

## Retraction

# Retracted: Design of the Vocal Music Feature Recognition System Based on the Internet of Things Technology

### Journal of Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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] H. Huang, "Design of the Vocal Music Feature Recognition System Based on the Internet of Things Technology," *Journal of Sensors*, vol. 2022, Article ID 1164042, 7 pages, 2022.

## Research Article

# Design of the Vocal Music Feature Recognition System Based on the Internet of Things Technology

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In order to meet the needs of vocal feature recognition, the author proposes a system design based on the Internet of things technology. The principle of the method is that the body sensory layer of the body puts the sound sensors in different positions, records the primary sound signal, and monitors and makes the sound signal using the TMS320VC5402 light red processor. The network transport layer audio signal processes and sends the voice signal database in the process layer. The sound characteristic analysis module in the application layer uses a real-time dynamic change algorithm to obtain the best similarity between the experimental model and the design, identify the characteristics of the sound set red, and identify the content of the voice feature, the music, and the emotional results of the song. Experiments have shown that the system is capable of recognizing speech in a noisy environment, with an accuracy of approximately 95%, resulting in better sound control and the ability to switch switches and remote control. The system, developed with the Internet of things technology, has been proven to improve voice recognition.

## 1. Introduction

The history of the development of modern science proves that “computer music,” which appeared in the 1970s, is the intersection of the art of music, research of literature, and the intersection of different disciplines. For the past thirty years, computer music has achieved a wide range of performance and the rapid development of electronic instruments, digital encoding of music, digital compression, and digital storage. It promotes the popularization and application of CD, DVD, digital broadcasting and multimedia, and shows a broad market prospect. However, computer vocal music as a new discipline, its fundamental goal is to use computers to simulate people's cognition and creative intelligence of vocal music. It is very difficult to deal with such subjects as vocal theory, cognitive science, artificial intelligence, information processing, pattern recognition, intelligent control and automation. It should be noted that research in this area has only just begun.

The characteristics of vocal music can be divided into basic characteristics, complex characteristics, and overall characteristics. Correspondingly, the identification of vocal features can also be divided into three levels: firstly, the basic features of vocal music are extracted, the second is to analyze the complex features on this basis, and the last is to identify the overall features of the music according to the basic and complex features of vocal music, including the musical structure, style, and emotional connotation of vocal music.

Recognition of sound features depends on the development of the art of speech recognition, the acquisition of the sound content through music, and the acquisition of sounds such as sound style and feelings. The study of sound features covers a wide range of topics, including the study of psychoacoustics, the analysis of musical instruments, and the study of music theory. Currently, voice recognition technology is not widely used due to the lack of design capabilities to help improve data performance. With the advent of the Internet of things technology, it has become a voice recognition tool.

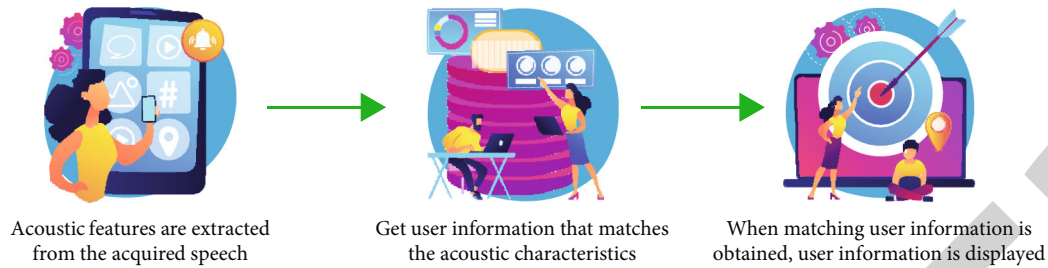


FIGURE 1: User recognition method based on sound features.

Figure 1 shows the user experience based on the characteristics of the sound. Internet of things technology enables intelligent detection, operation, and monitoring of audio signals by transmitting data over wired and wireless networks in real time, with improved accessibility, high quality, good delivery, convenience, and speed. Create an Internet of things that recognizes sound based on Internet technology, and use the Internet of things technology to receive, transmit, and recognize music [1].

## 2. Literature Review

The advent of computers and communication has led to many interdisciplinary disciplines that provide science and art. In the search for music, music has gradually shifted to digital literature and technology as an art form that interacts with everyday life and learning. In recent years, the development of modern musical instruments, including the use of electronic music, has led scientists to pay more attention to the recognition, production, and integration of computer music [2].

