Song recognition in music library based on cloud computing

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Abstract. There are many types of music, and due to the increase of music creators and the development of the Internet, there have been a large number of music. Identifying songs in the music library is conducive to the management and operation of songs, and helps listeners to choose their favorite music. Aiming at this problem, this paper proposes a song recognition method in a music library based on cloud computing. This paper first analyzes the advantages of cloud computing technology, and then proposes a song feature recognition method. Based on the similarity matrix of musical notes, a criterion for selecting note features is given to identify songs in a music library. Finally, the song feature recognition method is combined with cloud computing technology for song recognition. Experiments show that compared with the musical note recognition method with feature weights and the musical note recognition method based on invariant feature extraction of musical notes, the song recognition method in the cloud-based music library proposed in this paper has higher recognition accuracy and faster recognition speed.

Keywords: Song recognition in music library, cloud computing, feature recognition, similarity matrix

1. Introduction
With the development of information technology and the popularity of the Internet, people are more and more accessible to various songs. Songs can be pleasing to the body and mind. Time is passing. Music creators have more and more songs. Thousands of songs form a music library [1]. Everyone has their own unique preferences when listening to music. Therefore, the identification of songs in the music library will help listeners to better choose the music that suits them [2]. At the same time, it also helps music operating companies to better manage music and improve music service level [3]. Nowadays, there is a large amount of music. In the identification of songs, the processing of massive music is also a hot issue that has been concerned by relevant personnel.

Song recognition is also a kind of voice recognition. In the field of voice recognition, many people have carried out research and achieved fruitful results. In [4], the author proposes music chord recognition based on syllable features and support vector machines, and models the harmonic information and vocal information corresponding to chords in the spectrum, and uses the spatial distribution information to achieve the recognition effect. In [5], the author pointed out that the complete situation of family glass is related to the safety of the family. Aiming at glass breakage, the author proposes a glass break sound recognition method based on wavelet packet analysis. After
extracting data features, the glass break sound is recognized from the frequency domain and the time domain. In [6], the authors proposed the use of convolutional neural networks to identify abnormal sounds. For different abnormal sound samples, the analysis of the differences in feature dimensions of different sounds improves the weak robustness of previous speech recognition. In [7], the author proposed a sound recognition method for the recognition of sounds emitted by mammals in the ocean. The linear cepstrum coefficients, Mel cepstrum coefficients and time-domain features were fused. The expression level of sound in different frequency bands has been enhanced to describe the information contained in the sound more scientifically and reasonably. Although the above studies have achieved certain results in song recognition and voice recognition, there are still some shortcomings, such as poor real-time performance, low recognition accuracy, and weak robustness in the recognition process. The existence of these shortcomings has always been an urgent problem in the field of song recognition and speech recognition. Once these problems are improved, it will greatly help the research in the field of speech recognition to achieve a major breakthrough.

Cloud computing belongs to distributed computing. It can process massive data in a short period of time. It has the characteristics of fast computing speed and no limitation of time and space. Cloud computing technology has applications in many fields, and all have achieved good results because of the introduction of cloud computing technology. In [8], the author used cloud computing technology for personalized drug recommendation. Through analysis and calculation of massive data, the customer's personalized drug recommendation effect was achieved, and customer satisfaction was greatly improved. In [9], the author applied cloud computing technology to the construction of a digital education resource sharing platform, fully utilizing the advantages of cloud computing technology, realizing the effective sharing of digital education resources, and providing an effective new model for education resource sharing. In [10], the author used cloud computing technology for genomic data analysis and collaboration, effectively alleviating the difficult problems of large sequencing data sets, and helping to effectively manage genomic data with privacy guaranteed.

Aiming at the problems of poor real-time performance, low recognition accuracy, and weak robustness of traditional methods in song recognition, this paper proposes a song recognition method in a music library based on cloud computing. By comparing with the musical note recognition method with feature weights and the musical note recognition method based on the invariant feature extraction of the notes, the method proposed in this paper shows obvious advantages in recognition accuracy and speed in music libraries with 100, 300, 500, and 1,000 songs, respectively.

