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*Research Article*

# Design of Pitch Control Software Infrastructure Based on Collaborative Filtering Algorithm

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The pitch control of electronic equipment is the overall and key problem of electronic equipment system. The traditional pitch control of electronic equipment mainly depends on the volume control table, but this method depends too much on the hardware design, the corresponding pitch control effect is relatively unstable, and the cost is high. Based on the research of traditional pitch control software, this project improves the collaborative filtering algorithm and reduces the range of nearest neighbour set of pitch samples by introducing clustering algorithm, to further shorten the search time of neighbour set and finally improve the real time and scalability of the system. To adapt to the environment and user preferences, this study proposes to calculate the attributes between different items when improving the collaborative filtering algorithm, so as to further determine the unique attributes between items and determine the similarity between items, so as to introduce the pitch preference correction factor based on user attributes, so as to realize the high precision of electronic equipment based on pitch control software preference recommendation setting. Based on this, this project takes the improved collaborative filtering algorithm as the core algorithm to build a set of digital TV pitch control software system and realizes the verification of the algorithm proposed in this study based on MATLAB simulation software. The experimental results show that the pitch control accuracy of the algorithm is about 10% higher than that of the traditional algorithm. In terms of the intelligence of the corresponding algorithm, the algorithm proposed in this study has obvious advantages compared with the traditional algorithm. At the same time, its intelligent recommendation to users also has high intelligence, and the corresponding intelligent recommendation rate is about 4%–10% higher than that of the traditional algorithm, which proves that the algorithm in this study has obvious advantages.

## 1. Introduction

At the level of traditional electronic equipment pitch control software, the current mainstream audio processing is mainly based on compression and non-compression. The corresponding compression method is mainly based on lossy compression and lossless compression. The corresponding lossy compression is mainly to reduce the resource occupancy of the audio system in the system by increasing the compression rate. In essence, it can realize different sampling rates and accuracy problems through the user's own needs. The corresponding lossless compression is lossless compression of volume through a certain linear algorithm, to realize the full control of the audio part. With the rapid progress of information processing technology and artificial intelligence technology, the intelligent and adaptive pitch control software is also constantly optimized and improved. The traditional pitch control system relies heavily on the volume control table, which needs to realize the pitch control of the volume adaptive environment through interruption, so as to realize the adaptation to the surrounding environment and user preferences [1–3]. However, with the increasing complexity of electronic equipment and the increasing abundance of corresponding load information, the traditional pitch control software cannot meet the current load information. Therefore, intelligent and efficient pitch control software is conducive to further improve the volume quality of

electronic equipment and the intelligence of volume control [4, 5].

As a typical intelligent control algorithm, the collaborative filtering algorithm mainly depends on the feedback information of user data for system control and analysis. The collaborative filtering technology commonly used in pitch control system mainly follows two ways, which correspond to user environment-based recommendation and system-based recommendation [6, 7]. Based on the collaborative filtering algorithm, the system does not need to collect the characteristics or corresponding characteristic information of the user or environment in real time. It only needs to compensate or process the pitch through the scoring information fed back by the user or environment, which can make up for the shortcomings of traditional technology [8]. However, with the continuous development of information technology, especially the continuous development of multimedia digital technology, the traditional collaborative filtering algorithm cannot meet the extraction situation and difficulty of multimedia information, so it can not realize the intelligent and adaptive control of the pitch of the system, and at the same time, the traditional collaborative filtering technology cannot further mine the potential corresponding pitch trend of users or environment, to adapt to changes in real time [9, 10]. However, the traditional collaborative filtering technology still has certain advantages in the pitch control system, which is also the advantage technical point that the subsequently improved algorithm needs to continue to follow. It can simply mine or find the problems and potential control factors in the surrounding environment with the help of digital mining technology, and based on this algorithm, adaptive processing of potential adjustment of users or environment can be realized through relevant systems [11, 12]. The traditional collaborative filtering algorithm can also realize the comprehensive pitch recommendation for users or environment. It is core recommendation algorithm that directly determines the recommendation accuracy and efficiency of the system.

Based on the above analysis, this study will focus on solving the disadvantages of the current traditional collaborative filtering algorithm and analyse the corresponding factors. Based on this, this project improves the traditional pitch control software based on the collaborative filtering algorithm and reduces the range of the nearest neighbour set of pitch samples by introducing the clustering algorithm, to further shorten the neighbour set search time and finally improve the real time and scalability of the system. To adapt to the environment and users' preferences, this project proposes to calculate the attributes between different items when improving the collaborative filtering algorithm, so as to further determine the unique attributes between items and determine the similarity between items, so as to introduce the pitch correction factor based on user attributes, so as to realize the high precision of electronic equipment based on pitch control software preference recommendation setting. Based on this, this project takes the improved collaborative filtering algorithm as the core algorithm to build a set of digital TV pitch control software system and realizes the verification of the algorithm proposed in this study based on MATLAB simulation software. The experimental results show that this algorithm has obvious advantages in pitch control accuracy and intelligence. At the same time, its intelligent recommendation to users also has high intelligence. Based on the above algorithm selection and application, the collaborative filtering algorithm used in this study controls the pitch, because in essence, the collaborative filtering algorithm reduces the range of the nearest neighbour set of pitch samples by introducing the clustering algorithm, further shortens the search time of adjacent sets, and finally improves the real time and scalability of the system. Other traditional neural network algorithms do not have this function in essence. At the same time, their corresponding algorithm efficiency is also low, which will consume a lot of computing resources and is not suitable for the application background of this project.

Based on the above analysis, the structure of this study is arranged as follows: the second section of the article will mainly analyse and study the current application of collaborative filtering algorithm in pitch control system; the third section of this study will focus on the optimization analysis of collaborative filtering algorithm under clustering algorithm, discuss the efficiency, and build the corresponding pitch control system based on this; the fourth section of this study will simulate based on MATLAB software and analyse the experimental results; and the last section of this study will summarize the article.

