Research on Social Network Advertisement Delivery Platform Based on Blockchain

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Abstract

This paper briefly introduces the advertisement delivery model based on blockchain and the storage of key point information that can reflect the whole delivery process. After that, the simulation experiment was carried out on the advertisement delivery platform in a laboratory with the local server and the virtual server provided by Ethereum. The experiment detected the advertisement delivery function and the resistance to click fraud. The results showed that the advertisement delivery platform successfully completed the advertisement delivery and left a complete record. Facing the attack of tampering with the click frequency record of advertisements, the advertisement delivery platform using blockchain still maintained accurate records.

Keywords: Blockchain, advertisement delivery, Internet, practical byzantine fault tolerance.

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1 Introduction

With the development of the Internet, social networks have gradually become one of the main channels through which people can communicate and obtain information in modern society [1]. The operation of social networks requires cost expenditure, and the size of the expenditure depends on the operation scale. For a large social network, it is difficult to be maintained solely by the interest of individuals or small groups. Profits must be obtained in the operation process, and advertisement delivery is one of the main means of social network profit [2]. For advertisement delivery campaigns, the presence of the Internet has significantly enhanced efficiency in ad placements. However, it has also led to excessive advertisements, creating difficulties for users engaged in advertisement placements and inadequate transparency regarding advertisement placement data [3]. This easily gives rise to click fraud, which adversely affects advertisers and contributes to a scenario where inferior advertisements displace superior ones, thereby impeding the growth of the advertising market. As a distributed ledger technology, blockchain technology also provides traceability, transparency, and trust mechanisms for advertisement delivery with its characteristics of decentralization, traceability, and transparency. Ullah et al. [4] proposed a new proposal of a blockchain-based advertisement delivery platform. The privacy-preserving user analysis system provided on this platform could realize various transactions of advertising operations in a blockchain-based network. Liu et al. [5] combined blockchain with advertising attribution, proposed an architecture to improve the degree and amount of privacy protection, and verified its effectiveness from aspects of communication cost, attribution accuracy, and time cost. Yu et al. [6] designed a highly efficient algorithm for safeguarding the privacy of social network information. It employed the blockchain to store the user's public key and encrypted the plaintext by the hybrid hash encryption algorithm after binding. They found after simulations that the algorithm could effectively resist different types of attacks. Zhong et al. [7] proposed a fast encryption method for social network privacy data based on blockchain. They found that this method effectively improved encryption efficiency and security, with a maximum encryption security coefficient of 0.98. Mo et al. [8] presented a framework for healthcare network community data management based on consortium blockchain and federated learning, achieving secure data sharing between medical institutions and research organizations. Chen et al. [9] designed a blockchain-based functional infrastructure framework for the collaborative governance model for online public opinion. This paper

briefly introduces the advertisement delivery model based on blockchain and the storage of key point information that can reflect the whole process of advertisement delivery. After that, the simulation experiment was carried out on the advertisement delivery platform in a laboratory with the local server and the virtual server provided by Ethereum. The contribution of this article lies in utilizing the advantages of blockchain to ensure the authenticity and traceability of various information in the advertisement delivery process, providing an effective reference for improving the security of advertisement delivery.

2 Blockchain-Based Advertisement Delivery

2.1 Blockchain-Based Advertisement Delivery Model

Blockchain is a data structure in the form of a chain composed of blocks that store information, and blocks are connected according to their time order [7], thus forming a distributed and decentralized data storage system. Blockchain technology originated from the underlying technology of Bitcoin. As a self-referent data structure, each data record will be connected from behind to forward in chronological order, which has the characteristics of openness and transparency, non-tampering, and convenient traceability [8]. In the system composed of blockchain, each server that accesses the system is a node. To modify the information stored in the blockchain, consent is required from more than half of the nodes, and these nodes are often controlled by different individuals. Therefore, it is extremely difficult to modify the data of the blockchain by illegal ways, ensuring the authenticity of stored information [9].

As mentioned above, a major problem of advertisement delivery in social networks is that it is easy to lead to click fraud due to opaque data. This paper combines advertisement delivery with blockchain and uses the characteristics of blockchain to make advertisement delivery traceable and transparent.

