Design and Implementation of Computer Aided Art Teaching System Based on Intelligent Internet of Things Technology

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Abstract. With the continuous development of IoT(Internet of things) technology in the Internet age, the teaching content has gradually become rich and colorful. For example, the corresponding teaching content can be completed through various teaching forms such as words, pictures and videos. In order to explore the role and value of fine arts in cultivating aesthetic consciousness in spiritual level, its research work uses computer-aided technology in the field of fine arts teaching. Aiming at the problems existing in the current intelligent teaching assistant system, this paper studies the design and implementation of computer-aided art teaching system based on intelligent IoT technology. The overall structure of the system is given, each functional module of the system is designed in detail, and the database of the system is designed. An IoT big data compression algorithm based on feature vector is proposed. The algorithm takes the actual reading interval of each tag, the number of times of reading in this period and the average signal strength of the tag as the characteristics of the radio frequency tag. From the experimental results, when the label data size is only 150 tuples, the cleaned data still has 95 tuples, and the compression ratio is only 63%. It can be concluded that with the increase of scale, the data compression effect is getting better and better.

Keywords: IoT; Computer assistance; Art teaching.
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1 INTRODUCTION

The emergence of the Internet of things (IOT) has attracted great attention all over the world. It is a research hotspot of Chinese universities and scientific research institutions. Hua [1] analyzed computer-aided design and computer-aided instruction, and provided powerful help for solving practical problems by using powerful computing power and rigorous logic analysis function. Sumner [2] studied the intelligent teaching mode combining teaching objectives and tasks at each stage of the daily teaching process. Spinellis and Diomidis [3] have formed a complete intelligent teaching system through the design of intelligent teaching mode. Because different teaching stages are characterized by idleness, Figueras and Rafael [4] help students understand the diversity of art knowledge, gain better life experience, and build self-confidence in learning and development. It is a good attempt to apply Internet of things technology to art teaching, explore intelligent art teaching mode, and create open art teaching. Generally speaking, the courses of art painting are divided into theoretical teaching courses and practical courses, and only theoretical teaching courses are discussed here. Theoretical courses need to be integrated into the practice process in the end to ensure that the theory and practice are not disjointed. In view of the problems existing in the current intelligent teaching assistant system, Yang and Feng [5] studied the design and implementation of the teacher-side software of the intelligent teaching assistant system based on IoT. Yamaguti et al. [6] designed and implemented a homework management system with personalized learning environment. In this system, teachers can choose the desired questions from three levels of star ratings and assign them to students. Felix and Orlandi [7] have realized the mode of marking students' homework on the Internet. The system can check students' specific homework writing steps and identify and compare the correctness of students' writing steps. The online homework system developed and designed by Mohamed and Lamia [8] has the functions of inserting mathematical formula, online correction, online rating and automatic correction. Liu [9] designed and developed an interactive multimedia synchronous real-time teaching system based on IP network. This system not only realizes the main link of traditional real-time teaching functionally. Radwan and Farouk [10] tries to design and implement some application systems that can help teachers in fine arts colleges achieve their teaching goals better by using the theory and method of software engineering.

The modern Internet is the foundation of IoT operation, and the fundamental embodiment is to use the internet that connects things with each other to build the things space that contains all users. Through computer network technology, students' pursuit of art is not limited to classrooms and textbooks. Teachers can provide students with a large number of appreciation materials, which can be displayed in the form of videos and images, making some works of art come alive and greatly enriching the teaching connotation. In view of the fact that no one has developed and designed the teaching assistant software system for the related courses of art and painting at present, this system adopts C/S architecture and MVVM (Model View View Model) design pattern, and after the system is completed, it uses the black-box test method to test its functionality and non-performance so as to keep the system running well.

