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The Application of Blockchain Technology Based on Network Communication in the Design of Library Readers' Intelligent Query System

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Abstract: With the increase of data volume and query complexity in the process of data processing, due to the use of single data retrieval and retrieval method and the lack of intelligent data retrieval methods, many problems may arise. The main reasons for the above difficulties are insufficient knowledge processing and insufficient understanding of the methods of obtaining information. Improving database query from current database to knowledge-based query is the foundation and key to solving the problem. Researchers in the library industry are gradually realizing this intelligent technology that can significantly improve service quality and improve work efficiency. This article takes a smallest cell of the bookshelf as the research object, and then expands the entire bookshelf. Taking the second-order weights as the weights and perform simulations respectively. It is found that when the number of reference beacons is 8, the average positioning error is the smallest, and the average positioning error for 100 positioning errors is 0.0332 m.

1. Introduction

With the gradual development of social civilization, knowledge and information have shown a massive increase. In the face of widely disseminated information, people's demand for knowledge is more urgent, and their demand for reading also has more personalized functions. With the development of the information society, obtaining and disseminating information has become an important part of people's work and life. Digital libraries have the characteristics of huge amount of information, easy storage, and convenient use. Therefore, searching for resources quickly and accurately has become a prominent requirement when people retrieve documents.

Regarding blockchain technology, related scientists have done a lot of research. The purpose of Sikorski J J is to explore the application of blockchain technology related to the fourth industrial revolution (Industry 4.0) and show an example in which blockchain is used to facilitate machine-to-machine (M2M) interaction and establish an M2M power market. The scenario presented in the background of the chemical industry includes two electricity producers and one electricity consumer transacting with each other through the blockchain. In addition, Sikorski J J also described and discussed the research and application prospects of blockchain technology

related to Industry 4.0. It concludes that this technology has significant research potential in terms of supporting and improving the efficiency of the revolution, and it determines the field of future research [1]. Miraz M H believes that blockchain (BC) is the technology behind the Bitcoin cryptocurrency system. It is both attractive and essential for ensuring enhanced security and (in some implementations, untraceable) privacy for various applications in many other areas, including the Internet. The Internet of Things (IoT) ecosystem is currently undergoing in-depth research in academia and industry to apply blockchain technology to various applications. Proof of Work (PoW) is a cryptographic problem that plays a vital role in ensuring the security of BC by maintaining a digital ledger of transactions considered to be incorruptible. In addition, BC uses a variable public key (PK) to record the user's identity, which provides an extra layer of privacy. Not only has BC been successfully adopted in cryptocurrency, but it has also been implemented in various non-currency systems [2]. Yeoh aims to study the major regulatory challenges affecting blockchain and innovative distributed technologies in the European Union (EU) and the United States. Yeoh relies on primary data from applicable regulations and auxiliary data in the public domain, including relevant case study insights. The smart regulatory non-interference approach adopted by the European Union and the United States to a large extent predicts the future innovative contribution of blockchain in financial services and related fields and the enhancement of financial inclusion. Yeoh's research results support the advancement of blockchain technology with minimal regulatory brakes to achieve greater value-added and efficiency improvements. In particular, it is beneficial to financial services, thereby expanding accessibility and thereby expanding financial inclusion. The research helps to draw more attention to the technology that supports virtual currencies, and it also highlights other economic potential brought about by the advancement of blockchain [3]. The concept of smart cities has become more and more popular in the past few years. It contains multiple dimensions, depending on the meaning of the word "smart", and benefits from innovative applications of new information and communication technologies that support public sharing. Relying on the existing literature, Sun J proposed a three-dimensional conceptual framework: (1) people, (2) technology, and (3) organization. He discusses a series of basic factors of urban intelligence from the perspective of sharing economy, using this triangular framework. Sun J discussed which emerging blockchain technologies may contribute to these factors, and how its elements can help smart cities develop shared services. The research discussed how blockchain-based shared services can contribute to smart cities based on a conceptual framework. Sun J hopes that it can stimulate people's interest in theory and practice to promote discussion in this field [4]. Gabisori G believes that policymakers need to re-examine some laws and rights when considering switching to blockchain technology. Privacy and copyright have been compromised in the Internet era, and blockchain technology may not be able to alleviate this problem, even if it was created with privacy in mind. The government may not have discovered the need to switch to blockchain technology to keep records. Its implementation involves switching costs and variable costs, which cannot be justified by marginal improvements in record keeping; nevertheless, policies and political push to increase transparency may prove to be the decisive factor [5]. Tezel A believes that the blockchain is a peer-to-peer, controlled and distributed database structure, which is likely to have a profound impact on current commercial transactions in the construction industry and reliable asset tracking through smart contracts and encrypted currencies. As blockchain technology gains attention in many other industries such as finance and banking, the study examined the readiness of the blockchain technology supply chain through exploratory analysis. The empirical data for the study was collected through semi-structured interviews with 17 experts. In addition to the advantages, disadvantages, opportunities and threats (SWOT) analysis, the research also shows the requirements and stages of the construction procurement structure promoted by blockchain technology [6]. Nagasubramanian G believes that the maintenance and sharing of health records is

