Research on Jewelry and Jade Precious Metal Inspection System Under Computer Virtual Reality Technology

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Abstract. This paper analyzes the gold and silver jewelry inspection work management control system based on computer virtual reality technology. This article introduces the overall design of the system, process control, etc. The focus is on summarizing the changes in the existing work after the application of the management software, and making a detailed analysis of its function and the impact on the informatization of the quality inspection system. Then, a systematic study was conducted on the application of X fluorescence spectrometer in the detection of jewelry and jade. Finally, this paper uses a number of technologies in computer science such as database, pattern recognition, and information coding to realize computer-aided identification and related information query in appraisal practice.

Keywords: computer; virtual reality technology; precious metals; jewelry; jade; online monitoring system

1. Introduction

Traditional jewelry and jade inspection work is to hire some professional connoisseurs to carry out the inspection, so it is easy to be affected by human factors leading to judgment errors. Under the background of the rapid development of modern science and technology, the counterfeiting of jewelry and jade occurs frequently, and the counterfeiting technology is constantly innovating, and the method of relying on manual inspection alone can no longer meet the needs of rigorous inspection. In this context, the state authorizes some institutions to inspect the quality of jewelry and jade jewelry in order to ensure the normal circulation of jewelry and jade market transactions, and to crack down on some products with quality problems [1]. In recent years, the number of jewelry and jade jewelry transactions continues to increase, the amount of its inspection tasks is also constantly improving, under the background of big data, the traditional inspection workflow is cumbersome and inefficient, only innovative jewelry and jade jewelry inspection management system, in order to efficiently achieve the quality of jewelry and jade jewelry quality control and protection.

Jewelry and jade identification are a complex task that uses a variety of instruments and inspection methods to test multiple parameters of a gemstone and make comprehensive judgments based on these inspection data. It places high demands on appraisers. Only by effectively using various instruments and interpreting the various information provided by the instruments, but also by familiarizing themselves with the identification characteristics of various major gemstones, so as to grasp the key to identification and make accurate and rapid identification and judgment of gemstones. Based on this situation, the Institute of Product Quality Supervision and Inspection Technology has developed a jewelry and jade auxiliary identification and information system using computer information technology [2]. The software is a set of jewelry and jade computer-aided identification and related information query as one of the expert system software. Relevant identification data and materials were collected, classified, and standardized during development based on the gemological knowledge architecture. The software adopts a number of information technologies such as database, pattern recognition, and information coding in computer science, and has achieved good results in practical application.

2. Gold and silver jewelry online monitoring system design

2.1. System architecture

The gold and silver jewelry inspection work management control system can realize the centralized management of the electronic network of the inspection work, effectively manage and monitor the elements affecting the quality of the inspection, which can effectively improve the accuracy of the inspection results, significantly improve the work efficiency and save office costs [3]. At the same time, monitoring and managing every link of sample inspection reduces the error caused by human factors and improves the safety and reliability of sample circulation. The management of instrumentation and reference standards has also been strengthened. The system is characterized by low risk, simple operation and easy maintenance.

The system database adopts the Microsoft SQL Server 2000 database management system, and the programming tools mainly use Power Builder 10.5. The system uses a client/server architecture that combines a browser/server. All data is stored on the server, ensuring the security and integrity of the data. In order to improve the security of the system, the management module for the inspection work adopts the C/S structure, and the inspection result query module adopts the B/S structure to realize the customer's query and verification of the inspection results. The key architecture of the system is shown in Figure 1.