2 RESEARCH METHOD

2.1 Overall Design of Computer-Aided Art Teaching System

In recent years, most universities have built corresponding digital platforms by using the Internet, digital and information technology and corresponding equipment, and the construction of digital campus has basically been completed. Based on the analysis of teaching tasks, Yadav et al. [11] clearly explained the key points and difficulties in learning by using computer high-definition display technology and good visual communication effect. And use vivid means to show the boring teaching content, and improve the students' learning enthusiasm. Through the design of teaching content and the main problems solved in the classroom, students can discuss, and the cloud computing system can provide customized teaching services for teachers.

IoT can be divided into three layers: perception layer, network layer and application layer. Obtain unique digital virtual visual effects according to teaching needs, and assist teachers to break through the key and difficult points in teaching. and integrates abstract logical thinking with concrete image thinking, making it a multi-dimensional dynamic way to participate in the learning process together, breaking through the difficulties and limitations of abstract logical thinking. Make students' visual, auditory, tactile and other sensory systems participate in the process of collecting information, form a two-way interaction between teaching and learning, give full play to students' imagination and creativity.

Requirements analysis is a process of discovery, refinement, modeling and specification. This process includes detailed refinement of the software scope initially established by system analysts and determined in the software project plan, creation of models of required data flow, control flow and operation behavior, and selection of solutions based on this. Reverse requirements explain what the software system should not do. Theoretically, there are infinite reverse demands, so we should only select those that can clarify the real demands and eliminate misunderstandings. The purpose of this is to prepare for the possible expansion and modification of the system in the future during the design process, so that such expansion and modification can be easily carried out once it is really needed.

According to the overall demand analysis of the system, the teacher end of the intelligent teaching assistant system can be divided into five parts: the front page, red pen correction, in-class mode, online correction and personal center. Besides meeting the functional requirements mentioned above, the teachers of the intelligent teaching assistant system should also ensure that the system is reliable, stable, easy to use, safe and excellent in performance. The following principles should be followed in the process of system design: completeness, practicality, maintainability and openness. The architecture of computer-aided art teaching system is shown in Figure 1.

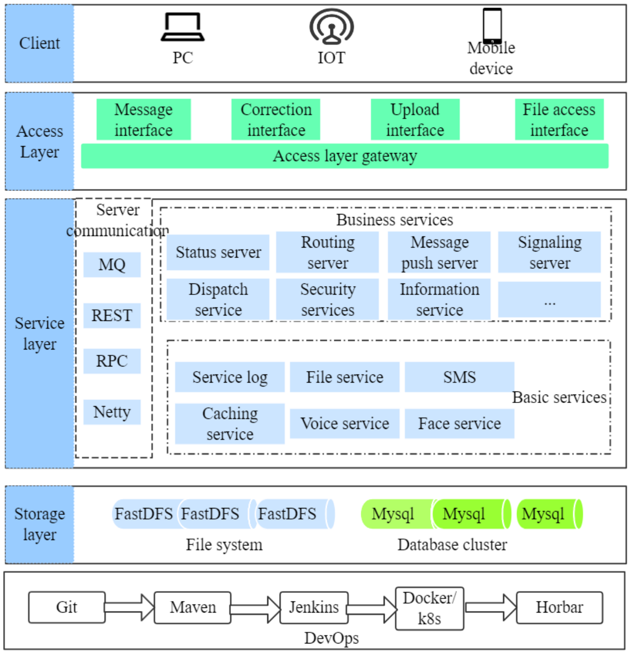

Figure 1: Computer-aided art teaching system architecture.

Message queue service is used for the communication of internal modules, which reduces the coupling between modules. Instant messaging service is used to communicate among the sub-modules of the system, ensuring the interaction among the modules; Slow. The state serv is used for manage that class, answering state of the student answering machine and the class state of the teacher in the current class; The push server is used to push the messages of starting class, starting answering questions, ending answering questions, ending class, etc. issued by the teacher; The state change interface is used to change the state of the student answering machine, and the task acquisition and addition interface is used to acquire the teacher's task and the teacher adds the task for himself.