At present, the research on vocal music information is mainly divided into three aspects: vocal music cognition, vocal music creation, and vocal music database retrieval. In terms of vocal music cognition, it includes not only the analysis and recognition of complex features such as rhythm and harmony but also a computer system that can analyze vocal music style, feel vocal music like a human, and perform vocal music like a performer. In terms of vocal music creation, it includes the following two aspects: one is to recombine some vocal pieces according to a certain style. The other is to combine vocal music with visual art and produce different graphics and animations according to vocal music. In terms of vocal music database retrieval, according to a short melody, the corresponding songs are found in the vocal music database, which will be of great significance for the search of vocal music data [3]. Because vocal music information contains a lot of fuzziness and uncertainty, lack of strict mathematical description and mathematical model, can not be solved by traditional information processing methods. So most of the research uses fuzzy system neural network expert system genetic algorithm and other intelligent information analysis and processing methods.

With the rapid development and widespread popularization of computer technology, the Internet of things technology provides great convenience for vocal music recognition and has become a hot spot in the research and development

of vocal music recognition today. From the perspective of the needs of vocal music recognition, multimedia technology represented by sound spectrum analysis technology, MIDI technology, and audio workstation technology can reach a considerable level in terms of sound wave display, pitch measurement, and voice part determination; however, in actual vocal music recognition middle, the use of these techniques is rare. The reason is that, first, vocal musicians often have professional theoretical knowledge and practical experience of vocal music but lack systematic computer theoretical knowledge, so they cannot master various computer operation techniques in time. Second, many IoT technologies are scattered on their respective software and hardware platforms and can only be used for the analysis of a certain segment or several segments of voice and cannot be used as a systematic vocal recognition software. Aiming at the above problems, research and develop an intuitive and easy-to-operate vocal music recognition system, which has high practical and popularization value [4].

Based on the current research, the author presents models of voice recognition based on IoT technology. The author's design addresses the inadequacy of the existing voice recognition capability to eliminate noise and provides the MIC with a special antinoise function using the BU8332KV-M signal processing IC combined with the V290pub speaker recognition module, effective to reduce noise, voice recognition, and finally achieve the purpose of voice control terminal.

## 3. Research Methods

### 3.1. Identification Method of Vocal Features

**3.1.1. Rhythm Recognition.** In music, it is only when the repetition of the texts is set up that the music becomes more closely related to their relationships (e.g., percussion, atherosclerosis, and steady atherosclerosis) that it becomes important. Thus, the concept of atherosclerosis is a narrow reversal of the sequence of sounds and the main purpose of cognition is to find similar rhythms that are separated by the difference of the assembly. Because rhythm patterns have nothing to do with sound, rhythmic studies are usually included, So the rhythm can be represented by a set of numbers. How to show in [5]. Although this method is simple, it does not affect the force of the form, so some studies use graphs to show the time of the horizontal axis and the speed and force of the vertical line [6].