one of the basic tasks in the healthcare system. It is necessary to design a system that uses the cloud to help ensure identity verification and provide the integrity of health records. The keyless signature infrastructure used in the proposed system to ensure the confidentiality of digital signatures also ensures all aspects of identity verification. In addition, data integrity is managed by the proposed blockchain technology. The performance of the proposed framework is evaluated by comparing the average time, size and cost of data storage and retrieval between blockchain technology and traditional data storage technology. The results show that the response time of the proposed blockchain technology system is nearly 50% shorter than that of the traditional technology. Nagasubramanian G also stated that, compared with the existing technology, the storage cost of a system with a blockchain is reduced by about 20% [7]. These methods have provided some references for our research, but due to the short time and small sample size of the relevant research, the research has not been recognized by the public. The innovation of this paper is to establish a knowledge base suitable for intelligent query, realize the required model of intelligent query, and establish a model suitable for its knowledge base on the basis of knowledge-based intelligent query technology. To deal with inaccurate data processing requirements in uncertain environments, methods such as approximate reasoning, intelligent semantic expansion query and intelligent response mechanism are used to provide query results.

2. Methods for the Design of Library Readers' Intelligent Query System

2.1 Network Communication

Network communication is the communication basis of the smart audio system. The server communicates with smart speaker devices via Ethernet to send and receive data and commands [8]. Below the application layer, the system uses the TCP/IP network protocol for transmission. TCP/IP is the most basic protocol of the Internet, and it is also the foundation of the Internet. It has undergone continuous testing and optimization in the long-term development process, and is now very mature, and the protocol transmission is very stable. In order to realize the network communication function of the system, a special communication protocol needs to be designed on the application layer to transmit commands and data between devices [9]. Figure 1 shows the network communication flow chart.

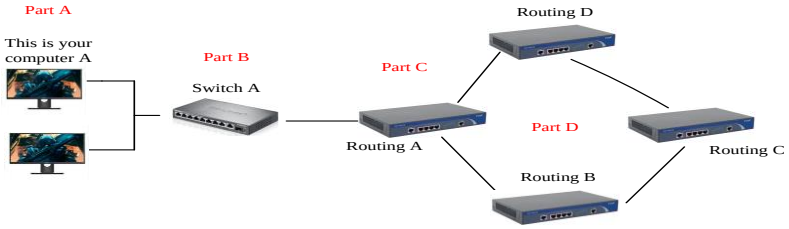

Figure 1: Network communication flow chart

The network communication technology in the computer control system used today is not a one-time research and development by the relevant researchers, but through several development, improvement and update processes. Research results are constantly updated in the hands of researchers at the Internet stage and in different eras, and only then has the network communication technology we use today. The network communication technology in the computer control system can be easily divided into two distinct types: Ethernet technology and fieldbus technology [10].