The data layer caches the data generated by the teacher's operation or reads the data from the database for the page display, including the teacher's correction data, the analysis of the corrected homework, the teaching of class learning and so on. Business layer, which deals with various events triggered by teachers, including issuing questions, correcting, viewing data analysis, attending classes, etc. After the data changes, the page will be updated and rendered accordingly. After the data changes on the page, the data layer will directly receive the corresponding changes and updates.

Psychological research has found that changing teaching methods in time can stimulate students' vision and hearing, which can keep students interested in learning. The application of computer technology will make students study harder with enthusiasm and curiosity for new things, and at the same time, they will feel that class is a very interesting thing.

The artistic atmosphere of scene blending created by multimedia technology makes students' vision and hearing resonate in the process of appreciation, and enjoy beauty in a relaxed and pleasant atmosphere, which makes appreciation more realistic, three-dimensional and vivid, thus fully deepening their experience of works. According to the idea of overall functional design of computer-aided art teaching system, the functional structure diagram of each module of this system is shown in Figure 2.

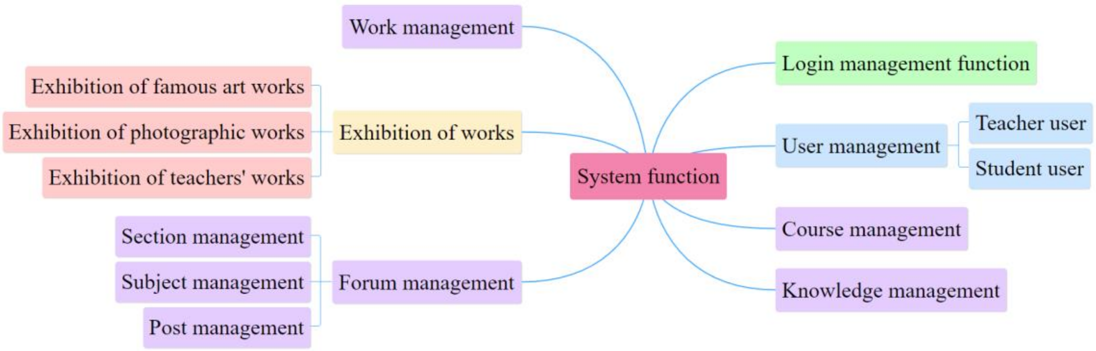

Figure 2: Functional structure of each module of the system.

When the user starts using the system, the login management module provides a user login page to display to the user, judges the user's identity according to the user's name, and displays the corresponding page on the user interface according to the different user identities. The function of the notification management module is to publish some notification messages on the page of the system and manage these messages, and its authority belongs to the administrator.

The picture display module mainly realizes a page, on which famous art works, photographic works, teachers' works, etc. are displayed according to the information content stored in the database. The actual location of this module is in the administrator page, the teacher page, the student page and the general user page. In the forum management module, teachers and students are regarded as "registered users", and their status in the forum is equal. However, users who have not logged into the system effectively, as general users, can only browse the content of the forum and cannot speak.

2.2 Key Technology Realization

Through computer-assisted instruction, the length of explanation and demonstration of knowledge and skills that students can easily master can be shortened, the teaching of key contents and key difficulties can be strengthened, and the spread density of knowledge can be increased, so that students can actively participate in the process of acquiring knowledge and achieve the goal of optimizing art classroom teaching. Computer-assisted instruction is widely used in art class and has practical instructional significance. Through computer-assisted instruction, wonderful sound effects, vivid process animation and flexible picture presentation can be displayed in front of students more intuitively and fully, so that art class can receive better teaching effect.

Set the function $h(v), a(u)$ to represent the hub value and authority value of the webpage, the initial value $h(v)=1, a(u)=1$, and define the I operation:

$$a(u)=\sum_{h(v)\in A} h(v) \tag{1}$$

The computer-assisted art teaching process is established. According to the different functions of each module of the system, the educator system management module and the learner system application module. Through intelligent education and teaching, students' learning ability is improved. Through online evaluation of students' learning ability, data based on students' learning content and behavior are formed, and the collected data are studied and analyzed to form a report.

