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Research and Development of Copyright Registration and Monitoring System Based on Digital Watermarking and Fingerprint Technology

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Abstract—According to the characteristics of the existing copyright protection system and market demand, a copyright registration and monitoring system based on digital watermarking and fingerprint technology was designed and implemented.Users can register audio, video, image and other types of digital content on our system, in which the only fingerprint is used to replace the original work itself for registration. After the approval, the unique watermark is issued for embedding in the digital content, so that when the infringement is identified, the watermark can be extracted from the suspected infringing works to prove the copyright, and this will break through the difficulty of obtaining evidence and safeguarding rights.The system also is real-time and accurate for copyright monitoring works. It can provide users with instant feedback, including suspected infringement works. Our system combines the advantages of digital watermarking and fingerprint technology in copyright protection, simplifies the copyright registration, makes the infringement identification effective, and makes the copyright monitoring accurate, so as to effectively prevent the occurrence of infringement and piracy, which is conducive to the promotion and popularization of digital works copyright protection.

Keywords-copyright;watermark;fingerprint;monitor

I. INTRODUCTION

Nowadays, in the era of booming and inclusive Internet, network media and We Media produce a large amount of digital content every day. The development of modern information technology provides various and convenient channels for the dissemination of network digital content. But, at the same time, network copyright protection is also facing many new challenges. Because it is not easy to collect evidence in network infringement cases, and the process of safeguarding rights is easy to fall into the dilemma of high cost and difficult law enforcement, the protection mechanism of network copyright industry is not smooth. In the current circumstances, network copyright protection urgently needs to cross the threshold of imperfect systems and regulations, difficulty in safeguarding rights and obtaining evidence, lack of funds and energy, and establish a benign network copyright protection ecology.

Therefore, after investigatated the existing copyright registration and protection platform and analyzed its advantages and disadvantages, combined with the current mature network copyright protection technology, this paper proposes a copyright registration and monitoring system based on digital watermarking and fingerprint technology. Under the dual conditions of local and network, users can register and register the copyright of digital works according to their own needs and through fingerprint technology. The platform can monitor whether infringement or not in the Internet in real time. When the platform detects suspected infringement or users encounter copyright disputes, the platform can authenticate the copyright through digital watermarking technology, so as to achieve easy forensics The effect of safeguarding rights is easy. This platform not only facilitates the application and approval process of copyright owner's works, but also can effectively and quickly carry out copyright authentication and rights protection under the condition of saving manpower and material resources, so as to further prevent the occurrence of infringement and piracy, which is conducive to the promotion and popularization of digital works copyright protection.

II. RELATED WORK

At present, there are three main types of copyright protection systems in the market：

A. Copyright protection system based on DRM technology

Digital rights management (DRM)[1] uses encryption to protect digital content. It encrypts the works that need to be protected in order to prevent the illegal copying of digital media, or make the copying difficult to some extent. The works encrypted by DRM technology can not be used even if they are downloaded and saved by users without

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authorization. That is to say, users must be authorized to use digital media, so as to strictly protect the copyright of works.

With the continuous development of technology, DRM technology has exposed more and more problems: (1) the encryption technology of digital media files is permanently invalid after the user obtains permission, and the use and dissemination of digital content after decryption are no longer protected.(2) Encryption technology makes the digital content can not be read normally, or limits the reading device, which affects the spread of many high-quality digital content.(3) In DRM technology, the user's identity usually needs multiple interactions to complete the verification, which makes it very inconvenient to confirm the right and provide evidence, and can not provide effective traceability function.

B. Digital rights service system based on DCI system

The copyright registration, which takes digital copyright identifier system as the core, is to register the copyright of digital content online through the Internet. After the user submits the copyright registration application online, after the approval, the user randomly assigns the unique DCI code (a series of indefinite codes composed of English letters, Arabic numbers and symbols according to certain rules) to each digital content copyright, so as to establish a reliable system of rights and responsibilities and provide the basic support of public services.

However, there are some problems in the way of applying for copyright and giving copyright registration certificate based on DCI: (1) the unique DCI code randomly assigned has nothing to do with the content of the registered digital works and cannot be bound with the corresponding digital works in essence.(2) In the process of applying for copyright registration, it is necessary to upload the original works that have not applied for the copyright certificate, and there is a risk that the works will be stolen in this process.(3) Although the way of giving the copyright registration certificate can provide copyright authentication and protection for the copyright owner to a certain extent, usually the infringer will make subtle modifications and adjustments (such as changing the size of the work, or intercepting the fragments of the work) before using the work in order to evade the responsibility, which makes it difficult for the system to find the matching works in the filing database, Thus, it is impossible to determine the copyright owner of the work, so it has little effect in protecting rights and obtaining evidence.