## 2. Related Research

*2.1. Analysis of Research Status of Pitch Control Software Infrastructure Design Based on Collaborative Filtering Algorithm.* A large number of research institutions and scholars have done a lot of work on the pitch control software of collaborative filtering algorithm. Different institutions have analysed and discussed the single traditional collaborative filtering algorithm and its corresponding recommendation core algorithm [13–15]. At the level of traditional collaborative filtering algorithm, relevant research institutions in the United States have proposed an interest measurement algorithm based on multiple interests, which mainly integrates recommendation accuracy and recommendation accuracy [16, 17]; relevant Japanese scientists have proposed the collaborative filtering algorithm based on environment or user characteristics, which mainly analyses the user's filtering behaviour and the characteristics of the environment and comprehensively statistically analyses the preference of the user or the current environment [18, 19]. The corresponding research institutions in Europe mainly use collaborative information to improve the corresponding collaborative filtering algorithm, which can enhance the recommendation effect through the corresponding collaborative information. At the level of the corresponding recommendation algorithm, the main consideration and research direction focus on the sparsity of collected data, the cold start of the system, the scalability of the system, and the robustness of the system [20–23]. Corresponding to the problem of data sparsity of the system, relevant research institutions mainly focus on the research of

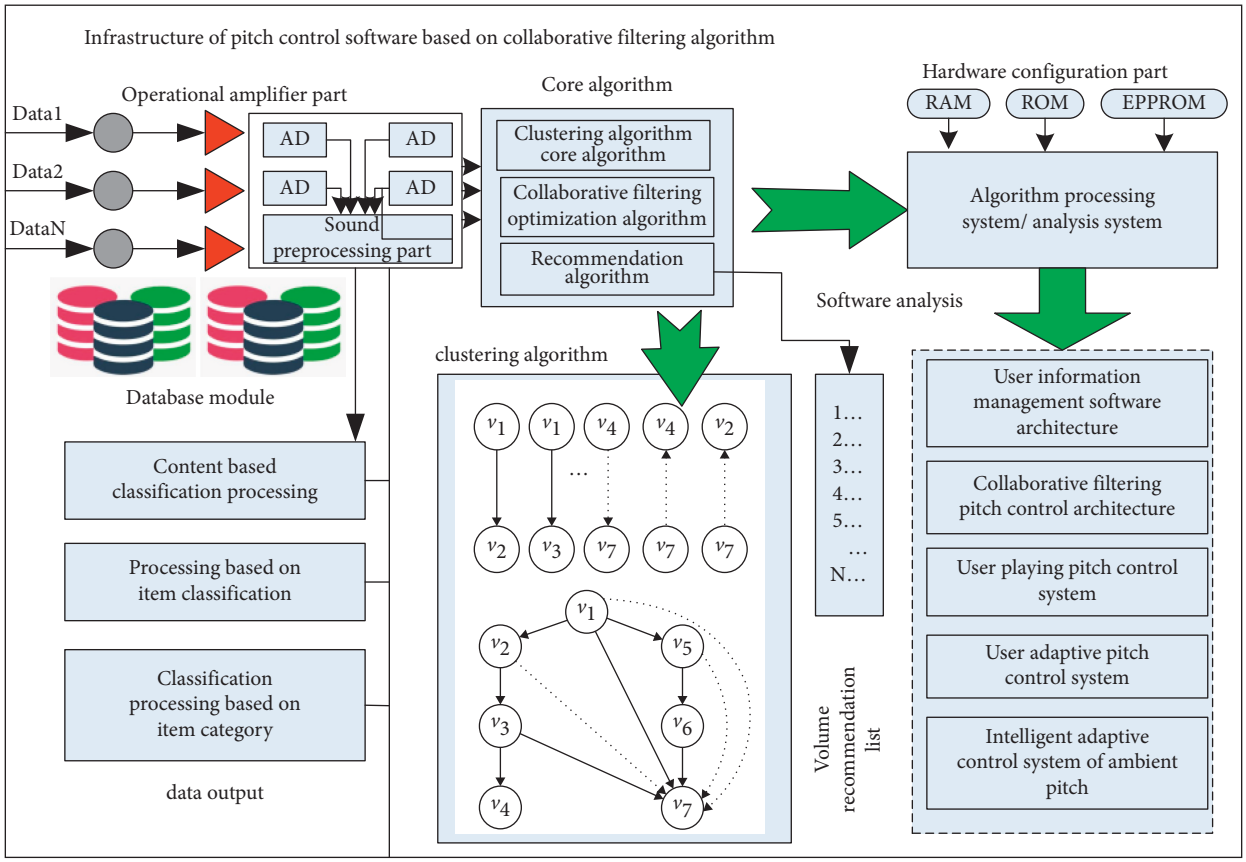


Figure 1: Basic architecture block diagram of pitch control software based on collaborative filtering algorithm.

dimension reduction algorithm and semantic search model algorithm [24, 25]. On the corresponding system cold start problem, it is mainly another embodiment of the problem of data sparsity. Based on this, relevant research institutions have proposed algorithms such as implicit variable model and probability model algorithm [26, 27]. At the level of corresponding scalability problems, corresponding research institutions have proposed algorithms such as matrix singular value decomposition algorithm and collaborative filtering algorithm based on clustering. However, such algorithms not only improve the system performance, but also abandon a large amount of effective information, resulting in the loss of a large amount of information [28, 29]. On the issue of corresponding robustness, relevant research mainly focuses on the similarity recommendation of historical data. At the core recommendation algorithm level, the current mainstream algorithms include collaborative recommendation filtering algorithm, ant colony collaborative filtering algorithm, and cross-collaborative filtering algorithm [30–32]. Based on the above analysis and research on the collaborative filtering algorithm and the software and hardware of the corresponding pitch control system, it can be seen that the current research status is as follows: at present, whether it is a simple collaborative filtering algorithm or a simple pitch control system, there are problems of low accuracy and efficiency; for the collaborative filtering algorithm, the traditional collaborative filtering algorithm has the phenomenon that the range of adjacent sets is large, so the search time is too long, which leads to the problem of low efficiency of the whole algorithm and further affects the efficiency of the recommended algorithm of the system. For the pitch control system, it is mainly used in the corresponding electronic equipment. The traditional pitch control system mainly depends on the volume control table. With the increasing complexity of the system, the corresponding volume control table will increase the complexity, resulting in low response rate and low efficiency of the system. Therefore, based on the above analysis and research, it is very important and meaningful to introduce a new algorithm to make up for the disadvantages of the traditional algorithm based on the traditional collaborative filtering algorithm. At the same time, it has practical significance in further improving the intelligence and accuracy of the pitch control system. Based on this, this study mainly analyses and discusses the above problems.

