNR of three speech enhancements under different noises.

Input noise(5 dB)	Output segment SNR SegSNR (dB)		
	Signal subspace method	DNN-noise classification	Method
White noise	1.87	3.07	2.54
Noise in public places	1.43	2.31	2.07
Car noise	1.57	2.06	1.97

TABLE 3: Average processing speed of three speech enhancements.

Voice enhancement	Signal subspace method	DNN-noise classification	Method
Average processing speed	0.577	1.75	0.179

advanced DNN-noise classification, but the stability of speech enhancement in the face of different noises is high [23]. While conducting the above two tests, the author also recorded the processing speed of the three speech enhancement methods, and the average processing speed of the three speech enhancement methods is shown in Table 3.

By comparing the average processing speed of the three kinds of voice enhancement, it can be seen that although the voice enhancement method designed by the author is slightly less than DNN-noise classification in terms of the effect of voice enhancement, however, its processing speed is much higher than that of DNN-noise classification, and its processing speed can reach 0.179 s, which is more suitable as a voice enhancement method for smart home voice control systems [24].

5. Conclusion

The author proposes a smart home voice control system scheme based on the use of smart home Internet gateway to complete remote voice control and environmental monitoring tasks. Firstly, the network of the existing household appliances of the smart home voice control system is tested, and the feasibility of the design in this paper is verified by testing the network scheme of the existing household appliances; then, the speech enhancement algorithm is tested, and the test results show that the speech enhancement method proposed by the author can improve the processing speed of speech enhancement under the premise of ensuring the effect of speech enhancement, which is beneficial to improve the response speed of the system. The test results show that the smart home voice control system designed by the author can improve the response speed of the system on the premise of ensuring the recall rate of voice command understanding, and it proves that the smart home voice control system designed by the author can not only face the current traditional home appliance networking but also face the future and provide an efficient smart home networking solution.

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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