C. Copyright registration system based on blockchain technology

Because most of the existing copyright registration systems are centralized systems, the centralized system not only has opaque information, but also bears a huge network load. The system has differentiated access control for different information. When registering copyright information, users usually need to submit some sensitive information (such as the real identity of some authors) in addition to some copyright information that needs to be disclosed. Although the information is only disclosed to specific members of the copyright system, it is inevitable that there is a risk of privacy leakage. Blockchain technology can solve the problems of centralization and information privacy. The copyright registration system based on blockchain is a decentralized copyright registration system which can ensure the publication of copyright information and protect user privacy.

The copyright registration based on blockchain technology has a good application prospect. However, in the current practice of blockchain technology applied to copyright registration, there are still some problems: (1) the unique hash value hinders the judgment of originality of the work[2].(2)The data cannot be deleted, which makes the copyright registration impossible.

As the public has higher and more stringent requirements for copyright protection, researchers put forward digital watermarking and fingerprint technology as a popular research content from the perspective of digital research.

Digital watermarking technology is a kind of technology that can realize information hiding and tracking in the open network environment[3].By hiding the copyright identification information in the digital content, and extracting it correctly when necessary, it can prove the copyright of the digital content. Watermark embedding will not reduce the quality of digital works, and will not affect the normal use and spread of digital works. Digital watermarking technology has strong robustness. When the infringer makes intentional or unintentional modifications to the data of the works, the watermark can still be detected from the infringed works.

After analyzing the digital content, combined with the specific types of digital works, through some transformation, statistical analysis and other methods and strategies, the stable information that can represent the content characteristics and integrity is extracted from the digital content; Then, through the analysis of the feature information, the extracted feature information is transformed into a specific length of 0/1 sequence by using the methods and Strategies of secondary transformation or mapping, which is the digital fingerprint that can represent the content of digital works.

Therefore, in order to solve the problems of the mainstream copyright protection system, and analyze the characteristics of digital watermark and digital fingerprint technology, this paper attempts to introduce digital watermark and fingerprint technology, design and implement the copyright registration and monitoring system based on digital watermark and fingerprint technology. The fingerprint information extracted by digital fingerprint technology is used to replace the original works, and the functions of copyright registration, copyright monitoring and inquiry can be realized; The watermark is embedded in all registered works, and the copyright owner is further proved by extracting the watermark from suspected infringing works, so as to solve the problems such as the difficulty of obtaining evidence for the right confirmation. Digital fingerprint and digital watermark technology complement each other. A few suspected infringing works can be identified from the mass digital works crawled by digital

fingerprint technology to extract the watermark, which greatly reduces the workload of watermark extraction, improves the effectiveness of watermark comparison, and further verifies the suspected infringement works by using digital watermarking technology to ensure the accuracy of copyright identification, To provide strong proof for the confirmation of power.

III. DESIGN AND IMPLEMENTATION OF SYSTEM ANALYSIS

A. Copyright demand analysis

This system provides copyright registration, copyright monitoring and infringement identification services for users who need copyright protection. The relationship and structure of the three functions are shown in Fig.1.

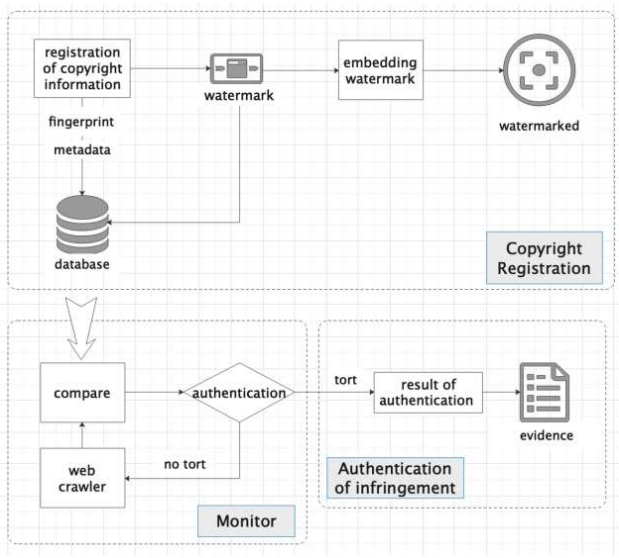

Fig.1. System structure diagram

1) Copyright registration

Users log in to the system for registration of copyright information. Users do not need to upload the work to the network. Using the fingerprint extraction tools provided by the system, the only fingerprint information representing the work and robust is extracted locally. The user uploads the fingerprint information, copyright owner information and other metadata for registration and registration. After the registration is successful and approved, the system returns the copyright identification representing the copyright, Using the watermark embedding tool provided by this system, the copyright mark is embedded in the registered works locally, and then the works with copyright identification are published to the network. The purpose of registration is not only to obtain copyright identification and watermark tools, but also to authenticate copyright by comparing registered copyright information when copyright disputes arise.