2. Method

2.1 Cloud computing features

The existence of cloud computing has opened up a new form of computing. Cloud computing technology is also growing. This article uses cloud computing technology to identify songs in the music library because cloud computing has the following advantages:

(1) Super high computing power

Cloud computing systems include many servers, and the processing power in the cloud exceeds the capabilities of a single terminal. When a user sends a request for a computing service to the cloud, the cloud can use multiple servers to coordinate and complete the user's computing tasks in parallel. Compared with serial calculations performed on a single computer, cloud computing technology can greatly save the time consumed by calculations. Therefore, cloud computing is a very suitable technology for song identification work in a music library containing thousands of songs.

(2) Virtualization services

Relying on the cloud computing technology platform, users can apply for the required services from the cloud computing platform anytime, anywhere through any terminal. There is no installation of various complicated software, and no complicated work such as debugging of various software. Once the user successfully connects to the cloud terminal, they can apply for services from the cloud and obtain various cloud resources.
(3) High safety and reliability
Cloud computing uses homogeneous computing nodes to achieve the interchangeability of computing nodes, while using multiple data copies to improve the fault tolerance of cloud computing, these measures ensure the security and reliability of the cloud computing platform. In addition, because the numbers are in the cloud, users don't have to worry about data loss or attack all day. The existence of cloud computing has greatly improved security.

(4) Scalable across platforms
Cloud computing agrees that different devices based on different operating systems share data and applications between different devices or between different devices and cloud platforms through the standard HTTP protocol. This is one of the reasons why cloud computing technology is widely used.

2.2 Song feature recognition method
In the recognition of songs, firstly pre-process the input note signals, extract the starting point features of the notes, and form a vector sequence of the starting point feature parameters of each frame. Remove the control notes in each track and the tracks without melody information. Based on this, note recognition is completed. The specific approach is as follows:

(1) Two pieces of note data R and T are selected. The dimensions of the two pieces of musical note data are K. \( R(m) = (r_m(1), r_m(2), \cdots, r_m(K)) \), \( T(n) = (r_n(1), r_n(2), \cdots, r_n(K)) \). D represents a weighted Euclidean distance, and q represents a weight value. Then, the weighted Euclidean distance between two musical note data can be calculated by the following formula:

\[
D(T, R) = \min \sum_{n_i=1}^{N} D[n_i, m_i]
\]  

In the above formula, \( D[n_i, m_i] = \sum_{k=1}^{K} q^2 (t_i(k) - r_i(k))^2 \).

(2) Calculate the similarity matrix.
Suppose \( C_1, C_2, L, C_N \) represents the N note classes to be divided in the pattern space, and \( C_i \) represents any kind of notes in the pattern space. Let \( \Omega = \{C_1, C_2, L, C_N\} \), where the number of samples of each note class is \( M_i \), then each musical note sample is composed of a finite number of multidimensional feature vectors in the same dimension. For any \( x \in C_i \), suppose the distance between \( x \) and other music groups is:

\[
d_i(x) = \min D(x, x')
\]

In the above formula, \( x' \) represents the remaining musical notes, then the vector formed by the group spacing of all note samples of the \( C_i \) category to the remaining note categories is called the threshold vector. The threshold vector constitutes a non-linear boundary between the musical note class \( C_i \) and other note classes.

Assume \( y_j(C_i) = (y_j(v_1), y_j(v_2), L, y_j(v_n)) \) is the threshold vector for note-like \( C_i \). \( G = < V, E > \) represents a simple directed graph, and the number of nodes is \( n \), then the square matrix \( A(G) = (a_{ij}) \) is called the similarity matrix of \( G \), and the calculation formula of \( a_{ij} \) is as follows:

\[
a_{ij} = \begin{cases} 
1, & D(v_i, v_j) < y_j(v_i) \\
0, & \text{others.}
\end{cases}
\]

At this time, \( A(G) \) is a symmetric matrix, which is also a musical note similarity matrix. According
to the musical note similarity matrix, the selection criteria of note features are given to identify songs in the music library.

2.3 Song recognition process of music library based on cloud computing
The song recognition method of music library has been proposed in the previous section, and this method is explained in combination with cloud computing. The process of song recognition in a music library based on cloud computing is as follows:

(1) After the client has collected the music note data information, it uses the standard HTTP protocol to send the note feature information of the song to the cloud. The cloud server processes through cloud technology to complete the extraction of note features, removal of control notes in each track, and tracks that do not contain melody information. The note characteristics of the song to be identified are extracted, and feature values describing the music to be identified are constructed.

(2) According to the characteristic value of the music note to be identified, a database request is constructed, and the request is sent to the cloud database.