Manage formatted and unformatted data, which can be stored in one site or distributed in different sites. This layer mainly completes the storage management and transaction management of multimedia database. The E-R diagram reflects the relationships among the entities of the system, and Figure 3 depicts the E-R diagram of students. Figure 4 is the E-R diagram of students, teachers and administrators.

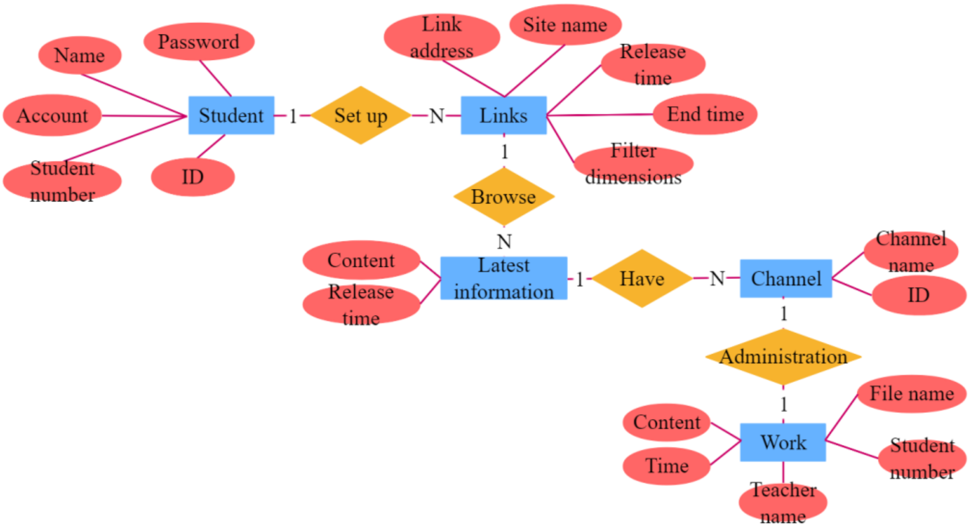

Figure 3: E-R diagram of students.

The Internet of things is an extension of the Internet. Wang and Guan [12] studied that a large number of events with fuzzy and chaotic characteristics occurred during its operation. Lee et al. [13] analyzed the depth first method and pseudo nearest neighbor algorithm to find out the chaotic correlation characteristics of IOT events in the aggregation-oriented cloud mode. Frequent data item set Pfd_i, improve Pfd_i cloud drop vector ZSX_i, generate cloud mode IoT event chaotic correlation feature collaborative filtering mapping function:

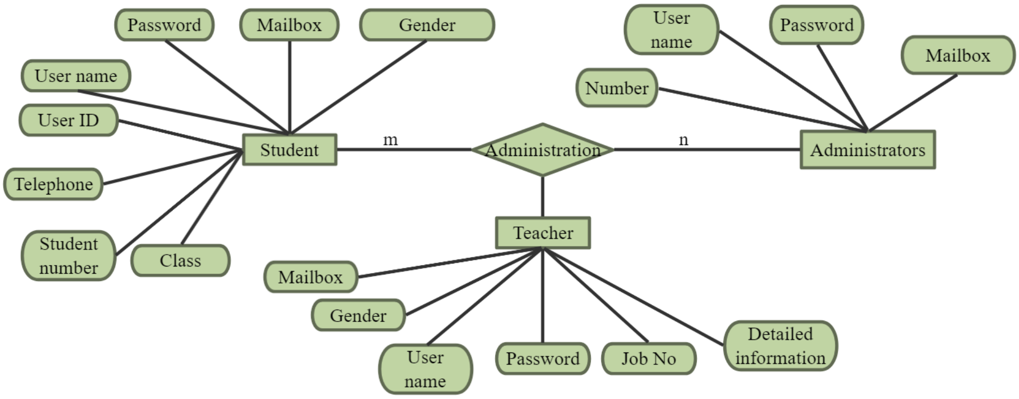

Figure 4: E-R diagram of students, teachers and administrators.