*2.2. Optimization Analysis and System Construction of Collaborative Filtering Algorithm under Clustering Algorithm.* The optimization framework of collaborative filtering algorithm under the corresponding clustering algorithm is shown in Figure 1. As can be seen from Figure 1, the corresponding system composition includes two parts: the hardware part of the system framework and the core algorithm part of the software. The corresponding software part mainly includes the core algorithm of clustering

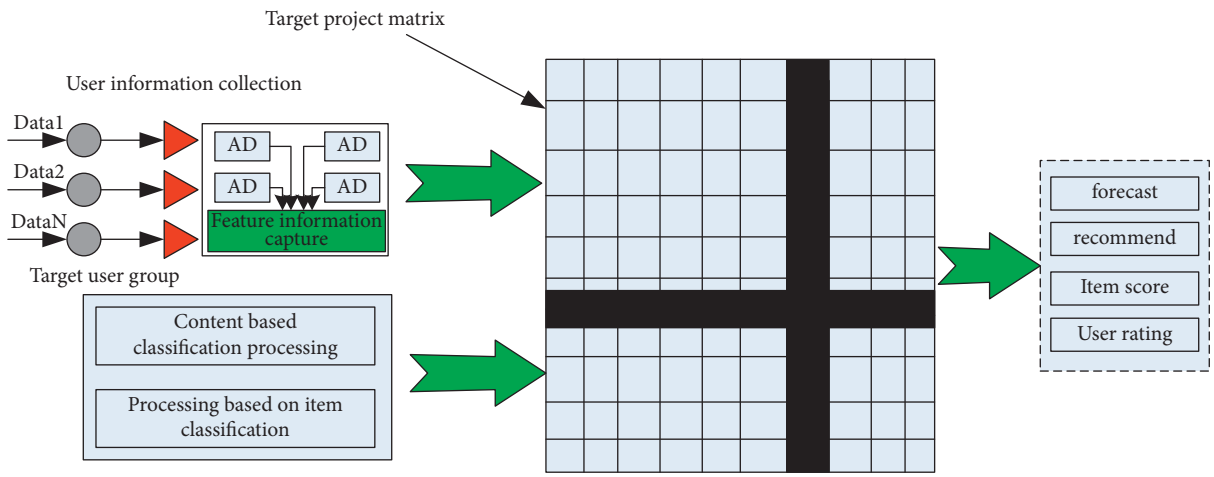


Figure 2: Flow chart of collaborative filtering algorithm.

algorithm and collaborative filtering optimization algorithm based on this. At the software system level, it also includes user information management software architecture, collaborative filtering pitch control architecture, user playing pitch control system, user-adaptive pitch control system, and ambient pitch intelligent adaptive control system. The corresponding collaborative pitch filtering optimization algorithm mainly includes pitch environment adaptive recommendation, pitch personal preference adaptive recommendation, and intelligent recommendation. At the corresponding hardware design level, it mainly includes the main designed modules, including the hardware design of the pitch recommendation system. The corresponding hardware part includes the system input function module, the system recommendation processing function module, and the system output function module. The corresponding system input function module is mainly used to store the pitch storage memory related to the user and the environment, and according to a large amount of information, the user's behaviour habits and corresponding environmental preferences are obtained. The corresponding input modules are divided into two categories, the first is the input module of the target user and the second is the environmental input module. The main data recorded and stored include pitch, audio rate, sound type, and user score; the corresponding recommendation processing function mainly includes the storage of recommendation algorithm. Its specific work mainly includes data analysis, data model establishment, recommendation strategy generation, and recommendation list generation. The technical details of the collaborative filtering algorithm under the corresponding clustering algorithm and the construction of the pitch control system are shown below. Considering the environment of the corresponding pitch control system, it can be seen from the basic frame diagram that the analysis objects are classified, and the corresponding discussion is also carried out around the classification items. In the actual experiment, this study only considers the project-based (i.e., the environment part).

Correspondingly, the main flow chart of the collaborative filtering algorithm mainly analysed and studied in this

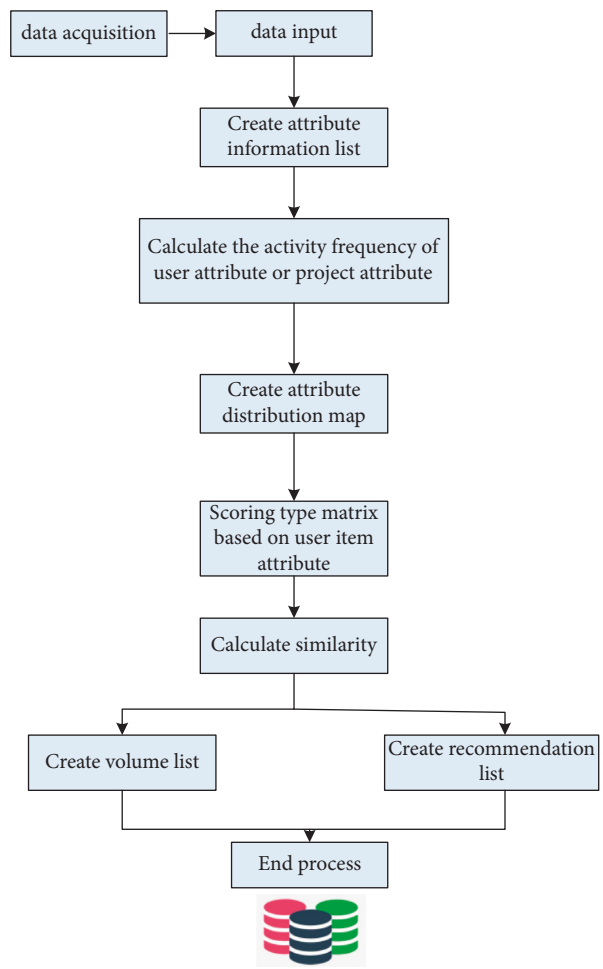


Figure 3: Flow chart of collaborative filtering algorithm based on the clustering algorithm.