(1) The core content of Ethernet

Ethernet is one of the most widely used and most frequently used technologies in computer control, and is used as a medium together with CSMA/CD technology. In addition, because the total

cost of software and hardware required by the Ethernet technology is relatively low, most of the interconnection schemes are twisted pair or optical cables. The low price of the connection medium also reduces the cost of setting up a local area network. At present, Ethernet technology develops frequently, and the system has been perfected, which can transmit data at a high speed, increasing the sharing and efficiency of information and data resources. However, Ethernet is not perfect and reliable, and its main disadvantage is low reliability.

(2) The main content of fieldbus technology

Fieldbus technology is also a part of field-level industrial communication technology. It greatly enhances the connection between the manufacturing site and the production control technology, and also improves the work efficiency and digitization degree of the digital communication between the two. The data transmission method of fieldbus technology is based on baseband transmission, which has the main advantages of fast communication speed, strong real-time performance, and strong anti-interference ability [11]. Stream cipher is widely used in network communication because it is a simple, fast, and low-cost encryption queue. Vigenère cipher is one of the well-known stream ciphers, which encrypts messages by using a series of different Caesar ciphers based on key letters. In order to facilitate the calculation, the keys and the letters a-z in the plain text are converted to the corresponding numbers 0-25, so the ciphertext space is 26. It uses the key K to encrypt the plaintext:

$$C_i = EK(P_i) = (P_i + K_i) \bmod \{26\} \tag{1}$$

$$P_i = DK(C_i) = (C_i - K_i) \bmod \{26\} \tag{2}$$

$P = P_0 P_1 \ldots P_n$ -Plain text

$C = C_0 C_1 \ldots C_n$ -Ciphertext

By adding the number of characters, the frequency of a single letter can be reduced. The encryption and decryption process after expanding the ciphertext space becomes:

$$EK(P_1, P_2 \ldots P_m) = (P_1 + K_1, P_2 + K_2, \ldots P_m + K_m) (\bmod 92) \tag{3}$$

$$DK(C_1, C_2 \ldots C_m) = (C_1 - K_1, C_2 - K_2, \ldots C_m - K_m) (\bmod 92) \tag{4}$$

It uses LFSR to generate a new key, first generates a shorter key, and then generates a new key according to the length of the plaintext to be encrypted. The new algorithm is as follows:

$$K_i = EK(K_i) = (K_{i-n} + K_{i-n+1} + K_{i-n+2} + \ldots + K_{i-1}) \bmod \{26\} (i >= n) \tag{5}$$

$$K_i = K_i (i < n) \tag{6}$$

$$EK(P_1, P_2 \ldots P_m) = (P_1 + K_1, P_2 + K_2, \ldots P_m + K_m) (\bmod 26) \tag{7}$$

$$DK(C_1, C_2 \ldots C_m) = (C_1 - K_1, C_2 - K_2, \ldots C_m - K_m) (\bmod 26) \tag{8}$$

n -The length of the original key

P_i -Bytes in the key

K_i -Plain text bytes

C_i -Ciphertext byte

2.2 Blockchain Technology

Blockchain technology was originally applied to the design of the Bitcoin system, where the blockchain was used to record data generated by transactions. There are many definitions of blockchain, and in Wikipedia, the definition of blockchain is:

Blockchain is an ever-growing file connected using encryption methods, and blocks usually contain hash values, timestamps, and transaction data from the previous block. The blockchain is an open distributed directory that can record and verify transactions, and the timestamp and hash value are the directory page numbers. Taking the Bitcoin block as an example, a block contains the information shown in Table 1 [12].

Table 1: The structure of the Bitcoin block

Byte	Field	Content
4	Block size	Explain the size of the block
80	Block header	Record the summary information of the block
Indefinite	Block body	Record the specific content of the transaction
Rsa-prik	varchar	User ras Public key
User-priority	int	User rights