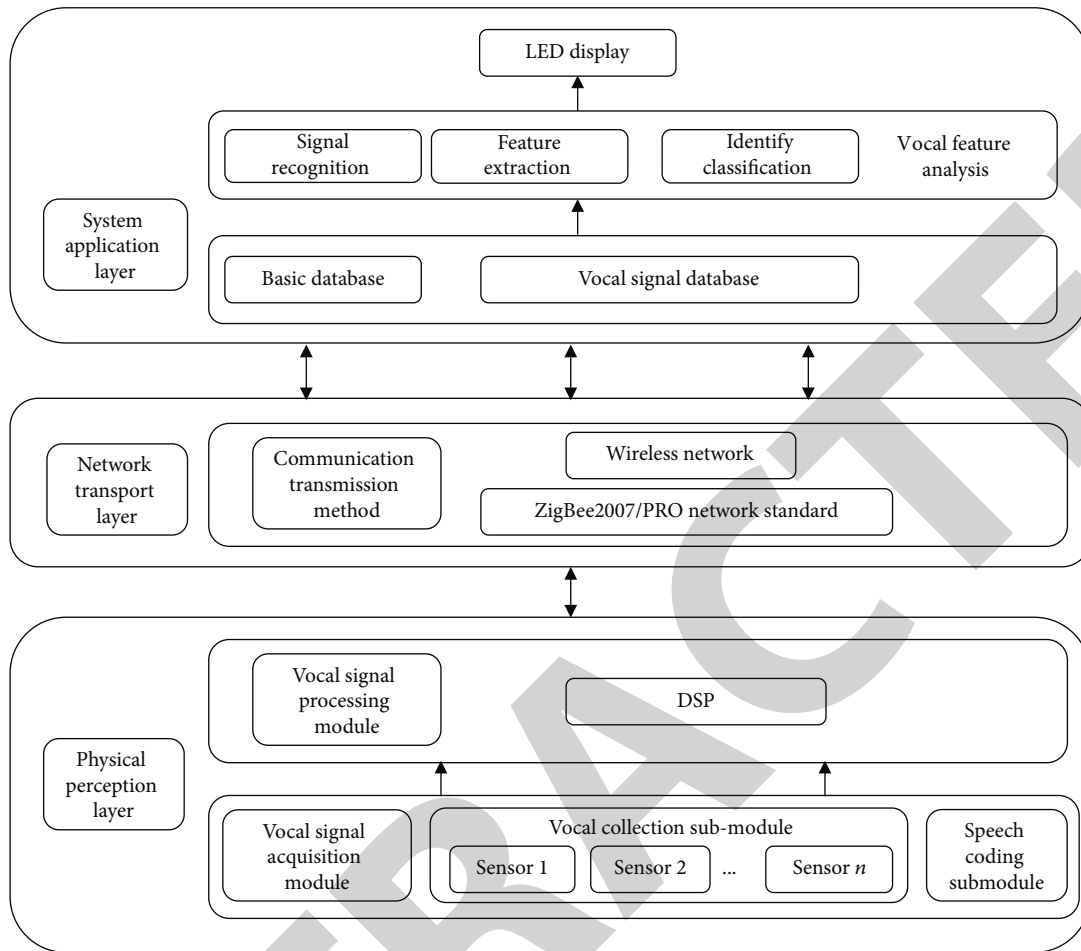


FIGURE 2: Block diagram of the overall structure of the system.

In order to be familiar with music, it is first necessary to design a traditional assembly pattern in a stable assembly [7]. The patterns of sound and percussion patterns are intertwined and together represent the structure of the period. In Western music, this type of continuity is usually multilayered, so the assembly pattern must be multilayered. One way to identify music is to compare the music that has been identified to the original melody patterns, which is difficult because the music is constantly changing [8]. So now, the experience of the ensemble is focused on the stable and the special music, especially the dance music.

**3.1.2. Identification of Melody.** The main factors that affect the melody are pitch and length. Since the melody perceived by people is only a meaningful outline, it is far more than the perception of pure pitch, so the method of recording the relative pitch is often used (for example, the minor second is "1") [9, 10]. There are roughly three ways to describe the melody: the first method is based on the first note of the studied piece, as a standard note to record the pitch difference of other notes from the standard note. The second method is to record the pitch difference of two adjacent notes. The advantage of these two methods is to save storage space, and it avoids the influence of transposition on the melody

itself; the disadvantage is that it is not imagery enough and it is not suitable for recording harmony. The third method is extended on the basis of the above two methods, and the relative pitch value is represented by two-dimensional coordinates; this method is more intuitive and solves the problem of recording harmony. The fourth method is to use a tree-like structure, which can not only record the outline of the melody but also reflect the structural characteristics of the melody. In addition, some scholars have adopted the fuzzy set method [11].

A piece of music is often played by many kinds of instruments, including melody, harmony, and rhythm parts, so the main content of melody recognition is to find the main melody of the piece [12, 13]. Since a piece of music or a movement of a piece of music will have a theme, such as Beethoven's "Fate" and Tchaikovsky's "Sadness," these themes are mostly repeated through the main melody, so the main melody can be used in the whole piece (movement) to search for the number of repetitions of a certain melody and locate the one with the highest number of repetitions as the main melody. The difficulty is that these main themes are often rewritten in six ways: imitation, canon, inversion, increment, depreciation, and retrograde, rather than simply repeating [14]. Therefore, the key to determining the main melody is to determine

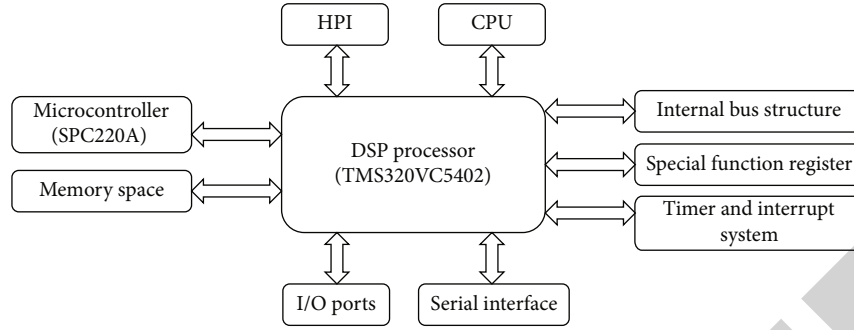


FIGURE 3: TMS320VC5402 functional structure diagram.