study is shown in Figure 2. As can be seen from Figure 2, firstly, the collaborative filtering algorithm collects various characteristic information in various ways to form the corresponding information matrix. Then, the neighbour set with the highest similarity to the corresponding target project or environment is generated. Finally, the

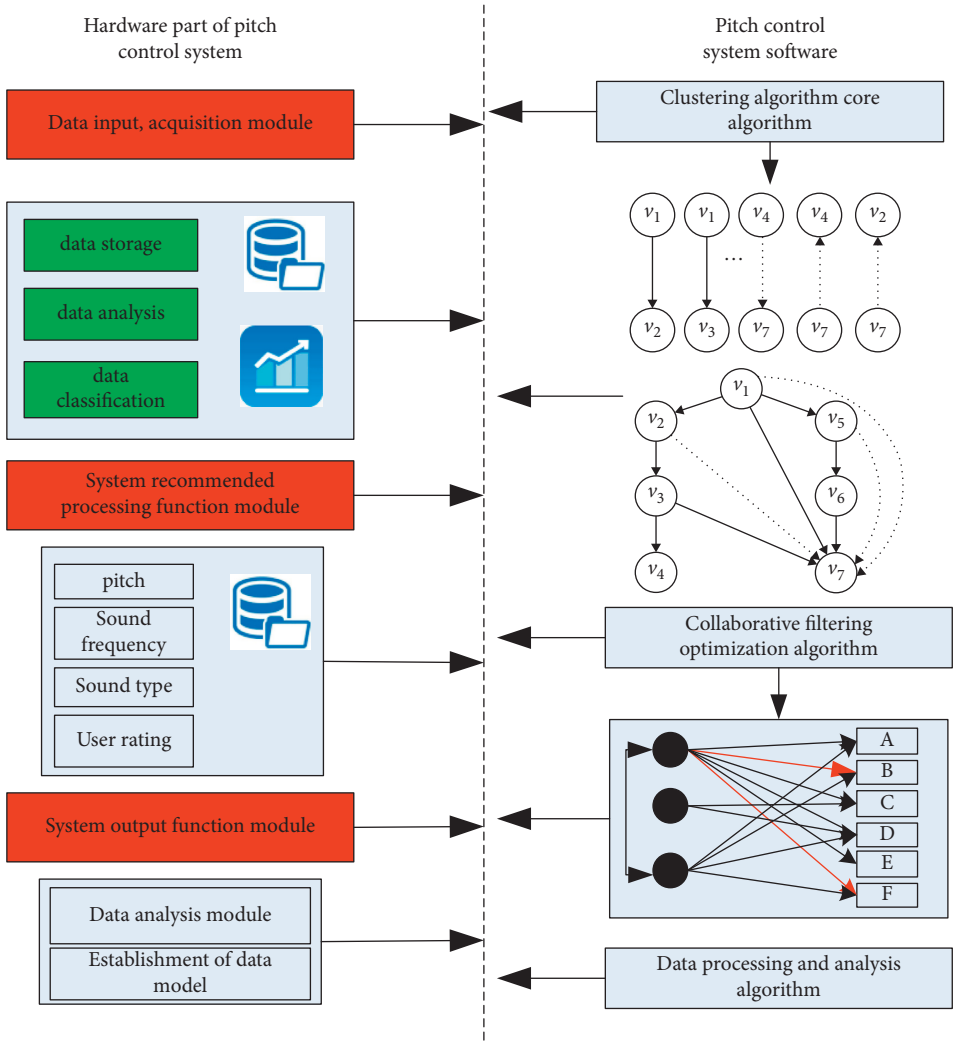


Figure 4: Software and hardware architecture of pitch control software system based on collaborative filtering algorithm.

corresponding recommendation list is generated (this study mainly refers to the pitch system).

*2.3. Optimization Analysis of Collaborative Filtering Algorithm Based on Clustering Algorithm.* The above traditional collaborative filtering algorithms mainly have the problems of large range of nearest neighbour sets and the accuracy of corresponding recommendation algorithms.

In this study, the clustering algorithm is used to deal with the nearest neighbour set. There are two main processing methods. First, the optimization problem of the corresponding weight function in the project is solved. The optimized formula of the corresponding weight function is shown in the following formula:

$$W(m,n) = \frac{\{[U_iU_j] * [U_i'U_j']\}}{\{(U_iU_j)\}}. \quad (1)$$

At the same time, a new average difference weight function is proposed, and the corresponding function formula is shown in formula (2). Based on the above formula (1) and formula (2), the neighbour set similarity calculation formula shown in formula (3) can be further optimized. The corresponding formula is shown in formula (3). Based on the similarity formula, the recommendation accuracy of collaborative filtering algorithm based on the clustering algorithm can be further improved.

$$W(m,n)^{\text{dif}} = \cos\left(\frac{\text{average}(\text{diff})}{\max(\text{diff})}\right) * \frac{3.14}{2}, \quad (2)$$

$$W(m,n)^{\text{dif}} = W(m,n)^{\text{average}} * W(m,n)^{\text{cards}}. \quad (3)$$

Similarly, to further improve the recommendation efficiency of the system, this study divides the originally large item set into many small item sets based on the clustering algorithm, to further reduce the search time of neighbour set. The corresponding calculation steps are as follows:

Step 1: input a user item scoring matrix set and generate the number k of cluster sets to be divided for

