Design of batch audio /video conversion platform based on JavaEE

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Abstract. With the rapid development of digital publishing industry, the direction of audio / video publishing shows the diversity of coding standards for audio and video files, massive data and other significant features. Faced with massive and diverse data, how to quickly and efficiently convert to a unified code format has brought great difficulties to the digital publishing organization. In view of this demand and present situation in this paper, basing on the development architecture of Spring+SpringMVC+Mybatis, and combined with the open source FFmpeg format conversion tool, a distributed online audio and video format conversion platform with a B/S structure is proposed. Based on the Java language, the key technologies and strategies designed in the design of platform architecture are analyzed emphatically in this paper, designing and developing an efficient audio and video format conversion system, which is composed of “Front display system”, "core scheduling server " and "conversion server " . The test results show that, compared with the ordinary audio and video conversion scheme, the use of batch audio and video format conversion platform can effectively improve the conversion efficiency of audio and video files, and reduce the complexity of the work. Practice has proved that the key technology discussed in this paper can be applied in the field of large batch file processing, and has certain practical application value.

1. Introduction

With the rapid development of information technology, digital publishing has gradually replaced the traditional publishing industry and become a new development trend in the publishing industry[1]. As an important part of digital publishing, audio/video publishing has also increased its publishing demand. However, for publishing organizations, the vigorous growth of audio/ video data resources, the diversity of encoding methods and other significant features have brought great difficulties to the audio/video publishing[2,3]. Due to the large number of audio/video files, varied coded format for files, if we use ordinary audio and video conversion mode, not only is inefficient, but also overloads the PC and even leads to system collapse and paralysis. Therefore, for publishing organizations, how to quickly and efficiently convert audio and video files to a unified code format has become a big technical problem[4].

The rapid development of information technology, especially the development of Internet technology, has continuously promoted the development of Web application[5,6]. As a B/S architecture, Web applications can be accessed only by browsers without the restrictions of the operating system[7]. When use, you simply open the corresponding web page with your browser and...
operate it, the business process is very simple. At the same time, the deployment, maintenance and upgrading are also very easy, and the development and maintenance cost is low. Combined with these advantages, this paper uses B/S architecture to design an efficient audio and video format conversion platform.

2. Literature Survey
How to improve the efficiency of the audio and video format conversion platform mainly depends on two factors: first of all, the network quality of network operators, the network quality is mainly provided by the third-party operators, such as China Mobile, China Unicom etc, and efficient network quality has a direct impact on the upload and download of audio and video files. Because the improvement of network quality is mainly solved by the third party operators, so it is not discussed in this paper; secondly is the design of conversion scheme, efficient implementation scheme and algorithm plays a vital role in the design of the conversion system.

The constructed batch audio and video format conversion platform in this paper is built on the Spring+SpringMVC+Mybatis architecture, code management and version control with GitLab, the front end using JSP technology for page display, combined with the MySql database. Compared with the traditional PC or server-side format conversion, it has many advantages, such as easier to operate, higher conversion efficiency, stronger maintainability and so on. Through this scheme, the conversion efficiency can be effectively improved, and the high-speed conversion of audio and video file format can be realized. At the same time, the key technologies discussed in this paper can be applied to the processing of massive data files, which can be applied to many fields, such as website background design, game development and so on and has certain practical application value.

3. System Architecture
The system architecture in this paper is mainly composed of the backend server and the front-end website operation page. The backend server is composed of the core scheduling server, the conversion server and the database server, which is responsible for intelligent classification of the audio and video files uploaded by the front end depending on the format and size of the audio and video and scheduling the corresponding conversion server for conversion.

The front-end page system is mainly written by JSP. The user can upload the audio and video files by logging in the website, and then view the conversion progress, download the converted files when the conversion is finished. The system architecture of the audio and video conversion platform is shown in figure 1:

![Fig.1 The system structure diagram of audio and video format conversion platform](image)

3.1. System design scheme
3.1.1. Front-end Web system design
In order to meet the needs of users, this paper presents the following requirements for the front-end Web system design:
① The system should meet different operation request of different users, while ensuring that each user can only access and view own working directory, so the system needs to support: user login/registration function, files upload and download function, file conversion status query function.

② Due to the case that the audio and video files are too large, the transmission speed of files must be guaranteed in the system. In file transmission, because FTP has obvious advantages compared with HTTP, so the all file does not need to be loaded into internal storage, and HTTP uploading in this respect is relatively weak. And the larger the file is uploaded, the bigger the multiples of the upload rates through the FTP faster than http uploading. Therefore, in order to improve the transmission efficiency, FTP should be used for the transmission of audio and video files.

③ As the input file may contain files in other formats, the system should support the filtering of non audio and video files when uploading.

3.1.2. The backend server design
Due to the complex types of video and audio files and different length of video that the publishing organization faces, therefore, the conversion platform should meet the following requirements.

① The conversion platform should support the conversion of audio files and video files at the same time, and support the classification of files.

② Because the audio and video files processed by the publishing organization are very large, conversion time is too long by using ordinary audio and video conversion tools for conversion, so the platform should support the rapid conversion of a single large file and also should support the rapid conversion of mass files.