2) Copyright monitoring

Through the digital content fingerprint technology and crawler technology based on deep learning, the system creates accurate, comprehensive and real-time Internet infringement monitoring, and timely feeds back the suspected infringing works to users, which greatly meets the needs of users for their own copyright asset protection and rights protection.

3) Authentication of infringement

If the user has a copyright dispute or needs to protect the rights, the user can apply for the infringement identification, and watermark the suspected infringing works in the system. The notary will compare the copyright identification extracted by the user in the system with the copyright mark at the time of registration and feedback the infringement recognition results to the user for the use of the evidence of rights protection.

B. System design

This system includes five modules: user management, copyright management,copyright monitoring, tool management and infringement identification. The division of system function modules is shown in Fig.2.

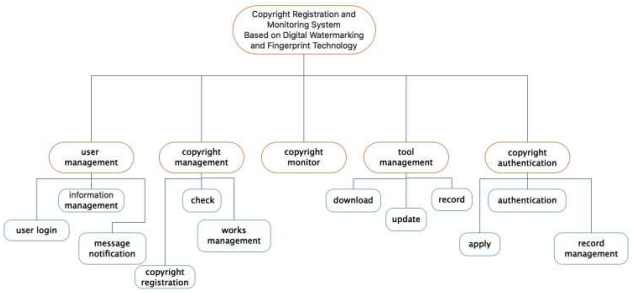

Fig.2. System function module diagram

1) User management module

This module is responsible for the registration and login of users, the management of user related information and message notification. Users can fill in relevant information according to their identity to register as individual users or enterprise users; User information management includes single condition or multi condition user query, user deletion, user login and operation log management; Message notification is sent by an administrator or professional to all users or to a specific user.

2) Copyright management module

The main function of this module is copyright registration and audit. The registration information submitted by users includes fingerprint information, copyright owner information, metadata of works, etc. The system will automatically audit the repeatability and integrity of the registration information. After the information is submitted, the auditors will audit the information to ensure that the registered information is true and in line with the law.After passing the audit, the system grants the user the copyright logo to embed the copyright logo locally. After entering the copyright management interface, users can query and cancel the registration of

their registered copyright information, view the audit status, and view the copyright logo corresponding to the registered information after the information is approved. The administrator or authorized reviewer can view the copyright information registered by all users, and audit the information. Through the audit, the copyright logo is issued, and if the audit fails, the reason for the failure is informed.

3) Copyright monitoring module

The module provides users with accurate and flexible copyright monitoring services. Real time Web data crawler is realized by using crawler technologies such as requests simulation login and filtering de duplication.Through the accurate comparison of fingerprint information, the suspected infringing digital content can be obtained.The module supports multi data synchronous monitoring at the same time, and effectively provides users with 7*24-hour copyright monitoring and monitoring results.

4) Infringement identification module

After submitting the application for infringement identification, users extract the watermark in the infringement identification management module, and then return the extracted copyright logo. After that, the process of infringement identification is handed over to the notary for notarization identification. After checking the copyright identification of the original digital content and comparing the extracted copyright identification, the copyright of the suspected infringing works is identified, and then the infringement identification certificate is issued to collect evidence for subsequent rights protection.

5) Tool management module

The module includes tool management, that is, managers update, query and delete tools. It also includes tool download, users use corresponding tools locally according to the operation instructions of different tools, and cooperate with the copyright registration of the system.

C. System implementation

The system uses code implementation, front-end and back-end separation framework, the back-end uses Springboot + Mybatis Plus + Shiro + JWT + swagger UI + redis framework, the front-end uses Ant Design Vue + Vue + webpack technology, and the database is MySQL database. The copyright monitoring module is implemented in Python language, and the neural network training adopts pytorch framework and alexnet pre training network.

1) Copyright registration

This page fills in the information related to the work according to the prompts. The copyright owner can fill in one or more information according to the actual situation. Click the Add button to add the copyright owner conveniently, as shown in Fig.3.