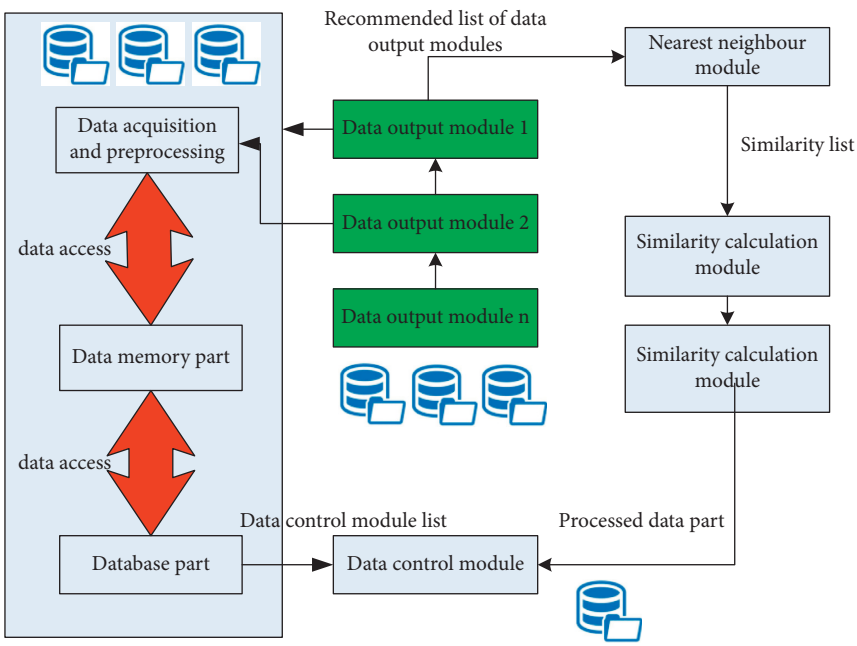


Figure 5: Development framework of pitch control software system logic layer based on collaborative filtering algorithm.

processing. The specific processing process is as follows: K items are extracted from the corresponding user item scoring matrix and used as the initial cluster center, and then, multiple cluster sets are initialized and processed by program.

Step 2: in the selection of the corresponding K value, the corresponding value should make the similarity between the corresponding clusters as small as possible and the similarity between the corresponding clusters as large as possible. The main idea is "high cohesion, low coupling." The corresponding calculation formula of the similarity between classes is shown in formula (4). The corresponding K in the formula represents the number of clusters. The corresponding Sim represents the similarity function. The calculation formula of the internal similarity of the corresponding cluster is shown in formula (5):

Table 1: Sample data list.

| Sample sequence | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Recommended pitch value (dB) | 11 | 34 | 23 | 56 | 43 |
| Sample sequence | 6 | 7 | 8 | 9 | 10 |
| Recommended pitch value (dB) | 23 | 25 | 54 | 63 | 21 |
| Sample sequence | 11 | 12 | 13 | 14 | 15 |
| Recommended pitch value (dB) | 11 | 13 | 41 | 27 | 76 |
| Sample sequence | 16 | 17 | 18 | 19 | 20 |
| Recommended pitch value (dB) | 19 | 45 | 67 | 24 | 53 |

$$\text{Outsim} = \frac{[(\text{sim}(ic1, ic1) * \text{sim}(ic2, ic2) * \cdots * \text{sim}(ici, icj)]}{(K * K - K)}, \tag{4}$$

$$\text{insim} = \frac{[((\text{sim}(ic1, ic1) * \text{sim}(ic2, ic2) * \cdots * \text{sim}(ici, icj))/mi)]}{(K)}. \tag{5}$$

To adapt to the environment and user preferences, this study proposes to calculate the attributes between different items when improving the collaborative filtering algorithm, so as to further determine the unique attributes between items and determine the similarity between items, so as to introduce the pitch preference correction factor based on user attributes, so as to realize the high precision of electronic equipment based on pitch control software preference recommendation setting. The corresponding processing steps are as follows:

Step 1: establish the corresponding environmental attribute category table;

Step 2: calculate the similarity between items;

Step 3: calculate the corresponding user activity attribute list;