The basic structure of the advertisement delivery platform model combined with blockchain is shown in Figure 1. The physical level of the platform is composed of multiple servers, one of which acts as a certificate center [10] for identity authentication of different client users, and the remaining servers are used as nodes in the blockchain. The advertisement delivery platform composed of blockchain nodes can provide exchange, advertising, reward, and evaluation services for clients such as advertisers, advertising producers, media owners, and individual communicators.

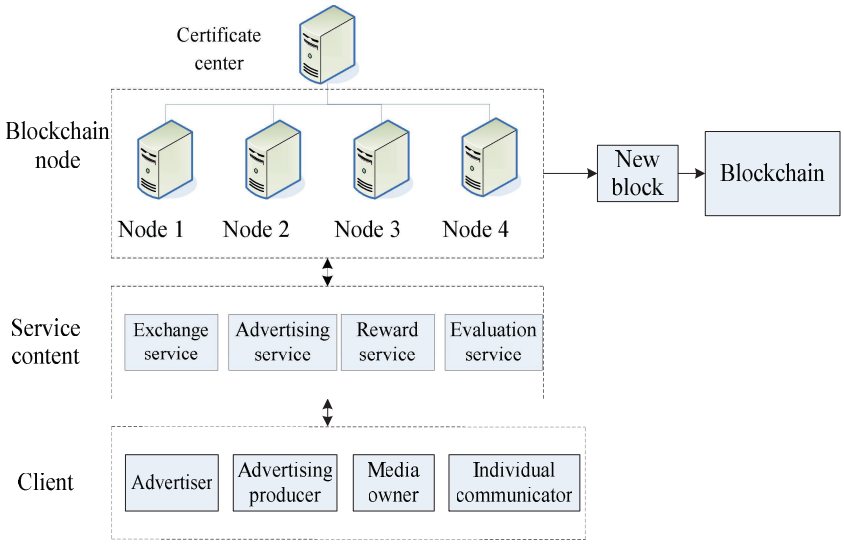

Figure 1 The basic structure of the advertisement delivery platform model.

Figure 2 Basic process of advertisement delivery.

In the advertisement delivery campaign, advertisers will initiate the request for advertising through the exchange service [11]. After receiving the request through the advertising service, the advertisement producer will make the advertisement and communicate with the advertiser through the exchange service. The media owner uses its communication channels to publish the advertisements produced by the advertising producer and gets the agreed remuneration through the reward service. Individual communicators evaluate the published advertisements through the evaluation service and voluntarily disseminate the advertisements for remuneration [12].

2.2 Information Storage in the Process of Advertisement Delivery Based on Blockchain

The basic process of advertisement delivery is shown in Figure 2. The overall process of advertisement delivery can be divided into three stages. The first stage is the advertisement transaction stage. In this stage, the advertiser will

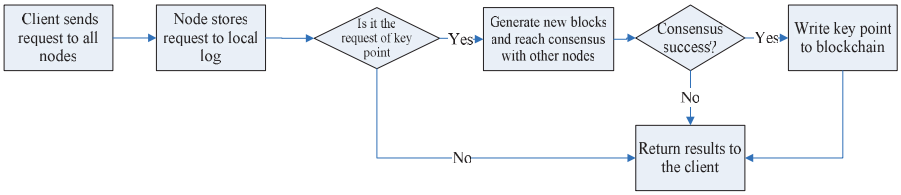

Figure 3 The storage process of key point information in each stage of the advertisement delivery process.

issue an advertisement request [13] in the platform and make a bidding to the advertising producer group in the platform. After the bidding is completed, the advertiser will conduct more in-depth negotiations with the winning bidder, sign a contract after reaching an agreement, and pay the advance payment. The key point information in this stage will be stored in the blockchain. The second stage is the advertisement service stage. The advertising producer produces the advertisement according to the contract and gets the balance payment according to the contract after the media platform reviews and the advertiser accepts it. Media owners use their own media channels to publish advertisements [14]. At the same time, after receiving the service feedback from the platform, the advertiser will publish a personal promotion task. After the individual communicator completes the task and passes the advertiser's review, the smart contract will automatically issue the bonus. The key point information in this stage will also be stored in the blockchain. In the final advertisement feedback stage, the platform collects the advertising effect according to the settings of the smart contract, verifies the authenticity, and stores it in the blockchain. According to the settings of the smart contract, the platform automatically pays the remuneration to the advertisement producer, media owner, and individual communicator.