The main features of blockchain include: anonymity, decentralization, trustlessness, collective maintenance, and reliable database. Decentralization means that there are no special nodes in the blockchain network, and each node has the same rights and obligations [13]. Any node has the authority to access the data block list to read the data information in it, and each node does not affect each other, and the damage of individual nodes will not cause problems to the overall network [14]. Trustlessness refers to the fact that the blockchain is both efficient and transparent in the process of recording information, and the recording method is very safe. It is non-tamperable and difficult to forge, nodes cannot deceive each other, and mutual trust is not required. Collective maintenance means that every node in the entire blockchain can participate in maintenance. Reliable database means that the storage method of blockchain is distributed storage, and data can be replicated and shared among all network nodes, rather than being made into multiple backups. Any node can download complete data information, and a single node cannot modify the content, and only nodes that control more than 51% can affect the database [15]. According to these characteristics of blockchain, this technology can be used in all application fields that require fairness and honesty, which is the reason why blockchain technology is selected in this article. The blockchain application in this article belongs to a huge medical data operation record book, involving every user in the operation process. Figure 2 shows the hierarchical diagram of blockchain technology.

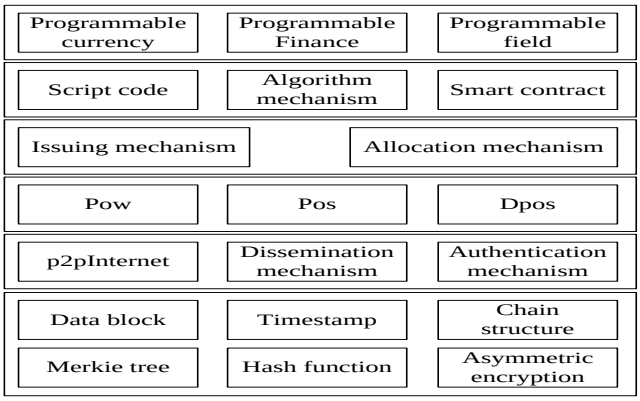

Figure 2: Blockchain technology hierarchy diagram

A big feature of blockchain technology is that in a decentralized system with decentralized decision-making power and no trust, each node can reach a consensus on the validity of the block data. The POW consensus is based on proof of work, and its core idea is to allow distributed nodes to solve a problem that can prove the workload through the competition of computing power to ensure the security of the consensus [16]. The commonly used method of proof of work is to use the SHA-256 algorithm, and first define a target value:

$$Tar = d/difficulty \tag{9}$$

$$BInfo = \left(B_H, B_N, B_K, B_T\right) \tag{10}$$

$$P = \lim_{\lambda\to\infty} \sum_{\alpha<k<\beta} \frac{\lambda^k e^{-\lambda}}{k!} \cdot \left(\frac{r}{\varpi}\right)^z, k = 0,1,2,\cdots \tag{11}$$

d -Constant

$difficult$ -Adjustable difficulty value

α, β -Set interval

It needs to find a suitable random number to satisfy:

$$Node: U_B \to U_B{}^C \tag{12}$$

The formula of Ethas algorithm is as follows:

$$RAND(h,n) \Leftarrow M/d \tag{13}$$

$$H_p = hash(P) \tag{14}$$

$$address = base58(H_p) \tag{15}$$

h -The hash of the block header

n -Nonce

The most important thing in the blockchain is the consensus algorithm, and the practical Byzantine algorithm is a consensus consensus algorithm based on message passing. The number of nodes is at least $3f+1$ node, f is the correct node, and a consensus can be reached when 1 error node is allowed. In a certain period of time, the node configuration information of the entire network is a view. In a view, all nodes must be initialized to the same state before the algorithm

starts to execute [17]. The main node selection formula is:

$$p = v \bmod (3f + 1) \tag{16}$$

$$Message = REPLY, b, v, i\sigma_i \tag{17}$$

v-Current view number

The client node (Client) is responsible for sending a message request to the primary node (Primary). The message request format is:

$$< REQUEST, o, t, c > \sigma_c \tag{18}$$

$$\forall m_0, m_1, E(Key, m_1) = E(Key, m_1) \tag{19}$$

$$IC = \sum_{i=a}^{i=z} f_i (f_i - 1) \tag{20}$$

2.3 Smart Query

In order to improve the user's use of information, computers directly analyze the content of the questionnaire instead of using knowledge, metadata and data-based data recovery methods to query and monitor certain processes, content or results [18]. It requests more applications to meet the needs of users and provide more information and data. Intelligent query should analyze the subject of the problem and provide a brief explanation, method or additional information for the problem. A reasonable answer to a data query is to obtain general, consistent or relevant results by analyzing the content of the query. There are many ways to respond emotionally to data requests, such as summarizing the results, interpreting the results or expected feedback, using relevant and up-to-date information to rewrite the question and the question result. The intelligent query process includes analyzing and investigating, interpreting the results of the investigation, summarizing, generating or summarizing data models, basic domain knowledge and semantic knowledge of data production technology.