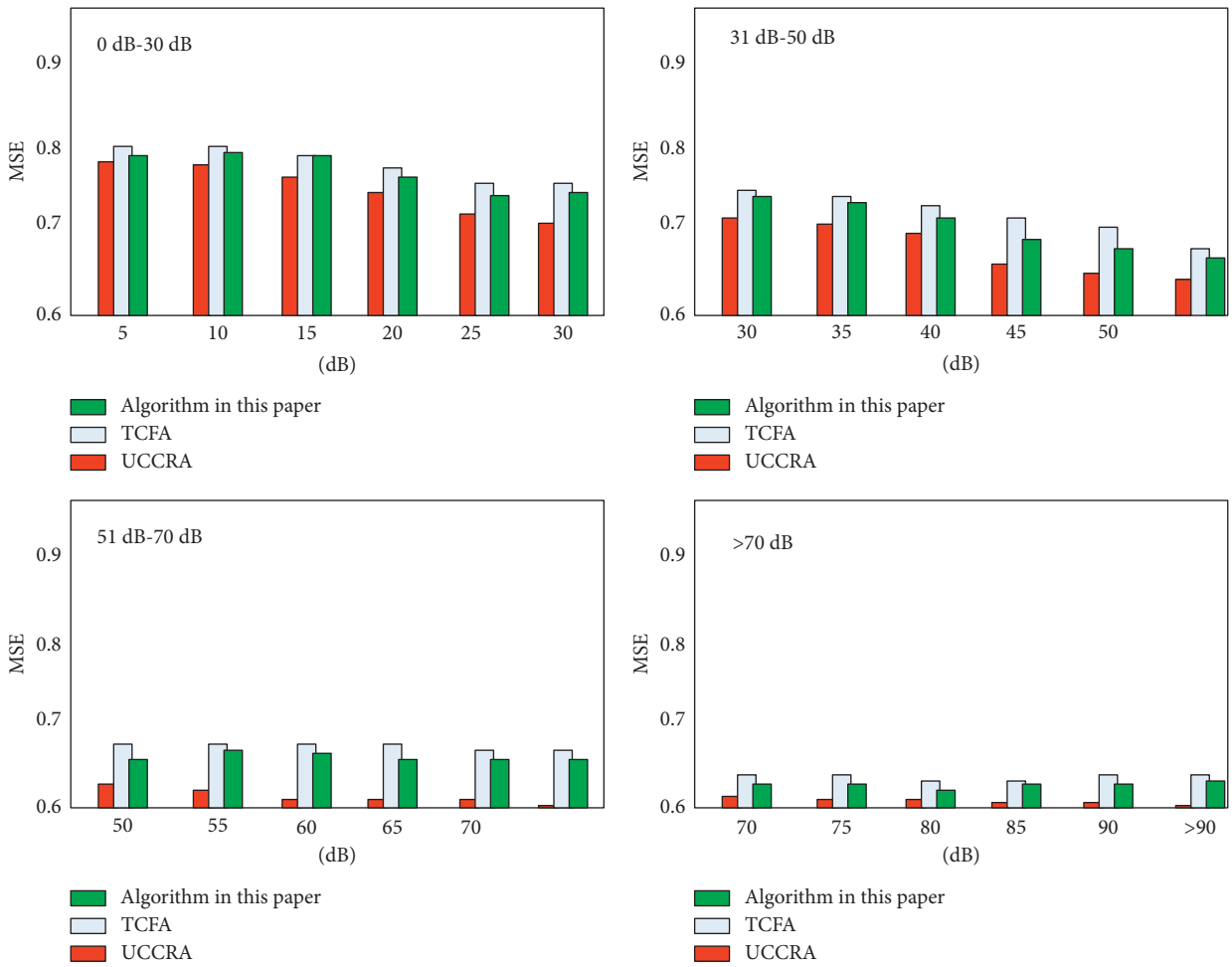


Figure 6: Variation curve of average absolute deviation corresponding to ambient sound decibel (0–30 dB, 31 dB-50 dB, 51 dB-70 dB, and 70 dB).

Step 4: establish the corresponding user environment attribute list based on the above steps;

Step 5: calculate the similarity between users;

Step 6: score prediction processing and analysis of corresponding items; and

Step 7: recommendation processing and analysis based on collaborative filtering algorithm under clustering algorithm.

The corresponding process framework is shown in Figure 3.

*2.4. Construction of Pitch Control Software Infrastructure Based on Collaborative Filtering Algorithm.* Based on the above principle analysis, the pitch control system is constructed, and the corresponding construction framework is shown in Figure 4. From Figure 4, we can see the software and hardware architecture of the pitch control software system based on collaborative filtering algorithm. As can be seen from Figure 4, the corresponding system software mainly includes clustering algorithm, core algorithm, collaborative filtering optimization algorithm, corresponding recommendation algorithm, data processing, and analysis algorithm. At the software system level, it also includes user information management software architecture and collaborative filtering pitch control architecture, user playback pitch control system, user-adaptive pitch control system, and environmental pitch intelligent adaptive control system. The corresponding collaborative pitch filtering optimization algorithm mainly includes pitch environment adaptive recommendation, pitch personal preference adaptive recommendation, and intelligent recommendation. At the corresponding hardware design level, it mainly includes the main designed modules, including the hardware design of the pitch recommendation system. The corresponding hardware part includes the system input function module, the system recommendation processing function module, and the system output function module. The corresponding system input function module is mainly used to store the pitch storage memory related to the user and the environment, and according to a large amount of information, the user's behaviour habits and corresponding environmental preferences are obtained. The corresponding input modules are divided into two categories, the first is the input module of the target user and the second is the