In the process of advertisement delivery, there are interactions among advertisers, advertising producers, media owners, and individual communicators in the platform, and these interactions can be used to prove the effectiveness of transactions. Although these interactions can also be stored in the blockchain, it will greatly take up the storage space of the node. After all, a single advertisement delivery will produce multiple interaction data, and there won't be just one advertisement delivery on the platform. Therefore, this article chooses to store only the key point request information in each stage of the advertising process. Key point requests include contract confirmation requests, acceptance requests, and transaction requests. These requests represent the end of one stage and the start of the next stage and

can explain the entire delivery process. The storage process of key point information for each stage is shown in Figure 3.

(1) The client will send various requests to all nodes within the blockchain.
(2) After receiving the request, all nodes will execute it and store it in the local log.
(3) The master node in the blockchain determines whether the request is a key point request through the smart contract. If not, it returns the request processing result to the client. If it is, it will enter the next step.
(4) The master node packs the key point information into a new block and makes consensus with other nodes. If the consensus fails, the new block is not stored in the blockchain, and the result is returned to the client. If the consensus is successful, the new block is written into the blockchain, and the result is returned to the client.

The consensus algorithm used in the above process is the practical byzantine fault tolerance (PBFT) algorithm [15], which is suitable for situations with a limited number of nodes, such as the advertisement delivery platform. When using the PBFT algorithm, one master node will be selected from all nodes, and the rest will be treated as slave nodes. The election formula of the master node is:

$$p = v \bmod |n|, \tag{1}$$

where p is the master node number, v is the view number, and $|n|$ is the total number of nodes in the view. At the same time, in order to select a more stable master node and encourage nodes to compete for the master node, the incentive value is introduced in the election of the master node. After the master node is selected using Equation (1), the incentive value of the node needs to be confirmed. When the incentive value exceeds the preset threshold, it becomes the main node; otherwise, another node is selected to repeat the operation. The calculation formula of incentive value is:

$$\begin{cases} \theta_1 = \alpha \cdot \theta \\ \theta_{GC} = \begin{cases} \dfrac{\theta}{n} - c & \text{nodes cooperate} \\ \dfrac{\theta_1}{n} & \text{nodes not cooperate} \end{cases} \end{cases}, \tag{2}$$

where θ refers to the service fee paid by the client to the blockchain network, α is the proportion coefficient of the service fee used to lure the node with the profit, θ_1 is the service fee used to lure the node, n is the number of nodes

in the blockchain, c is the cost each node needs to pay to participate in the cooperation, and θ_{GC} is the incentive value (net benefit) that each node can obtain after the consensus is successful, which varies according to whether it cooperates in the consensus process.

After the master node is elected, the new block is broadcast to the slave node, and the slave node verifies the new block according to the local log and sends the verification result back to the client. When the client receives the reply that more than two-thirds of the nodes pass the verification, the new block consensus is successful.

3 Case Study

3.1 Experimental Environment

The blockchain-based advertisement delivery platform model was tested on the laboratory server, and the virtual machine of Ethereum provided the required blockchain network. The relevant parameters of the server in the laboratory were quad-core i7CPU, 16 G memory, and 1,024 G hard disk. For the virtual machine provided by Ethereum, the parameters were uniformly set to a single-core i5CPU, 2.5 GHz working frequency, and 4G memory in order to facilitate simulation. The number of nodes provided by the virtual machine was 10.

3.2 Testing Content

(1) Advertisement delivery function test

The server in the laboratory was used as the client of the advertisement delivery platform, and four types of clients were set up: advertisers, advertisement producers, media owners, and individual communicators. After that, the advertisement delivery function of the platform was tested by simulating the entire process of the advertiser placing advertisements within the platform.

Step 1: The advertiser logged into the platform with their account and password and issued the advertising bidding task named “number 1” on the platform.

Step 2: After the producer logged into the platform through the account and password, it received the task issued by the advertiser. Since the simulation experiment was carried out in the laboratory, the bidding competition and the negotiation process after winning the bid were omitted. It is assumed that both parties have already reached an agreement and signed a contract.