The intelligent library query system realizes the intelligent query system of library book information. Users can express their query needs in their common language, and the system will analyze the query phrases entered by the user and extract information about books. The information system determines the query result through semantic query, and finally returns the query result to the user. The intelligent library query system realizes the intelligent query system of library book information. Users can express their query needs in their common language, and the system will analyze the query phrases entered by the user and extract information about books. The information system determines the query result through semantic query, and finally returns the query result to the user [19].

3. Experiment on the Design of Library Readers' Intelligent Query System

Readers need to perform actions such as book borrowing and returning, book query, book location search, book reservation, etc., while librarians need to take inventory, shelf management, shelf management, information management, etc. of books. It analyzes and describes the functional modules of the system according to the needs of the system. As shown in Figure 3, it is the functional module diagram of the library management system.

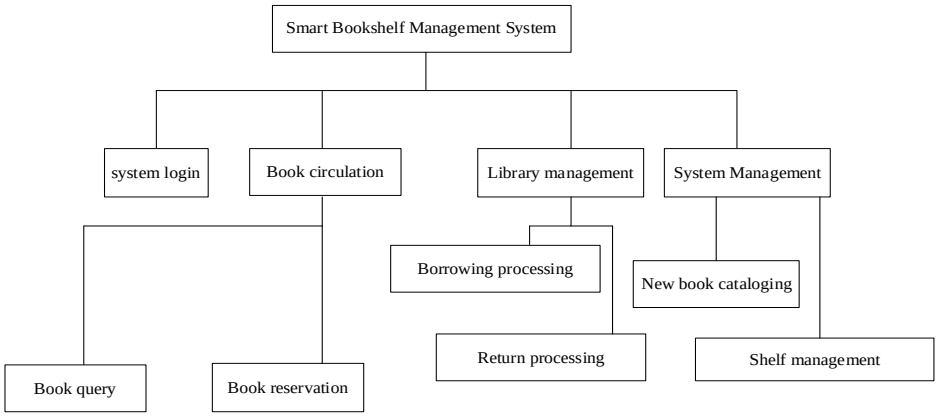

Figure 3: System function module diagram

There are four main entities involved in the library's intelligent bookshelf system: (1) Readers. It inquires, borrows, makes reservations, and returns books according to the needs of readers. (2) The smart bookshelf body. It stores books, locates the position of the books on the shelf in real time, and counts the books in the collection intelligently. If the books on the wrong shelf are found, it can promptly issue instructions to the librarian to facilitate the administrator to return to the shelf. (3) Librarian. It operates and manages readers' borrowing and returning actions, enters information for newly added books, manages information about various user types, and performs inventory and statistics collection of books. (4) Books and documents. It is the most basic circulation entity in order to facilitate the management and operation of some entities, maximize the performance of the intelligent bookshelf system and improve the performance of the system. As shown in Figure 4, it is the entity relationship diagram of the intelligent bookshelf system.