③ When the conversion is abnormal, the platform should have the corresponding exception handling mechanism.

3.1.3. Server structure
The server system in this paper is shown in Figure 2. The server is based on the self-developed core architecture, including converting information record to the database, the core scheduling module, the scheduling conversion server, and the distributed file system (NFS) to store the files. Through this hierarchical design mode, decouple the system, reducing the difficulty of system maintenance and debugging, improving the development efficiency and operating efficiency of the system.

3.2. Key technology
3.2.1. Verification and distribution mechanism of input file
Because the input audio and video file has great uncertainty, in order to ensure that the files entering the conversion system are audio or video file, so the corresponding verification mechanism must be taken for the input source file.
(1) At the upload-end of webpage, in order to ensure the uploaded files are video files or audio files, therefore, when the user clicks on the button to upload, the format of the uploaded file is checked, when they are not audio and video files, popups hint.

(2) In the back-end services, because the input file may contain both audio files and video files, so it is necessary to classify the uploaded files firstly, and then divide them into audio files and video files according to the format of the uploaded files.

3.2.2. Core scheduling conversion algorithm

1. Classify by single file size

The audio and video files after verification and classification, because the single audio or video file size is different, and conversion efficiency of the conversion tool for large file is relatively low, so in order to improve the conversion efficiency:

(1) Firstly, the audio and video files are classified according to the size, and the audio files are divided into audio files that single audio is smaller than 1024M and audio files that single audio is larger than 1024M. Video files are divided into video files smaller than 1024M and video files larger than 1024M.

(2) For the audio or video files larger than 1024M, such as audio or video file size is “a”, carry out remainder operation with “a” on 1024 (a%1024), if the result is 0, then the audio or video file is divided into a/1024 segments, if the result is not 0, the audio or video segmentation for a/1024+1 segments. At the same time, the segmented audio and video information is labeled and recorded into the database. When the conversion is finished, it will be merged into a complete audio or video.

2. Distributed Hash scheduling algorithm

Because the audio and video conversion task belongs to typical CPU intensive task, using a single conversion server to handle all audio and video conversion business will create great pressure on CPU of conversion server[8], so the way of conversion server cluster is taken in this paper, through cooperative work of multiple conversion servers, can effectively relieve the huge pressure of a large number of conversion tasks on a single server, improving the conversion efficiency.

For the conversion platform with N conversion servers, how to make effective use of N servers, how to load the conversion server evenly and averagely assigning task to each server is the key to improve the conversion efficiency. Therefore, it is necessary to design a reasonable algorithm to complete the distribution of conversion tasks. In order to solve this problem, we use the consistent Hash algorithm to solve. Consistent Hashing Algorithm is a distributed algorithm[9,10], which is often used to solve the load balancing problem. Compared with the traditional hash (object) %N algorithm, it can solve the problem of server additions and deletions which needs to be re calculated. Its implementation principle is as follows:

The consistent hash algorithm corresponds the whole hash space to a virtual closed loop of 0–(2^32) -1, as shown in Figure 3 below:

![Fig.3 Annular hash space](image)

(1) Firstly, take hash calculation according to the IP of each conversion server as the key word, and the result is mapped to the ring, and determines the location of each conversion server on the hash ring.
Then we calculate the hash value of each audio or video file by the same hash algorithm, and the value of hash is determined by its position in the hash ring, according to the position of each audio or video files on a hash ring, according to a clockwise direction, encountering the first server, the conversion task of the audio or video file is sent to the conversion server. For example, there are four video files with hash values of key1, key2, key and key4, corresponding to the annular space as shown in Figure 5:

Then, according to the consistent hash algorithm, the conversion tasks are assigned to the conversion server 1, the conversion server 2, the conversion server 3, and the conversion server 4.

If one of the conversion servers fails, then the conversion task will be assigned to the next conversion server in accordance with the clockwise migration rule. If you want to add a new conversion server to the conversion server cluster, you only need to add a node in the hash ring. Through this method, the nodes additions and deletions only need to reposition a small part of the data in the hash ring space, and it has good fault tolerance and expansibility.

However, when the conversion server nodes are too few, using the consistent hash algorithm is easy to cause task assignment skew problem because the nodes distributed by conversion server is unevenly. In order to solve this problem, virtual node mechanism is introduced in this paper. Through the calculation of multiple hash values for each conversion server node, the conversion server node is placed at the location of each calculation result, and this node is called the virtual node. The virtual node can be calculated with the IP of conversion server plus a number. For example: when there are only two conversion servers, IP respectively were 192.168.2.141 and 192.168.2.142, setting three virtual nodes for each conversion server, calculating the virtual node of the first conversion server as: Hash(192.168.2.141#1), Hash(192.168.2.141#2), Hash(192.168.2.141#3). The virtual nodes of second conversion servers are: Hash(192.168.2.142#1), Hash(192.168.2.142#2), Hash(192.168.2.142#3). The 6 virtual nodes that formed are shown in Figure 6:
3.2.3. Exception handling mechanism

The audio and video conversion platform carries out the corresponding exception handling according to the possible abnormal situations (such as interface anomalies, data anomalies, conversion exceptions etc.), as:

(1) The audio and video format conversion platform supports breakpoint resume of audio and video files, when the files are interrupted during uploading because of the network or other causes, and when the network condition returns to normal, supporting continual transfer of files.