$$XGLH(A,B): ZSX_i \xrightarrow{\theta_i} \frac{\sqrt[|Pfd_i|]{Hx_i \times Qr_i}}{GLH(A,B)^{|Hxp_i|}} \tag{2}$$

The function of formula (1) is to reconstruct ZSX_i through the best embedding dimension Qr_i, Hxp_i, and extract the points with the highest similarity and correlation, so as to realize the collaborative filtering mapping of chaotic correlation features of IoT events.

The state transition mechanism of tags is the core of cleaning algorithm, and the transition of tags is the process of data cleaning. In order to quickly query the tag reading records, a multi-level hash table will be used as the data structure to store the tag reading records. In order to adapt to more application scenarios and avoid presetting the signal intensity threshold in advance, this paper records the average reading intensity SS_{avg} of all tags in the cleaning process:

$$SS_{avg} = \frac{\sum_{i=1}^{totalCnt} SS_i}{totalCnt} \tag{3}$$

Where $totalCnt$ represents the total number of reads of the tag. According to the central limit theorem, when the power of a tag exceeds the current average value, it is reasonable to believe that the tag is normal data, thus ensuring that the data can still be judged as normal data even if the reading and writing times of the tag do not reach the threshold annoying situation, thus reducing the error rate of data cleaning.

The selection of algorithm is the key in the process of mining. First, we need to get the dimensions and structure of data. Then, we study the advantages and disadvantages of each algorithm and the applicable scenarios, and then choose the best processing model according to the needs, so as to obtain valuable information efficiently and accurately.

Cluster analysis can divide the data set into multiple clusters according to the given attributes. By selecting appropriate similarity measures, Zheng and Perez [14] concludes that the data within the cluster is similar and the data between clusters is different. Numerical data sets usually use Euclidean distance to compare the similarity between two data records. Euclidean distance is to calculate the absolute distance between two points in n-dimensional space, as shown in formula (3):

$$d = \sum_{i=1}^{n} \sqrt{(x_{1i} - x_{2i})^2} \quad (4)$$

We define the sensor access relevance in object retrieval as the relevance value sensor similarity between sensors. The calculation method of sensor similarity can traverse O_A, O_B, but it is a time-consuming process. Therefore, a more effective calculation method of sensor similarity is proposed. The calculation formula is as follows:

$$Jaccard(O_A, O_B) = \frac{|O_A \cap O_B|}{|O_A \cup O_B|} \quad (5)$$

Among them, the coefficient of jaccard can be quickly calculated by Minhash algorithm, which greatly reduces the calculation time of sensor similarity.

Therefore, it is hoped that the optimization of cluster power consumption can be realized from two aspects of resource utilization and CPU load balancing. The power consumption overhead of virtual tasks in the cluster is shown as follows:

$$VPW = P_{static} \cdot \frac{v_u - \sum_i v_i}{v_u} \quad (6)$$

Here, v_u refers to the available resources of the cluster.

Aiming at the redundancy and multi-reading phenomenon of RFID data, this algorithm uses deterministic finite state machine to clean the data, and creates a multi-level hash table as a filtering channel to filter massive RFID data quickly and effectively. The flow of the cleaning algorithm is shown in Figure 5.

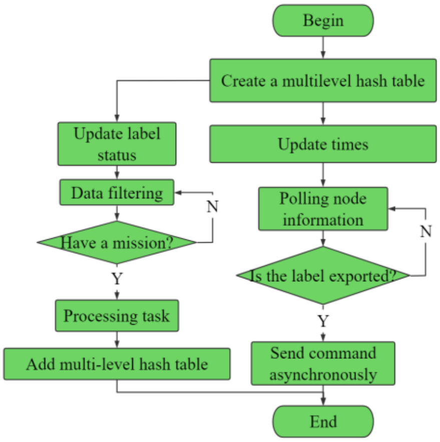

Figure 5: The flow of cleaning algorithm.