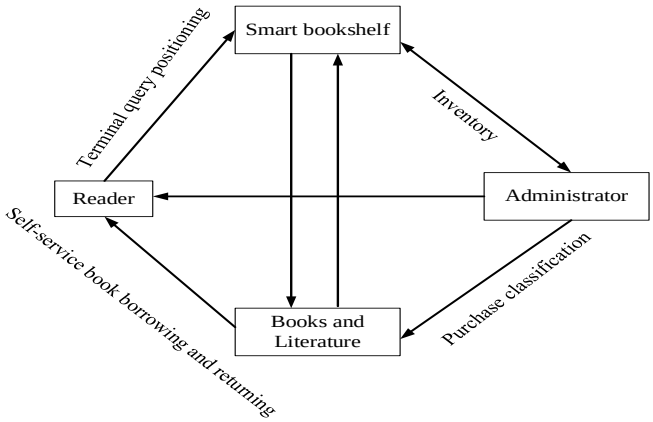

Figure 4: System entity relationship diagram

Because the position of the label to be located is finally located according to the positions of several reference labels distributed around it, the distribution method of the reference labels will significantly affect the accuracy of the algorithm. The positioning purpose of the intelligent bookshelf system is to be accurate to the smallest cell of the bookshelf, so we take a smallest cell of the bookshelf as the research object, and then expand the entire bookshelf. Let the parameter for evaluating the positioning accuracy be the average positioning error, where the actual position coordinates of the tag to be measured are (x0, y0), the estimated coordinates obtained by the positioning algorithm are (x, y), and M is the number of experimental simulations. At this time, we temporarily take the second-order weights as weights and perform simulations respectively, and the average positioning error obtained is shown in Figure 5.

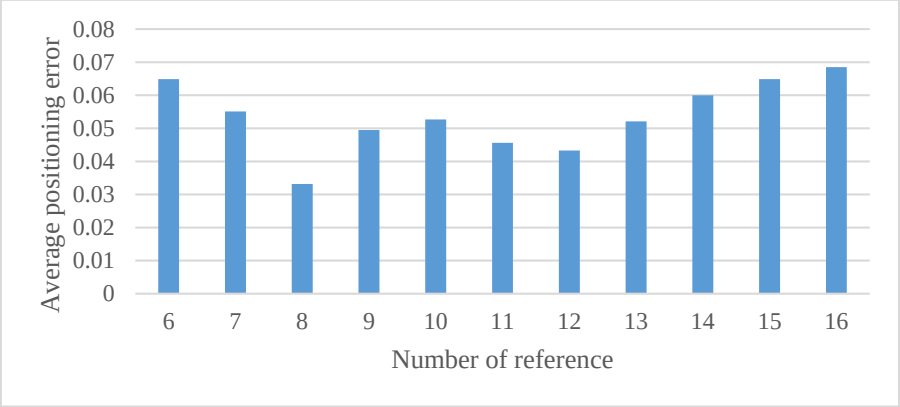

Figure 5: Average positioning error

4. Discussion

From the perspective of the openness of the blockchain, the blockchain is generally divided into public chains, consortium chains and private chains. (1) Public chain. In the public chain, the data on the blockchain is open to anyone. All nodes participating in the blockchain can send transactions and participate in the consensus process, so the data on the public chain has privacy issues. The public chain is suitable for individuals who are unfamiliar with each other to participate. The information in the blockchain is completely open and transparent, and it provides users with a trusted decentralized operation mode. (2) Consortium chain. In the consortium chain, a verification group forms an alliance to jointly determine the validity of the blocks and transactions of the blockchain. The consensus process is controlled by pre-selected nodes, and a certain number of member signatures are required to determine the validity of the new block. To a certain extent, it can solve the privacy problem of data in the public chain. The information on the blockchain in the alliance chain can be public or only visible to alliance members. (3) In a private chain, an organization fully controls the write permission of data in the blockchain, and the read permission of the data in the block can choose to open to the outside world or be restricted to any degree. The advantage of the private chain is that only a few trusted nodes are required to verify the transaction, and the block generation speed is faster. Because the verification is performed by a trusted node, there is no risk of collusion attack by the total lianzhong.

5. Conclusion

Since its development, blockchain technology has attracted attention in various fields. Although blockchain technology has gradually diversified after so many years of development, there are still many challenges and opportunities in many fields. The number of various digital documents in digital libraries is growing rapidly. In the face of huge amounts of data, how to perform intelligent queries on them has become a current research hotspot in the field of digital libraries. This article describes the related technology of the blockchain and the working principle of its implementation. Taking the second-order weights as the weights, respectively, perform simulations to obtain the average positioning error. This article starts a preliminary forecasting research, and given the limited data sources and academic level, there are unavoidable omissions in the research. The analysis of the status quo analysis stage is not thorough enough, only showing the changes of relevant indicators, lacking internal judgment analysis; the theoretical research stage, the grasp of the theory is not deep enough. Therefore, qualitative index research should be introduced in future research. In view of the diversification of current methods and the addition of artificial intelligence

algorithms, research can try to introduce other models to participate in order to improve query accuracy.