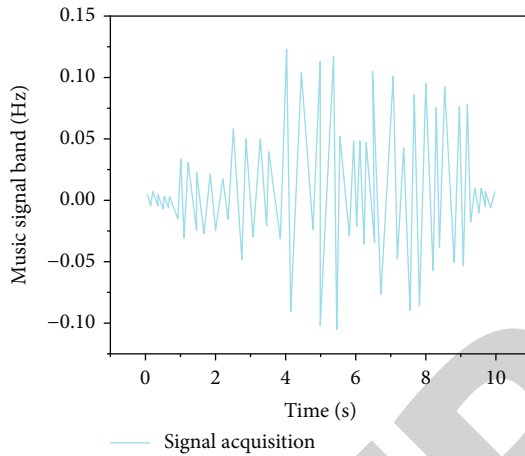


FIGURE 4: Vocal signal acquisition results (location 1).

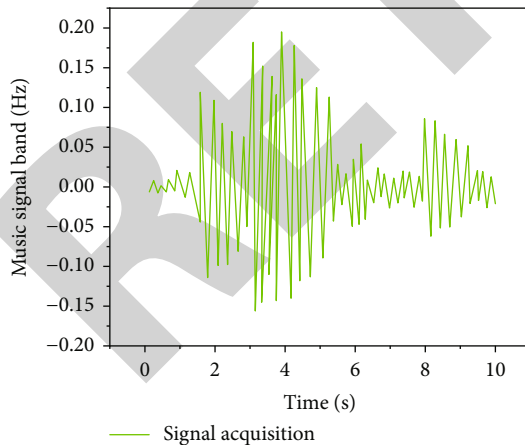


FIGURE 5: Vocal signal acquisition results (location 2).

whether the two melodies are essentially similar, such as whether there are ornamental sounds, additional sounds, missing sounds, etc. At the same time, for Western classical music, the melody part has the following characteristics compared with the rhythm and harmony parts:

- (1) The melody should be the loudest sequence
- (2) There should be no more than two octave changes in pitch between adjacent notes, and the number of large pitch changes should not be too many
- (3) A complete phrase should be played by the same timbre
- (4) The melody is coherent, usually lasting several bars

**3.1.3. Harmony Recognition.** Harmony analysis requires a comprehensive knowledge of harmony theory. The difficulty and key point of harmony analysis in music feature recognition system lies in how to embed this knowledge into the whole system in a reasonable way. Some research teams have successfully designed fuzzy systems that automatically analyze sound. [15]. However, because there are too many individual elements in music, it is difficult to fully explain it with the existing music theory, so the analysis of harmony is only limited to the category of music works of a certain style or a certain era.

**3.2. Overall Structure of the Vocal Feature Recognition System.** The system for recognizing the characteristics of music based on the Internet of things technology is usually a layer of physical understanding, a layer of network connections, and a layer of technology [16]. A block diagram of the entire structure of the system is shown in Figure 2.

The process of understanding the body usually includes patterns for receiving sounds and patterns for making sounds [17]. Among them, the audio signal receiver module determines the signal demand from the sound sensor receiver system in various locations and sends the audio signal to the signal processing module, which uses the DSP processor. This module uses DSP processor to process vocal signal. The network transport layer transmits the data collected and processed by the physical perception layer to the system application layer through wireless network communication. The network transmission layer records the level of physical understanding through the wireless network communication and sends the completed data to the process layer. The application layer of the system records the music and creates a record of the characters [18].

**3.2.1. The Design of the Vocal Signal Acquisition Module.** The audio signal receiving module includes the audio receiving



equipment and speech encoding submodule. The audio receiver submodule has sound sensors installed in different locations and is responsible for receiving the noise. The voice sensor has a voice-sensitive built-in capacitor power microphone, which is converted by an A/D converter and sent to a speech-encoding submodule. The speech-encoding submodule is responsible for compressing the main signal with high accuracy without loss, converting the signal into the input file, and then transmitting it to the audio signal processing module.