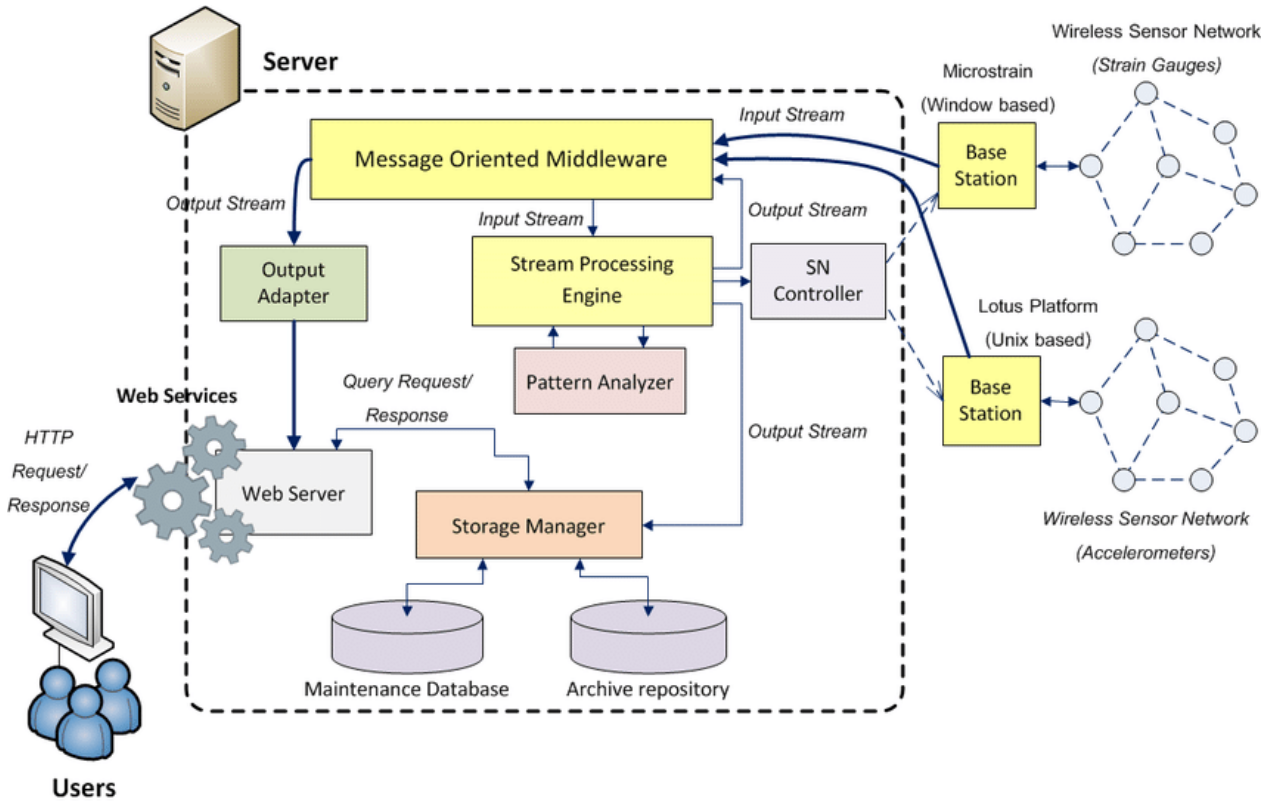

Fig 1. System-critical architecture

2.2. Functional module design

The system design takes the process of gold, silver, jewelry and jade inspection as the main line, and is divided into 10 modules, such as basic information setting, sample are management, sample identification, sample review, sample photo management, sample scale, certificate printing, accounts receivable, query statistics, and system management [4]. The functional module design is shown in Figure 2.