(2) When a conversion server goes down, scheduling server will assigns the conversion tasks to the next normal conversion server according to the consistency of the hash algorithm, and records the corresponding exception information in the journal file, to ensure the normal operation of conversion tasks.

(3) When audio or video format conversion fail due to some abnormal situations, the system will stored the file Information that fail to convert into the database and record the corresponding journal file, the user can log in the site to view abnormal file in order to carry out the next operation.

4. Experimental Results

In this paper, three schemes are used to test and analyze the running results of the platform, and the specific implementation scheme is as follows:

Input file: 100 video files, 100 audio files, there are 50 video files larger than 1G, there are 50 audio files larger than 1G.

Output requirements: Video files are converted to mp4 format; audio files are converted to mp3 format, the conversion should be lossless.

Scheme 1: Without using the platform mentioned in this paper, the input file is directly formatted by the ffmpeg installed on the server-side, recording the conversion time of the input file and the CPU utilization percentage of the conversion server.

Scheme 2: Using the platform mentioned in this paper, but the input large video and video files are not taken segmentation process, converting directly, recording the conversion time of the input file and the CPU utilization percentage of the conversion server.

Scheme 3: Using the conversion system designed by this platform, converting input files, recording the conversion time of the input file and the CPU utilization percentage of the conversion server.

Among them, the conversion parameters of the ffmpeg conversion tools are the same in the three conversion schemes, the network environment of the three schemes is the same.

After testing, the conversion results of the three conversion schemes are shown in Table 1.
Table 1

| Scheme | Input files | Average file size (M) | Time of Format conversion (s) | CPU utilization percentage of the conversion server (%) |
|--------|-------------|-----------------------|-----------------------------|------------------------------------------------------|
| Scheme 1 | 100 audio files, 100 video files | 670 | 6346 | 85 |
| Scheme 2 | 100 audio files, 100 video files | 670 | 4583 | 68 |
| Scheme 3 | 100 audio files, 100 video files | 670 | 3462 | 65 |

Comparison of conversion results of platform test scheme

The test results show that under the same conditions as the input file, network and other external conditions, compared with the ordinary audio and video format conversion tools, the audio and video format conversion platform has the advantages of the system running more stably, higher conversion efficiency, stronger exception handling capability and so on.

5. Conclusion
In view of audio and video conversion needs of the digital publishing industry in this paper, basing on the development architecture of Sprring+SpringMVC+Mybatis, and combined with the open source FFmpeg format conversion tool, a distributed online audio and video format conversion platform with a B/S structure is proposed, through the use of distributed hash scheduling algorithm and other means to improve the processing ability of the system processing batch file, improving system stability. The practice has showed the audio and video conversion scheme proposed in this paper solves the problem of audio and video format conversion in digital publishing industry, the system reduces the working pressure of processing personnel on audio and video conversion, and improves the work efficiency, at the same time, the key technology discussed in this paper can be used in batch file processing, server load balancing and many other fields, which has a certain practical application value.

References
[1] Pierre Danet, “The Future of Book Publishing: Seven Technology Trends and Three Industry Goals”, Publishing Research Quarterly, 2014, Vol.30 (3), pp.275-281.
[2] Yungeng Xu, Sanxing Cao, “Design and Implementation of a Multi Video Transcoding Queue Based on MySQL and FFmpeg”, IEEE, (2015).
[3] Lei Lei Deng, “FFmpeg Technology Based on Media Asset Management System Design” Trans Tech, (2013)
[4] Luo Tao, Yao Su-ying, Shi Zai-feng, Gao peng, ” A new motion estimation algorithms based on Zero Detection and vector filter in Video Format Conversion Chip”, International Conference on Solid-State and Integrated-Circuit Technology Sep.2008
[5] B.T Choi, S.H Lee, Sung-Jea KO, ” New frame rate up-conversion using bi-directional motion estimation.” IEEE, (2000).
[6] Nan Ma, Chao Fang and Wen Qiang Liu, ” Storage and Display System of Relic Information Based on JSP and MVC” TransTech(2011).
[7] Peter Sjöberg, Lars - Olof Kihlström and Matthew Hause, “An industrial example of using Enterprise Architecture to speed up systems development” INCOSE International Symposium,(2017)
[8] Xiaoming Wang, Dmitri Loguinov, “Load-balancing performance of consistent hashing” IEEE, (2007).
[9] Jia Kui Zhao, Ping Fei Zhu and Liang Huai Yang, “Effective Data Localization Using Consistent Hashing in Cloud Time-Series Databases”, Trans Tech,(2013).
[10] Yihua Lan, Xiaopu Ma, Yong Zhang, Haozheng Ren, Chao Yin, Huaifei Hu, “Two Levels Hashing Function in Consistent Hashing Algorithm”, ProQuest,(2012).