**3.2.2. Design of the Vocal Signal Processing Module.** The audio signal processing module is designed for the DSP processor [19]. The module uses a stable DSP chip TMS320VC5402DSP suitable for voice signal operation, and DSP chip has low power consumption, is fast, can carry 2 MCBSPS (multichannel non-stop port), and is connected to CODEC (codec) with audio input, 8-bit upgraded host parallel port (HPI8), 4KBROM, and 16KBDARAM. Its structure is shown in Figure 3.

The internal cabinets of TMS320VC5402 are as follows:

The interior design of the bus consists of 4 bus and 4 software/bus data which design 8 16-bit bus. The specialized >function file contains 26 specialized operational files for tracking, managing, and accessing each office. The timer and trigger itself include a 4-bit preset 16-bit timer. The main memory space of TMS320VC5402DSP is 192 KB, and all the storage space, data space, and input and output space are 1/3, and the application storage space can be up to 1 MB. The TMS320VC5402DSP has two general inputs and ports, BIO and XF. In addition, access to the input and output allows for input and output port expansion and the HPI and MCBSP of the TMS320VC54XDSP can be configured according to the general purpose owners. The MCBSP of the TMS320VC5402 is capable of operating in the SPI mode, which is effective for serial A/D and serial E2PROM connections. The host port provides a single connection for the DSP connection and the external process, which is ideal for exchanging data between the DSP and the external process.

### 3.3. Identification of Vocal Features

**3.3.1. Feature Recognition of Vocal Signal.** The voice characteristic analysis module in the system application layer uses the dynamic time (DTW) algorithm to determine the sound signal characteristics by comparing the Euclidean distance of the sound characteristics test models and designs [20]. Follow the research of the DTW algorithm to develop sound measurement models, use conversation patterns, and sound similarity. Assume that the design and test samples are represented as follows:

$$\begin{aligned} S &= \{S(1), S(2), S(m), S(M)\}, \\ P &= \{P(1), P(2), P(n), P(N)\}. \end{aligned} \quad (1)$$

In the model, all the word frames are included in the design and test model;  $m$  and  $n$  are arbitrary multiple numbers of  $S$  and  $P$ . The method of calculating the Euclidean distance is

shown in equation (2):

$$l[P(n), S(m)] = \frac{1}{k} \sum_{r=1}^K (H_r - H'_r)^2. \quad (2)$$

The DTW algorithm searches and marks the optimal local path, accumulates the local distance along this path to obtain the global cumulative distance, obtains the optimal template matching similarity, and takes this path as the optimal path. Assuming that the grid points that the path passes through in turn are  $(n1, m1), \dots, (ni, mi), (nN, mM)$ , according to the endpoint constraints, we can get  $(n1, m1) = (1, 1)$  and  $(nN, mM) = (N, M)$ , in order to meet the slope constraint; the slope selection interval is  $0.5 \sim 2.5$ .

From the perspective of local search, it is assumed that the last lattice point of the lattice point  $(ni, mi)$  passed by the best path is one of the three  $(ni - 1, mi)$ ,  $(ni - 1, mi - 1)$ , and  $(ni - 1, mi - 2)$ ; assume that the partial cumulative distances from the origin to these three grid points are  $L[(ni - 1, mi)]$ ,  $L[(ni - 1, mi - 1)]$ , and  $L[(ni - 1, mi - 2, respectively)]$ ; then,  $(ni, mi)$  selects some grid points with the smallest cumulative distance to move forward and so on. The cumulative distance of the final path is shown in formula (3):

$$L[(ni, mi)] = l[T(n_i, R(m_i))] + L[(ni - 1, mi - 1)]. \quad (3)$$

Therefore, the minimum cumulative distance is the maximum similarity between the test template and the reference template, that is, the vocal signal feature recognition result.