The query model and its processing are the same as those of relational database. For object-oriented data model, the query model and its processing should consider the influence of class hierarchy and aggregation hierarchy. For hypertext system, the navigation of nodes through the chain is the main means of information retrieval, and the query is only an auxiliary means of information retrieval.

3 RESULT ANALYSIS

Aiming at the compression algorithm designed in this paper, the following experiments are specially designed. The main experimental tools are Visual Studio and Matlab. The white noise sequence removal method is adopted to make the big data with the same equilibrium value and variance obey the normal cloud distribution, and select the node with the smallest error of the adjacent cloud droplet data nodes. The intelligence and dynamic evolution of clustering are mainly measured by intelligence coefficient and data access load, and the verification results are shown in Table 1.

Iterations	*Select the number of data points*	*Cluster similar data amount/GB*	*Intelligence coefficient*	*Data access load*
5	66.321	500.38	140	46.28
10	66.017	500.21	143	46.01
15	67.961	500.47	141	46.17
20	67.289	500.69	145	46.18

Table 1: Verify the result.

It can be seen that when the number of iterations is larger and the number of cloud drop data points is larger, when the fixed clustering index is larger than the expected value, that is, when the cluster is developing towards the cluster center, there will be more and more similar data in the cluster, and when the fuzzy data is nonlinearly mapped to the high-dimensional cloud space, the node with the smallest clustering error will be automatically selected, so as to adaptively recommend similar data.

In this experiment, several groups of original radio frequency data sets are generated, and the data before and after data compression are compared, as shown in Figure 6.

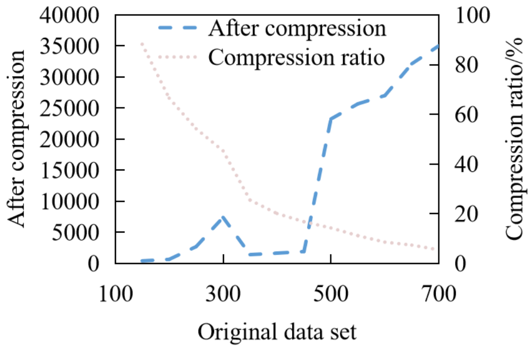

Figure 6: Compression effect of data set.

When the original data set is small, the data compression effect is not obvious; When the data scale is increasing, the compression effect begins to appear; From the experimental results, this algorithm is effective in compressing massive radio frequency data, which accords with the expected results. In addition, it should be noted that the data set of this algorithm is generated by random function, so the actual compression effect depends on the number of duplicate data. After repeated tests, its compression effect is still ideal.

This experiment then looks at the influence of different noises on the performance of data cleaning algorithm, and also uses the average time delay of each label as a measure of the performance of data cleaning. Considering that noise has little influence on the efficiency of data processing, the noise ratio is set at 10% in this experiment, and the running results are shown in Figure 7.

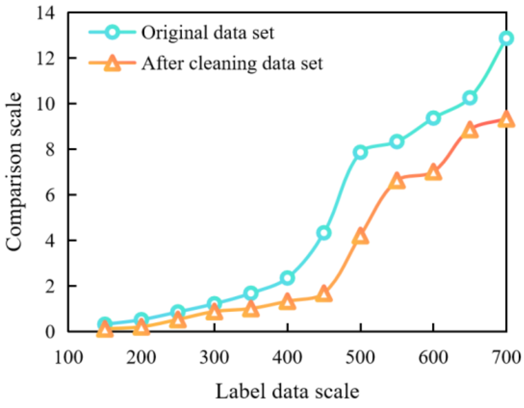

Figure 7: Scale comparison between cleaned data set and original data set.