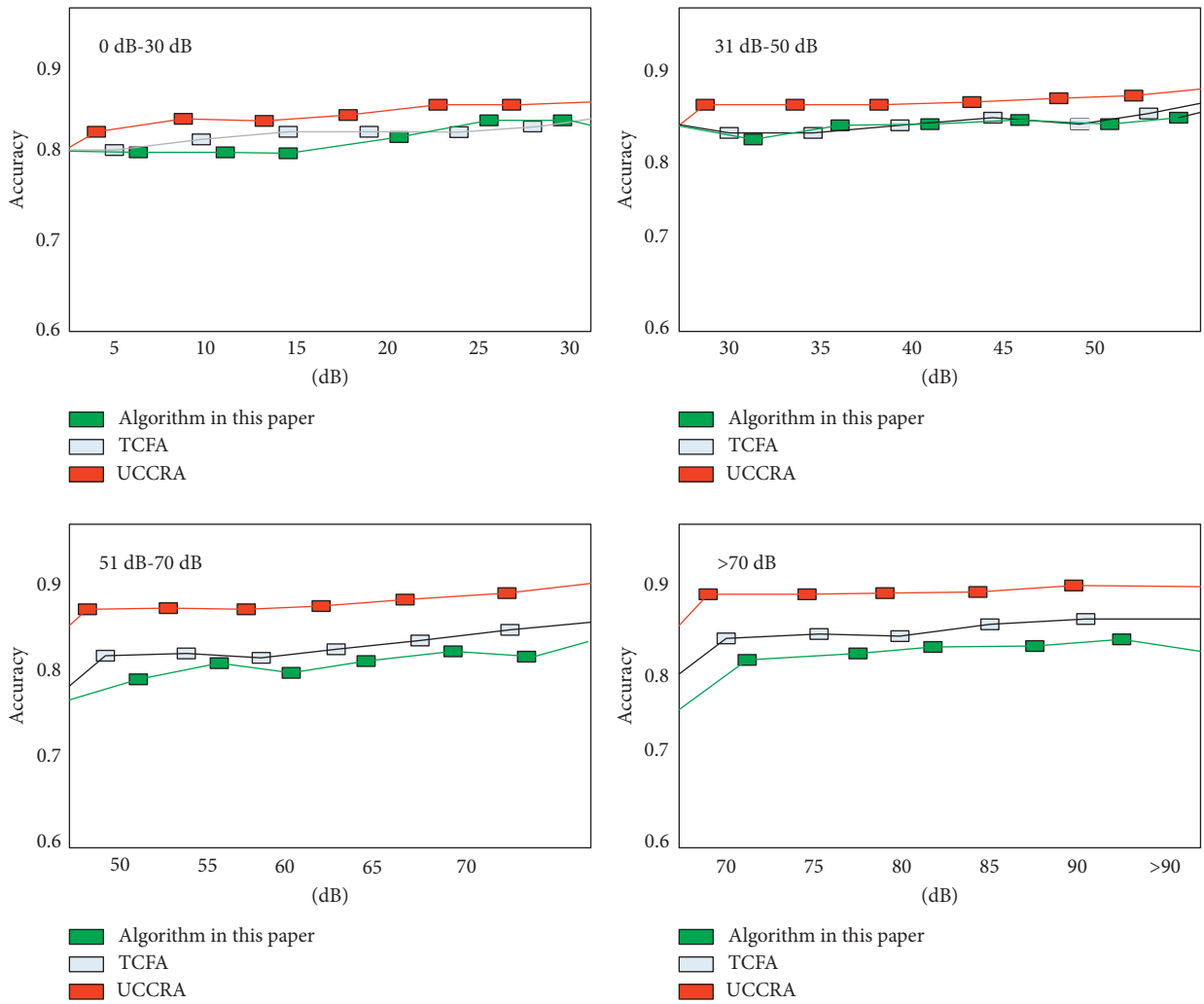


Figure 7: Accuracy variation curve (0–30 dB, 31 dB-50 dB, 51 dB-70 dB, and 70 dB).

environmental input module. The main data recorded and stored include pitch, audio rate, sound type, and user score; the corresponding recommendation processing function mainly includes the storage of recommendation algorithm. Its specific work mainly includes data analysis, data model establishment, recommendation strategy generation, and recommendation list generation. Other parts of the hardware also include the design of power supply, data storage, data acquisition, and other auxiliary hardware modules.

As can be seen from the above figure, the main system components include input data control module, similarity calculation module, nearest neighbour module, and data output module.

The corresponding input data control module mainly provides the function of data interface and mainly provides data input and output for the software part of the system. The corresponding data information includes user actual information, environment information, and user feedback information. This input data control module mainly grabs enough useful information from this kind of information for processing.

The corresponding similarity calculation module is mainly used to calculate the similarity between the user and the environment. Its main data source is the data information in the input data control module, which is an important part of the pitch control system.

The main input data of the corresponding nearest neighbour module are the output data of the similarity calculation module, which mainly formulates some rules to judge which items are adjacent items.

The main function of the module is to realize the personalized output of the user's recommended data based on the adjacent data.

In the corresponding hardware part, we also need to design the corresponding database to store the main information data set. Multiple information tables will be established in the corresponding database for query.

Figure 5 shows the development framework of the corresponding system logic layer. It can be seen from the figure that the pitch control software system logic driver is based on collaborative filtering algorithm. Based on this, the software development process of pitch control software

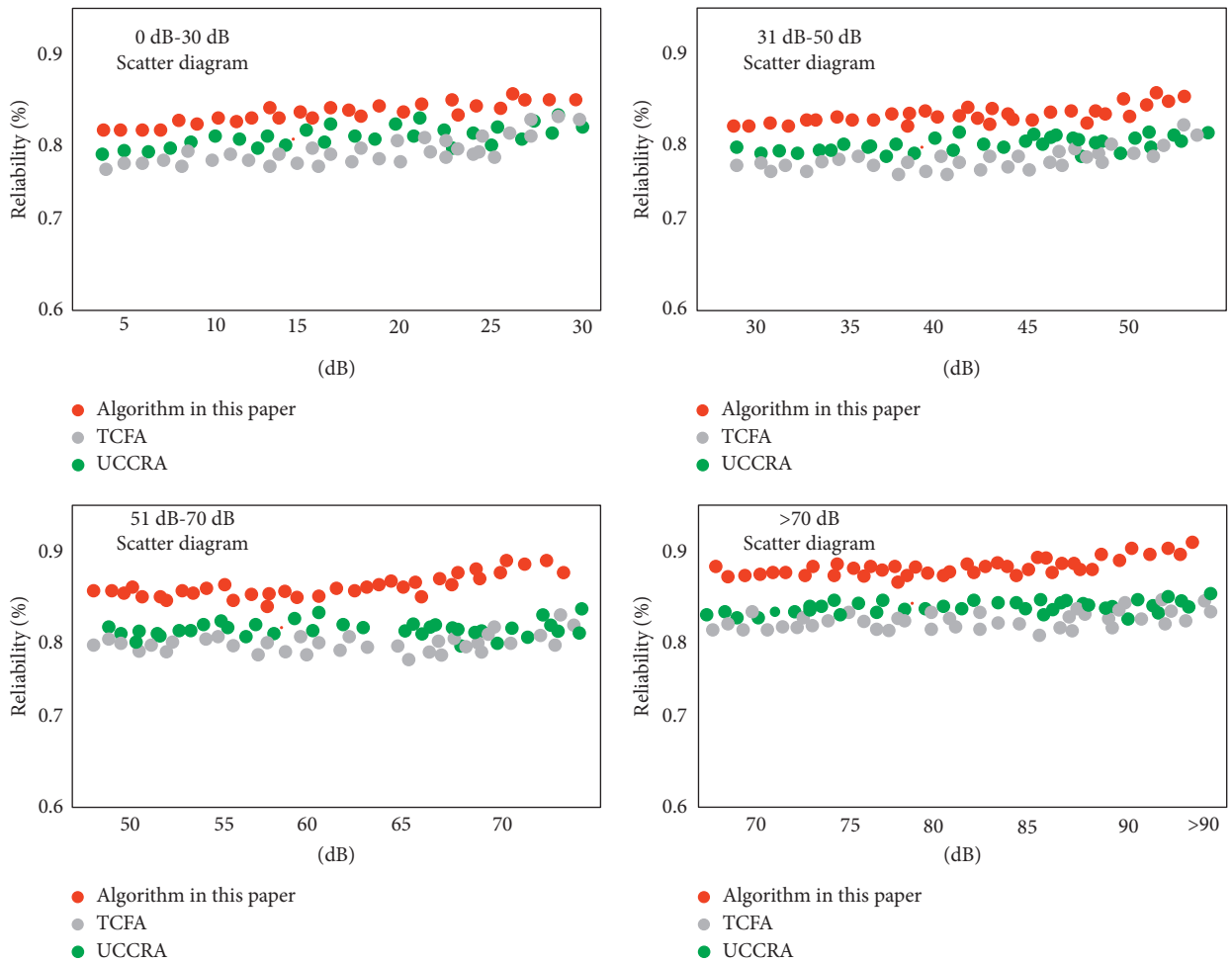


Figure 8: Reliability variation curve (0–30 dB, 31 dB-50 dB, 51 dB-70 dB, and 70 dB).