(3) After the cloud database receives the request, it uses the song feature recognition method proposed in the previous section to perform similarity calculation and returns the processed data to the cloud server.

(4) After receiving the data from the cloud database, the cloud server packages the results and returns the recognition results to the client to complete the identification of the music notes.

3. Experiment
In order to prove the effectiveness of the song identification method in the cloud-based music library mentioned in this article, after building the cloud computing platform, randomly select 100, 300, 500, 1000 songs to create music libraries of different sizes. It is diverse and basically covers all the current genres of classification, which ensures the universal applicability of the experiment. In addition, a comparison experiment is added to compare the method proposed in this paper with a musical note recognition method with feature weights and a musical note recognition method based on invariant feature extraction of notes. In the experiment, the operating system of the PC used was win10, and the memory was 8G.

4. Results
Result 1: Comparison of three methods in the accuracy of music note classification and recognition
The number of songs is different in different music libraries. The difference in the number of songs also affects the accuracy of recognition. In this paper, a music library with a scale of 100, 300, 500, and 1000 is used as the data source. The method in this paper (Method 1) is compared with the musical note recognition method (Method 2) with feature weights and the musical note recognition method (Method 3) based on invariant feature extraction of notes. Observe the accuracy of the classification and recognition of the three methods under different numbers of songs, as shown in Table 1.

| Number of songs in the music library | Music note classification recognition accuracy (%) |
|-------------------------------------|-----------------------------------------------------|
|                                     | Method 1 | Method 2 | Method 3 |
| 100                                 | 99.98    | 98.76    | 99.74    |
| 300                                 | 99.91    | 98.23    | 98.61    |
| 500                                 | 99.77    | 98.02    | 97.96    |
| 1000                                | 99.53    | 97.95    | 96.87    |

It can be seen from Table 1 that with the increase in the number of songs in the music library, the classification recognition accuracy of the three music note recognition methods has changed. From each method, as the number of songs in the music library increases, the accuracy of note recognition decreases to varying degrees. In terms of the degree of decline, the cloud recognition-based music library song recognition method mentioned in this article drops the slowest, and the classification
recognition accuracy has always remained at a high level of these three methods. It is worth noting that when the amount of song data in the music library is between 100, 300, and 500, the classification accuracy of methods 2 and 3 decreases relatively little. When the number of songs changed from 500 to 1,000, the classification and recognition accuracy of methods 2 and 3 both decreased by about 1%, while the accuracy of classification of music notes by method 1 only decreased by 0.24%. This shows that the song recognition method in the cloud-based music library mentioned in this paper has a good recognition rate and has obvious advantages for song recognition in large-scale music libraries.

Result 2: Comparison of three methods in the time taken to classify and identify music notes

The time taken for song identification in the music library is also an evaluation index to measure the pros and cons of a method. In the experiment, the time it took to complete the recognition task on three different-sized music libraries was recorded, as shown in Figure 1.

![Figure 1. Time taken by 3 methods to identify and classify music notes](image)

It can be seen from Figure 1 that as the number of songs in the music library increases, the time spent by the three methods on note recognition continues to increase. When the number of songs in the music library is between 100 and 300, the time consumed by the three methods is not much different. When the number of songs in the music library is 500, method 3 takes the most time and the duration is 131 seconds, while method 1 which takes the least time at this time only takes 94 seconds. When the number of songs is 1,000, the difference is very obvious. The time taken by method 1, method 2 and method 3 are 230 seconds, 190 seconds, and 136 seconds, respectively. The results show that the cloud computing-based music library song recognition method proposed in this paper takes the least time and shows a clear advantage in processing speed.

5. Conclusions

With the rapid development of information technology and the increase of music creators, many songs have emerged. Among hundreds of thousands of music, the use of computer technology for classification and identification is of great significance. It can help the public understand the direction of music development and help listeners to quickly select music that suits their tastes. For music operating companies, the workload in music management can be simplified. The cloud computing-based song recognition method proposed in this paper shows obvious advantages in recognition accuracy and speed. The advantage is especially obvious when the number of songs in the music library is particularly large. Of course, the method mentioned in this article still needs to be improved in the following areas:

- The pre-processing of music data is relatively simple. When dealing with complex data in the future, you need to consider the ability to process multi-track data;
(2) The method proposed in this article can identify common basic types of music, but it cannot identify some special and rare music well.

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