From the experimental results, the proposed data cleaning algorithm greatly reduces the redundant data in the original data. When the label size is only 150 tuples, the cleaned data still has 95 tuples, and the compression ratio is only 63%. It can be concluded that with the increase of scale, the data compression effect is getting better and better. The simulation results accord with the expected results. It is worth noting that the specific data compression ratio depends on the proportion of redundancy in the data, so the results of this experiment only reflect the average experimental results. For the division of non-central points, distributed processing can be used, and multiple Task can be enabled to divide large-scale data sets into clusters. For the calculation of the sum of error criteria, because the operation is run in each cluster, and the time for the algorithm to process data sets of different scales, and because one of the focuses of this paper is to study the improvement of the running time of the parallel algorithm on the single-node algorithm in large-scale data sets, the time test is performed on the algorithm. The experimental results are shown in Figure 8.

On-line tasks refer to streaming tasks being submitted to the cluster or leaving the cluster from time to time. Different from batch tasks, in online environment, when the tasks are submitted to the cluster, the existing tasks in the cluster are running. The results show that the deviation between the actual energy consumption value of the cluster and the estimated energy consumption value is less than 10%, which means that it is effective to evaluate the energy consumption with tasks as the basic granularity. Simulate the class information from the actual application scenario, refine the teaching task, and process the message according to the actual situation. Computer-assisted instruction can make up for this defect, and provide students with a lot of appreciation materials by using the network. For example, 3D animation creates a good intuitive feeling environment for students, which is also the content that traditional classroom teaching can't achieve. On the one hand, audio-visual equipment makes students feel the beauty of form and color, on the other hand, it can also improve students' comprehensive quality through auxiliary means. Using IoT technology, we can realize the one-to-one correspondence between books, people and people, and build the connection between them, so as to realize the intelligent management of the library. Multimedia teaching pays more attention to interaction, because of the strong support of background server, human-computer interaction, interaction between students, interaction between teachers and students are more prominent and interactive. In interactive practice, students' human-computer interaction can be fast or slow, difficult or easy. Students can choose different learning contents and exercise contents according to their actual knowledge level or their knowledge needs. Besides improving art teachers' knowledge and ability of appreciation teaching, we should also actively expand the media resources that learners can learn independently, so as to stimulate students' interest in learning and promote the development of art appreciation teaching towards individualized teaching and individualized education.

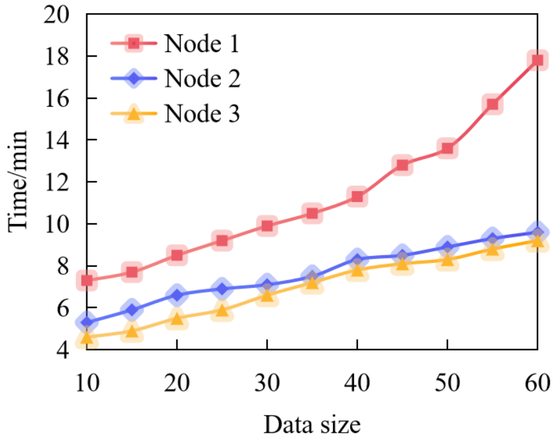

Figure 8: Processing time variation chart of data set.

4 CONCLUSION

At present, China's information technology is at a high level. It is an effective way to improve the construction level of universities by using IoT technology to link information technology with education, build a computer-assisted art teaching system and realize all-round intelligent management. Computer-assisted art teaching is the main form of classroom teaching in the future, and it can also realize the acquisition and utilization of art education resources. Aiming at the pain points in the current teaching process, this paper analyzes the functional points that the computer-assisted art teaching system should have, refines the functions, and designs and realizes the computer-assisted art teaching according to the task schedule. From the experimental results, when the label data size is only 150 tuples, the cleaned data still has 95 tuples, and the compression ratio is only 63%. It can be concluded that with the increase of scale, the data compression effect is getting better and better. Through IoT technology, a comprehensive teaching cloud platform has been built for teachers and students to realize intelligent education and management, which is of great significance for improving the level of educational informatization in schools.

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