Step 3: The producer produced the advertisement in accordance with the contract and submitted it to the advertiser for review. Also because of the simulation experiment, the process of mutual communication was omitted, and the advertisement was regarded as accepted.

Step 4: After the media owner logged into the platform through the account and password, it called the advertisements provided by the platform and provided the platform with information such as the website of the media used to publish the advertisement.

Step 5: The robot was used to click the advertisement issued by the media owner, and at the same time, the platform detected the click status of the advertisement through the website provided by the media owner.

Step 6: The advertiser published the promotion task to the individual communicator through the platform, the individual communicator submitted the credential after completing the task to the platform, and the advertiser distributed the reward according to the credentials shown by the platform. Since it was a simulation experiment, these communicators were assumed to have passed the review.

(2) Click fraud resistance of the platform

The same steps used in the advertisement function test were followed. The robot was also used to click on the published advertisement at a frequency of 20 times/min. The attack was launched 10 minutes after the start of the experiment by increasing the click frequency to 40 times/min. The attack lasted 10 minutes, and then the same attack was carried out again 10 minutes later, also lasting 10 minutes. In the above process, the advertiser inquired about the click volume of the advertisement from the platform. In addition, in order to make a comparison, the same click fraud resistance test was also carried out on a platform that did not adopt blockchain.

In the construction of the advertisement delivery platform without blockchain, the servers in the laboratory were used as the four types of users in the process of advertisement delivery, and a main server was used as the main body of the platform. The servers acting as the four types of users were independent of each other but were connected to the main server. The operations of the four types of users, such as publishing tasks, uploading data, and querying information, were carried out on the main server. In the click fraud resistance test, the main server was attacked, and the click volume of advertisements was modified.

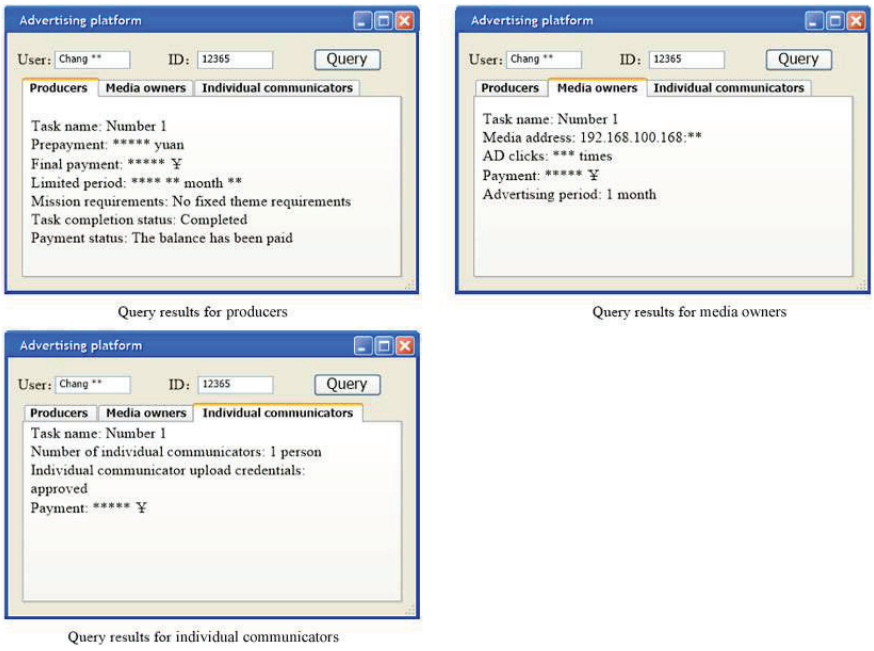

Figure 4 Query results of advertisers in the process of advertisement delivery function test.

3.3 Test Results

In the process of advertisement delivery function test, the advertiser client's query results in the platform are presented in Figure 4. When querying, the advertiser input the user name and ID number. After clicking the "query" button, there were three options: with the advertisement producer, the media owner, and the individual spreader. The "with the advertisement producer" option was the query result for the advertisement producer, which contained the task name, advance payment, balance payment, deadline, task requirements, task completion status, and payment status released by the advertiser. The "with the media owner" option was the query result for the media owner, including the task name, the website provided by the media owner, the statistics of the number of clicks on the advertisement, the payment, and the advertisement release period; The "with individual communicators" option was the query result for individual communicators, which contained the task name, the number of individual communicators, the upload credentials of individual communicators, and the payment.