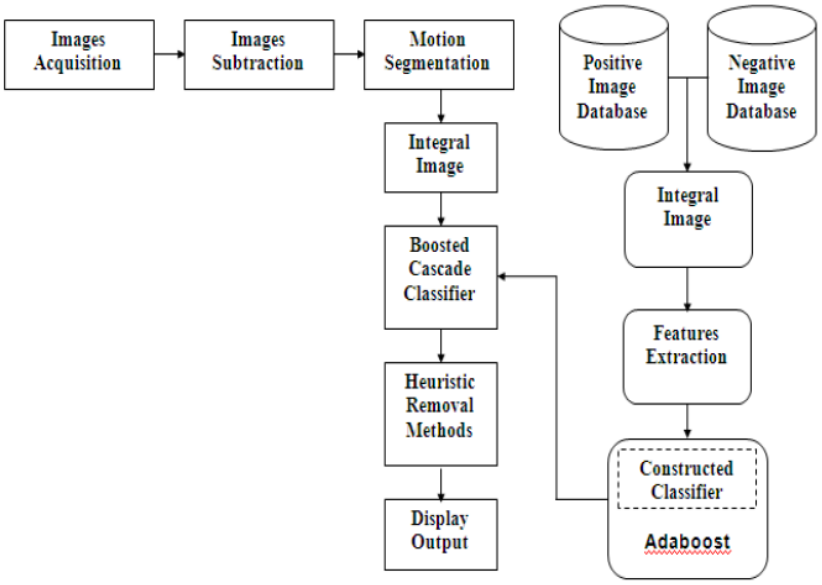

Fig 2. System function modules

2.2.1 Basic information settings

This module mainly sets various parameters in the use of the system. In this paper, the parameters of the appraisal results are entered into the computer and saved in the database for comparison and reference with the data at the time of inspection [5]. The second is to enter the information such as the number, name and effective date of various instruments and equipment to be used in the inspection into the computer and stored in the database to facilitate the registration of the use of various equipment and reference materials in the inspection work and the management of various instruments and equipment and reference materials. The third is to establish a detailed information base of the entrusting party, and set the charging standards for various types of appraisal certificates and labels in accordance with regulations.

2.2.2 Sample preparation management

Receiving samples for inspection, the reception personnel will enter the name of the unit for inspection, the classification of the received samples, the status of the sample and the number or total mass of the pieces, the inspection requirements of the entrusting party, and save them in the server database, and the system will automatically record the name and operation time of the operator who logged in to the system.

2.2.3 Sample identification

The sample to be inspected is sampled, and the computer automatically records the sample collector and the sample collection time. For some detection data that needs to be converted to obtain identification results, after the user enters the original data, the system will automatically convert it into the final detection data according to the conversion formula entered in advance, which improves the work efficiency. When the identification work is completed, the system will automatically record the equipment and reference materials used by the inspectors, and remind the inspectors to confirm and automatically identify and remind the validity period of the instruments or reference materials used, avoiding the problem of invalid detection data caused by the use of expired testing equipment.

2.2.4 Sample review

This module is set up to re-identify in a Back-to-back (back-to-back) manner to ensure the reliability of the identification results, and its function is basically the same as that of the sample identification module. If the results of the auditor's inspection are inconsistent with the results of the appraiser's inspection, the system will not pass and automatically send a reminder message to notify the appraiser to re-identify.

2.2.5 Sample sub-scale

This module weighs samples that have passed the audit and identification. The program will automatically read the indicator of the electronic balance through the computer serial interface, check the validity period of the selected weighing equipment, record the user and time, and remind the expiration date of the equipment that will expire [6]. At the same time, the specific jewelry name of the sample and the presence or absence of accessories can be recorded in this module.

2.2.6 Sample photo management

The module is to collect digital photos of each sample that needs to be photographed, and the program will name the picture after the sample coding after identification and review, and save it in the database to realize the correspondence between the sample and the digital photo.

2.2.7 Certificate printing

The certificate printing module is a sample that has completed all the inspection work such as identification, audit, weighing, etc., gives the corresponding inspection results, and prints out all kinds of identification certificates or labels required. Accounts receivable: When the entire inspection process is completed, when the sample is withdrawn to the entrusting party, the program automatically settles the inspection charges of this batch of samples according to the charging standards in the basic settings, and registers the accounts of the units or individuals that fail to pay in time to complete the function of statistical charges.

2.2.8 Query statistics

This module is a classification query and various types of statistics on all data recorded in the database. Such as: can count the customer's inspection frequency and quantity, inspection costs and workload. System management: The system management module mainly includes: 1. The permission setting is used for user management, and the rights and responsibilities of the inspectors are divided according to the relevant provisions of our hospital to ensure the accuracy and effectiveness of the inspection results. 2. System updates are used for future system upgrades. 3. Data backup and export is designed to ensure the safety and reliability of data.

3. System workflow

After logging in to the gold and silver jewelry inspection work management and control system, the user can work according to the process of the system. Under normal circumstances, the user needs to first carry out the sample work and record the information model of the sample. Subsequently, the inspection work is carried out according to the type of sample [7]. In fact, the system in the process of operation is often able to maximize the improvement of gold and silver jewelry identification efficiency, and enhance the flexibility of the work, to achieve the inspection effect. The system software workflow is shown in Figure 3.