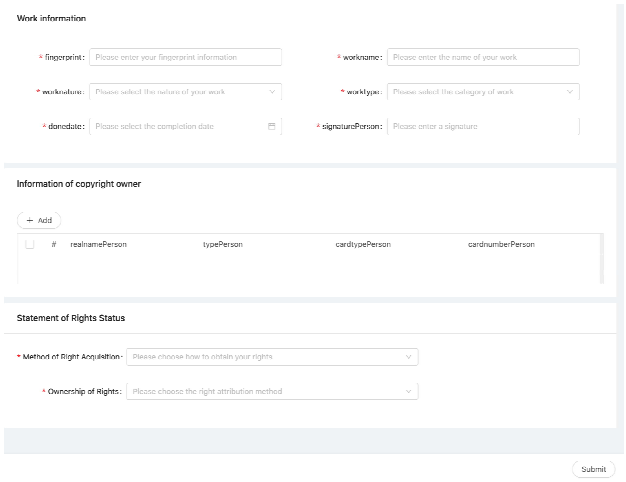

Fig.3. Copyright Registration

2) Copyright monitoring

On this page, users can timely see the suspected infringing works of the corresponding works obtained by the system after real-time monitoring. Users can click the infringement identification button to directly identify the infringement, as shown in Fig.4.

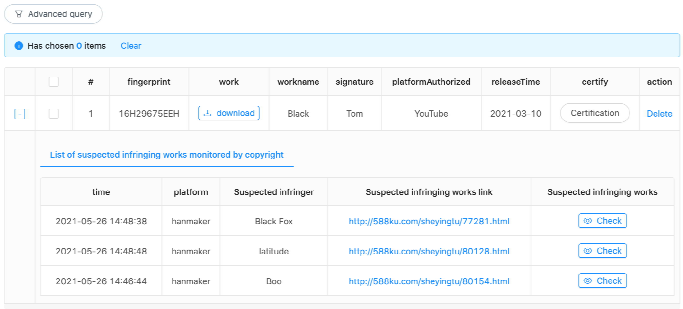

Fig.4. Copyright monitoring

IV. CONCLUSION

According to the demand of copyright market and the existing copyright protection platform, this paper proposes a new copyright registration and monitoring system based on digital watermarking and fingerprint technology. Users register and register the copyright of digital works according to their own needs and through fingerprint extraction technology, and get the unique copyright mark after audit. The original works are embedded with the copyright mark and then spread the works. When there is an infringement dispute, the effect of infringement identification can be achieved by extracting the watermark in the suspected infringing works. At the same time, the digital fingerprint technology is used to extract the fingerprint information instead of the original works to achieve copyright registration, copyright monitoring, query and other functions. The robustness of digital watermarking

and fingerprint technology shows its unique advantages in copyright protection. Combining the two mature technologies mentioned above, this system can greatly simplify the process of protecting rights and effectively protect network copyright.

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REFERENCES

[1]Hartung F, Ramme F. Digital rights management and watermarking of multimedia content for m-commerce applications[J]. IEEE Communications Magazine, 2002, 38(11):78-84.

[2]Lei-Meng. Problems and Countermeasures of blockchain technology in copyright registration[J]. Published in China, 2020(17).

[3]Verma V S, Jha R K. An Overview of Robust Digital Image Watermarking[J]. IETE Technical Review, 2015, 32(6): 479-496.

[4]Subramanya SR, Yi BK. Digital rights management[J]. Potentials, IEEE, 2006, 25(2): 31-34.

[5]Huang Y, Niu B, Guan H and Zhang S. Enhancing Image Watermarking with Adaptive Embedding Parameter and PSNR Guarantee[J]. IEEE Transactions on Multimedia, 2019, 21(10): 2447-2460.

[6]Huang Y, Guan H, Niu B and Zhang S. A Spread-Spectrum Watermarking Scheme with Adaptive Embedding Strength and PSNR Guarantee[C]. IEEE International Conference on Anti-counterfeiting, Security, and Identification (ASID), 2018:82-87.

[7]Wenwen Du, Daoshun Wang, Shundong Li, Xianghui Zhao. Histogram-based image watermarking algorithm using visual perception characteristics[C]. Proc. SPIE 11321, 2019 International Conference on Image and Video Processing, and Artificial Intelligence.

[8]Hang-Yu Fan,Zhe-Ming Lu,Yong-Liang Liu.A low-frequency construction watermarking based on histogram[J].Multimedia Tools and Applications,2020,79:5693–5717.

[9]Umair K, Muhammad M I, Muhammad A A, et al. Digital Watermarking Technique for Text Document Protection Using Data Mining Analysis[J]. IEEE Access, 2019, 7: 64955-64965.

[10]Guang Hua,Yong Xiang,Leo Yu Zhang.Informed Histogram-Based Watermarking[J]. IEEE Signal Processing Letters,2020, 27:236-240.

[11]Fan, H.-Y., et al. A Low-Frequency Construction Watermarking Based on Histogram. Multimedia Tools and Applications ,2020,79(9-10): 5693-5717.

[12]Zhou, L.-J., et al. Face Feature Extraction and Recognition via Local Binary Pattern and Two-dimensional Locality Preserving Projection. Multimedia Tools and Applications,2020 78(11): 14971-14987.