### 3.4. Vocal Feature Content Recognition

**3.4.1. Feature Extraction of Vocal Music.** The melody of vocal music usually includes two similar phrases. In order to analyze the structure of vocal music form, the method of searching similar melody is adopted. The search efficiency and accuracy are improved through the three-step identification method of preliminary identification, key identification and supplementary identification, while taking into account the rhythm and harmony characteristics of vocal music form. [21]:

- (1) Preliminary identification according to rhythm and tonality preliminarily divides the entire vocal music according to vocal rhythm and tonality characteristics, narrows the scope, provides a basis for key identification, and increases search efficiency
- (2) Through the identification of key points of melody search, according to the characteristics of vocal music, the 3-step hypothesis is adopted to further increase the search efficiency of similar melody

*Assumption 1.* 16 measures make up a phrase. This hypothesis is widely used in vocal structure research and has been tested to be correct.

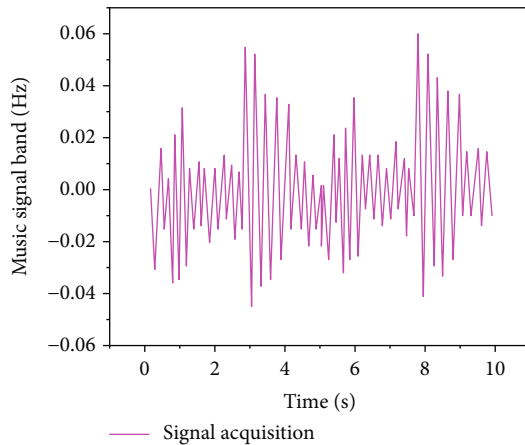


FIGURE 6: Vocal signal acquisition results (location 3).

TABLE 1: Music feature recognition results.

Place	Curved features	Emotional characteristics	Recognition accuracy (%)
1	One piece	Solemnly	100
2	Variation	Enthusiastic	100
3	Rondo	Lyrical	100

*Assumption 2.* The key part of the phrase is the first 4 bars. This hypothesis uses a small number of notes to characterize the phrase, and the hypothesis is correct.

*Hypothesis 3.* The clarinet, violin, and flute are the most likely instruments to play the main melody among many instruments. This assumption is conducive to quickly finding the main melody tone, which is the premise of key recognition through melody search.

Based on the 3-step hypothesis, a tree structure is used to record the overall outline of the melody and the search for similar melody is completed. The tree structure includes 4 layers: the first layer is a melody consisting of 16 bars. The 2nd layer is the first 4 bars of the melody. The 3rd layer is the 3 upbeats of each measure. The 4th layer is the upbeat and half beats of each measure. The rhythm of the tree structure is 34 beats, and the main function is to record the relative pitch of the vocal music.

- (3) Based on the harmonic characteristics and supplementary identification of vocal music, after preliminary identification and key identification, vocal-style features can be extracted but there are exceptions [22]. Therefore, by terminating a vocal structure and the harmonic complement of a musical idea to identify the musical structure, improve search accuracy

**3.4.2. Vocal Emotion Feature Extraction.** After the music feature was released, the song was divided into several smaller

tunes. The speed, music, sound, and other characteristics of each section are assessed, and the characteristics of the mind are obtained by the use of ambiguous materials. Finally, the notion of music is necessarily explained according to thought patterns [23].

## 4. Results Analysis

Using VisualC++ to simulate the system prototype on the Windows2010 platform, verify the validity of the system. The vocal signals of three different locations in a monitoring area collected by the system sound sensor are shown in Figures 4–6 [24]. It can be seen from the figure that the curve of the vocal signal collected by the system is smooth, there is no burr, and no signal interruption occurs, indicating that the system is running stably and the sound quality of the collected vocal signal is good [25]. According to the vocal signal collected, the results of using the system to identify the vocal characteristics are shown in Table 1.

From the analysis of Table 1, it can be seen that the system accurately identifies the characteristics of music and the perception of music and the level of knowledge of music in intelligence up to 100%. The experimental results show that the system is capable of detecting speech in a loud environment, with an accuracy of approximately 95%.

## 5. Conclusion

The author has developed voice recognition based on IoT technology output; the audio signal receiving system can receive music from multiple sources, set up speech-encoding submodules, get high-precision, lossless compressed original music signal, etc., can improve and reduce power consumption, and improve the accuracy of music feature recognition. The author provides the software and hardware design of each system modules, the choice of hardware equipment is reasonable, the design performance is perfect, the system certification is high, security is good, and integration is easy. Experiments have shown that the system is capable of recognizing speech in a noisy environment, with an accuracy of approximately 95%, which achieves sound control and can switch keyboards and switches remote control. As a result, the Internet-based system of any technology can improve the perception of sound quality.

## 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 competing interests.

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