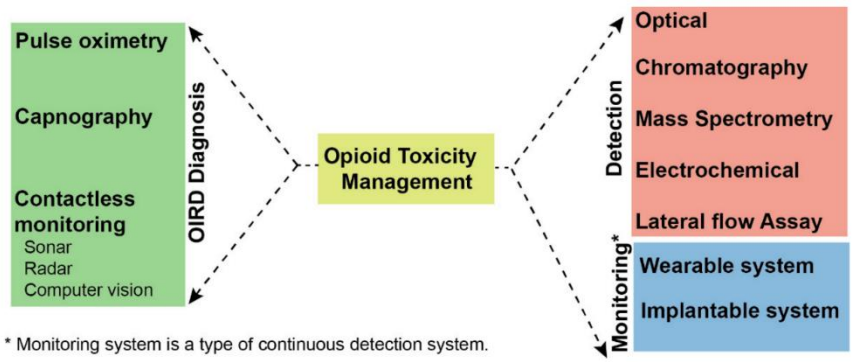

Fig 3. Gold and silver jewelry inspection work remote management control system workflow

4. Application of X fluorescence in gem type identification

Some jewelry jade in the wearing process due to the impact of type factors, its appearance will appear to varying degrees of wear, damage and other phenomena. By detecting it with an X-fluorescence spectrometer, it is possible to accurately determine the type of jewelry. Especially in the detection of rhodochrosite, the X fluorescence spectrometer has a very significant application effect. Rhodochrosite is a typical self-chromates mineral, and its main components are manganese carbonate, iron, calcium, manganese and so on. Among them, manganese is a chromogenic ion, red, rhodochrosite will gradually become lighter with the increase of calcium and iron content, and when the calcium content reaches a certain level, it will even completely replace manganese [8]. At this time, rhodochrosite is yellow or brown. If the jewelry jade is rhodochrosite, its hardness is relatively low, and people will inevitably have a certain degree of wear after wearing this for a period of time. In this case, the use of traditional detection methods cannot be accurate detection of rhodochrosite using X fluorescence spectrometer to detect the results are true and reliable. In this physical inspection, the detected rhodochrosite is a large red with high saturation. From the perspective of its color alone, it can be roughly judged that its ingredients have high Mn content, relatively low Ca content, low Fe content, and even do not contain Fe. Subsequently, this conclusion was verified using an X-fluorescence spectrometer. From Figure 4, it can be seen that the X fluorescence spectrometer has a very good application effect in the detection of rhodochrosite.

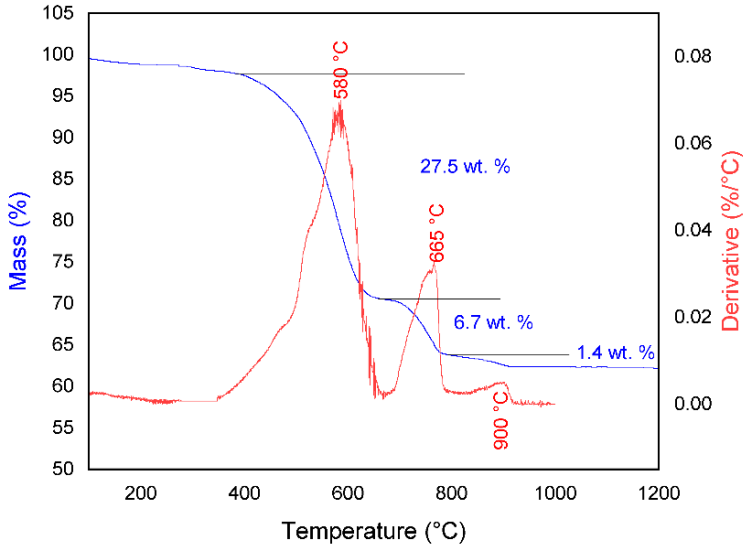

Fig 4. X-fluorescence spectra of rhombophyllite

Subsequently, an X-fluorescence spectrometer was used to detect a transparent gemstone resembling an aquamarine or topaz, and its refractive index was not measured due to poor polishing. However, for the analysis of other X fluorescence spectrometer detection results, the Ca peak (Figure 5) appeared, because the composition of the aquamarine is $Be_3Al_2(Si_2O_6)_3$, the chromogenic ion is Fe^{2+}, and the composition of topaz is $Al_2SiO_4(FOH)_2$, which is chromogenic and does not contain Ca. Therefore, the possibility that it is aquamarine and topaz can be ruled out.