References

[1] Sikorski J J, Haughton J, Kraft M. Blockchain technology in the chemical industry: Machine-to-machine electricity market. Applied Energy, 2017, 195(JUN.1):234-246.

[2] Miraz M H, Ali M. Applications of Blockchain Technology beyond Cryptocurrency. Annals of Emerging Technologies in Computing, 2018, 2(1):1-6.

[3] Yeoh Peter. Regulatory issues in blockchain technology. Journal of Financial Regulation & Compliance, 2017, 25(2):196-208.

[4] Sun J, Yan J, Zhang K. Blockchain-based sharing services: What blockchain technology can contribute to smart cities. Financial Innovation, 2016, 2(1):1-9.

[5] Gabisori G. Policy Considerations for the Blockchain Technology Public and Private Applications. SMU science and technology law review, 2016, 19(3):327-350.

[6] Tezel A, Papadonikolaki E, Yitmen I, et al. Preparing construction supply chains for blockchain technology: An investigation of its potential and future directions. Frontiers of Engineering Management, 2020, 7(4):547-563.

[7] Nagasubramanian G, Sakthivel R K, Patan R, et al. Securing e-health records using keyless signature infrastructure blockchain technology in the cloud. Neural Computing and Applications, 2020, 32(3):639-647.

[8] Gupta B B, Chaudhary P, & Gupta S. (2020). Designing a XSS Defensive Framework for Web Servers Deployed in the Existing Smart City Infrastructure. Journal of Organizational and End User Computing (JOEUC), 32(4), 85-111. http://doi.org/10.4018/JOEUC.2020100105

[9] Shackelford Scott J. Block-by-Block: Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace. Yale Journal of Law and Technology, 2018, 19(1):7-9.

[10] Andrea G. Blockchain Technology: Living in a Decentralized Everything. Cyberpsychology Behavior & Social Networking, 2018, 21(1):65-66.

[11] Bayrakdar I S, Yasa Y, Duman S B, et al. What can Blockchain technology bring to oral and maxillofacial radiology? Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 2020, 130(2):225-226.

[12] Garcia-Teruel R M. Legal challenges and opportunities of blockchain technology in the real estate sector. Journal of Property, Planning and Environmental Law, 2020, 12(2):129-145.

[13] Weidong Gai, Yue Gu, and Jiaming Qin. Financial Automation Audit Method Based on Blockchain Technology. Computational Intelligence and Neuroscience, 2022, https://doi.org/10.1155/2022/9941585.

[14] Sokolov B, Kolosov A. Blockchain Technology as a Platform for Integrating Corporate Systems. Automatic Control and Computer Sciences, 2021, 55(3):234-242.

[15] Rawat D B. Fusion of Software Defined Networking, Edge Computing, and Blockchain Technology for Wireless Network Virtualization. IEEE Communications Magazine, 2019, 57(10):50-55.

[16] Baumung W, Fomin V. Framework for enabling order management process in a decentralized production network based on the blockchain-technology. Procedia CIRP on SciVerse ScienceDirect, 2019, 79(C):456-460.

[17] Korb T, Michel D, Riedel O , et al. Securing the Data Flow for Blockchain Technology in a Production Environment - ScienceDirect. IFAC-PapersOnLine, 2019, 52(10):125-130.

[18] Capsoni C, Fedi F, Paraboni A. A comprehensive meteorologically oriented methodology for the prediction of wave propagation parameters in telecommunication applications beyond 10 GHz. Radio Science, 2016, 22(3):387-393.

[19] Li Y. Design of Library Archives Information Management Systems Based on Artificial Intelligence and Multimedia Technology. International Journal of Information Technologies and Systems Approach, 2023, 16(3): 1-17.