system based on collaborative filtering algorithm is as follows:

Step 1: program based on SQL query statement;

Step 2: portable corresponding interface program;

Step 3: complete the programming of business logic layer;

Step 4: write actual code to realize the business logic layer interface;

Step 5: write the program used to receive user requests in the control layer; and

Step 6: use the corresponding development tools for test processing and analysis.

## 3. Experiment and Data Analysis

Based on the above analysis, an environmental experimental sample is used for the experiment, and the experimental simulation software is MATLAB simulation software. The corresponding experimental scenario is set up as follows. The environmental sample data are 20 samples. The typical recommended pitch values corresponding to the recommended background music of the corresponding samples are listed in the sample data. In the experimental part of this study, the main indicators include the filtering accuracy of the algorithm, the intelligent degree of the system, and the recommendation accuracy. The corresponding indicators can basically represent the performance of the algorithm in the pitch control system. The corresponding data table is shown in Table 1.

Based on the above experimental samples, the experimental samples are analysed, and the main evaluation indexes are set as the average absolute deviation value, the accuracy value of sample analysis, and the efficiency value of sample evaluation. In the actual analysis, the corresponding sample data are divided into four cases for processing. The main comparative system algorithms include the pitch control system based on the improved collaborative filtering algorithm proposed in this study, the pitch control system based on the traditional collaborative filtering algorithm, and the recommendation algorithm based on user clustering.

Based on the corresponding four groups of average absolute deviation numerical experimental results, the curve is shown in Figure 6. From Figure 6, it can be seen that the absolute deviation value of the algorithm proposed in this study is small, which shows that the algorithm proposed in

this study has obvious advantages in recommendation accuracy compared with other algorithms. Figure 6 systematically shows the change curve of the average absolute deviation value when the ambient sound decibel is 0–30 dB, 31 dB-50 dB, 51 dB-70 dB, and above 70 dB. It is obvious that when the decibel is lower than 50 dB, the average absolute deviation values of the three algorithms show an upward trend, which indicates that the performance of the algorithms decreases in the low decibel environment. However, in this case, the improved collaborative filtering algorithm based on the clustering algorithm proposed in this study still has advantages in the application of pitch control system. When the corresponding environmental decibel is higher than 51 dB, the average absolute deviation of the corresponding algorithm proposed in this study is lower than the other two algorithms, and it increases with the decibel, the higher the difference between the corresponding average absolute deviations, the higher the performance of the algorithm proposed in this study.

To further verify the accuracy of the algorithm proposed in this study at the level of pitch control system, this study carries out accuracy experiments based on the above sample data, mainly to verify the accuracy of pitch control system in controlling preset sound decibels in complex environment. As can be seen from Figure 7, the algorithm proposed in this study has obvious advantages in preset sound decibel accuracy, and its corresponding sound decibel accuracy is about 7% higher than the traditional algorithm. In the actual experiment, the data are also divided into four groups of data, and the corresponding classification basis is 0–30 dB, 31 dB-50 dB, 51 dB-70 dB, and 70 dB. It can also be found from the figure that when the corresponding environmental decibel number is low, the accuracy is low, and when the corresponding decibel number is high, the accuracy is high, and this law also conforms to the change law corresponding to the above average absolute deviation value.

To further verify the efficiency curve of the algorithm, this study also verifies the efficiency based on the above sample data. The corresponding efficiency curve is shown in Figure 8. From the figure, it can be seen that the algorithm proposed in this study has obvious advantages in the efficiency of pitch control system compared with the traditional algorithm, and its corresponding reliability is also higher. During the corresponding experiment, the sample data are divided into four regions, which are 0–30 dB, 31 dB-50 dB, 51 dB-70 dB, and 70 dB.

Based on the above experimental results, it can be seen that the algorithm proposed in this study has obvious advantages in efficiency, reliability, and accuracy in the application of pitch control system. Therefore, it has obvious optimization for solving the application of traditional collaborative filtering algorithm in pitch control system, and the algorithm is also conducive to further promotion.

## 4. Conclusion

This study mainly analyses the application of traditional collaborative filtering algorithm in pitch control system and analyses the research status and existing problems of this algorithm. To solve the above problems, this study improves the collaborative filtering algorithm and reduces the range of nearest neighbour set of pitch samples by introducing clustering algorithm, to further shorten the search time of neighbour set and finally improve the real time and scalability of the system. To adapt to the environment and users' preferences, this project proposes to calculate the attributes between different items when improving the collaborative filtering algorithm, so as to further determine the unique attributes between items and determine the similarity between items, so as to introduce the pitch correction factor based on user attributes, so as to realize the high precision of electronic equipment based on pitch control software preference recommendation setting. Based on this, this project takes the improved collaborative filtering algorithm as the core algorithm to build a set of digital TV pitch control software system and realizes the verification of the algorithm proposed in this study based on MATLAB simulation software. The experimental results show that this algorithm has obvious advantages in pitch control accuracy and intelligence, and at the same time, its intelligent recommendation to users also has high intelligence. In the follow-up research, this study will focus on the application of the improved algorithm proposed in this study in other complex systems, further optimize the algorithm efficiency, reduce the algorithm energy consumption, and improve the accuracy of collaborative filtering algorithm and the efficiency of personalized recommendation. In addition to the application in pitch control, this study will also explore the application in other fields, such as image recognition and image tracking [33].

## 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 known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

## Acknowledgments

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