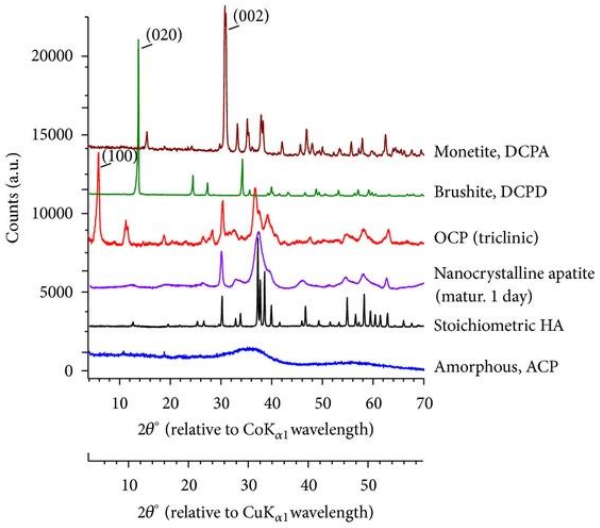

Fig 5. Ca characteristic lines of apatite

Previous detection experience and the X fluorescence spectrometer system suggest that it may be apatite $Ca_5(PO_4)_3$ (F, OH, Cl), which is a typical cationic Cation for Ca mineral. Dichroic mirrors and specific gravity tests have confirmed this speculation. In recent years, a kind of luminous jade has appeared in the jewelry jade market, and its bright spots are stimulated by phosphorescence, showing a mysterious feeling, which is more confusing to ordinary consumers and jewelry beginners. The X-fluorescence detector measured that its composition contains a large amount of Sr. In natural gemstones, this case of containing a large amount of Sr is very rare. Therefore, routine tests such as comprehensive density can conclude that this product is artificial strontium titanate.

5. System detection

The system develops software according to the flow process from sample reception to sample withdrawal, sets the switch variable in each circulation link, and can independently control the inspection workflow in the case of meeting the inspection requirements, which enhances the flexibility of the system and greatly improves the work efficiency. The system uses data tables to store a large number of inspection information and parameters, to achieve the traceability of the inspection process, but also through the combination of query, to provide a variety of statistical data, to achieve electronic management of inspection work. The data is automatically uploaded to the query website server, and the identification results are directly queried by scanning the QR code. The density, refractive index, and birefringence of different gemstones are shown in Table 1. The jadeite inspection diagram and the inspection and appraisal certificate are shown in Figure 5.

Table 1. The Density, Refractive Index, And Birefringence of Different Gemstones

Jewelry and jade ornaments	Density	Refractive index	Birefringence
ruby	4.00g/cm^3	1.762-1.770	0.008-0.010
sapphire	4.00g/cm^3	1.762-1.770	0.008-0.010
Emerald	2.72g/cm^3	1.577-1.583	0.005-0.009
jadeite	3.34g/cm^3	1.66	-
agate	2.60g/cm^3	1.53	-

Fig 6. Jadeite inspection drawings and inspection and appraisal certificates

6. Conclusion

The use of system technology to standardize and manage jewelry and jade inspection work, suitable for all kinds of gold and silver jewelry inspection agencies, in order to improve the automation, informatization and standardization of inspection work, to achieve the purpose of jewelry and jade product quality supervision. The system has been applied to realize the electronic management of inspection work, standardize the workflow of sample inspection, improve work efficiency, realize the traceability of inspection management, and eliminate the occurrence of various errors and errors. The system is stable in operation, friendly in man-machine interface, and has certain promotion and application value.

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