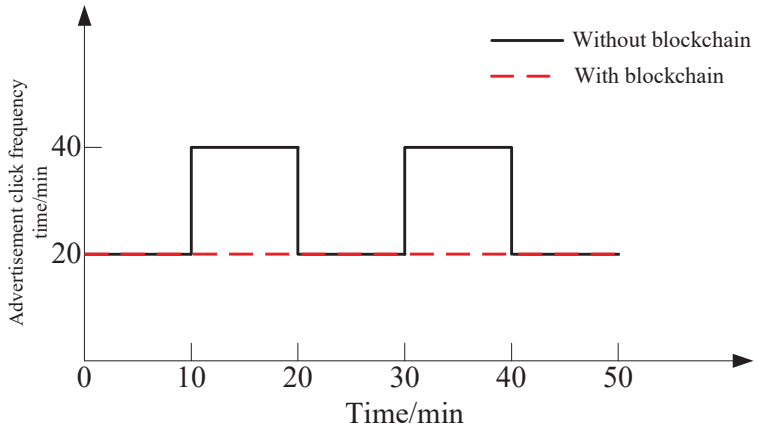

Figure 5 The change in advertisement click frequency of the advertisement platform with and without blockchain before and after the attack.

An attack was launched on the platform to tamper with the volume of clicks on the advertisement links provided by the media owner. Figure 5 shows the change in the click frequency of advertisements queried by the platform with and without blockchain before and after the attack. It can be seen that before the attack, the click frequency of the advertisements queried by the two advertising platforms was the click frequency set for the bot, i.e., 20 times/min. After the attack, the actual click frequency received by the two platforms was still 20 times/min, because the attack only targeted the click frequency recorded by the platform and did not change the click frequency of the bots. However, in the query results, the non-blockchain platform had a click frequency of 40 times/min, and the advertisement platform without blockchain still had a click frequency of 20 times/min. It can be seen that the advertisement platform using blockchain was able to show the real advertisement click frequency even if it was attacked by tampering with the click frequency.

4 Discussion

Social networks have become a part of daily life in the development of the Internet. As an important means of commercial marketing, advertisement plays a crucial role in social networks. However, traditional social network advertisement delivery platforms face many challenges, such as data silos, traffic fraud, and low delivery efficiency. The emergence of blockchain

technology provides a way to solve these problems. With its decentralized and traceable characteristics, blockchain can accurately record the information of advertisement delivery on social network advertisement delivery platforms. The article first introduces a blockchain-based advertisement delivery model, which utilizes blockchain to store key information during the advertisement delivery process. Then, simulation experiments were conducted in the laboratory using local servers and virtual servers provided by Ethereum. The advertisement delivery model built in this article can effectively record key information generated during its operation through blockchain. This model can effectively resist attacks and ensure that recorded key information is not tampered with when facing attacks such as tampering with click rates.

The reasons are analyzed. The key information generated when advertising is delivered using the model combined with blockchain will be stored in various blockchain nodes in chronological order, thus forming a blockchain. When third-party attackers attempt to tamper with the key information stored on local servers or other nodes, they must first breach the server's firewall or exploit vulnerabilities to manipulate the stored key points. Additionally, even if they successfully alter a single server node's key points, it must be verified through consensus algorithms when users query for this information. When the PBFT consensus algorithm is adopted, at least 2/3 of all nodes in the blockchain network need to be manipulated for altered information to pass verification – an almost impossible task within a short period.

5 Conclusion

This paper briefly introduces the advertisement model based on blockchain and the storage of key point information that can reflect the whole process of advertisement delivery. After that, the simulation experiment was carried out in a laboratory with the local server and the virtual server provided by Ethereum. In the experiment, the advertisement delivery function of the platform and the resistance of the platform to click fraud with or without blockchain were tested. The results are as follows. (1) The blockchain-based advertisement delivery model successfully completed the whole process of advertisement delivery, and advertisers queried the relevant information in the platform. (2) In the face of the attack of tampering with the click frequency of advertisements, the click frequency records of the platform that did not use blockchain were tampered with, while the click frequency record of the platform that used blockchain was not affected.

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