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Design of Miniature Spectrometer Based on Blockchain Technology

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***Abstract*—The data measured by traditional miniature spectrometers can easily be tampered with, and even if it is provided to others, the authenticity of the data cannot be ensured, and the data value is low. Blockchain network gives each registered miniature spectrometer a unique identity. It guarantees the authenticity of the data, can be fully utilized, and increases the value of the data.**

Keywords—miniature spectrometer, Blockchain, data analysis

I. INTRODUCTION

The miniature spectrometer is a small-sized, low-power, easy-to-use device that provides fast on-site spectral information. However, the data measured by the traditional miniature spectrometer is discarded when it is used up. Even if the data is stored, it can only be used by itself, because it cannot be self-certified or prove whether it has been modified.

Blockchain just solves this problem. Blockchain technology is a distributed ledger technology derived from electronic cash. It is a new application mode of computer technology such as distributed data storage, peer-to-peer, consensus mechanism, and encryption algorithm. Using blockchain technology can largely prevent data from being tampered and improve data credibility. The blockchain system gives each miniature spectrometer a unique identification number and a unique pair of keys [1].

This paper proposes a design of a miniature spectrometer based on blockchain technology. Spectral data is immediately signed after the spectral data is measured using a miniature spectrometer. The miniature spectrometer uploads the data to the blockchain and records them with the public key address to indicate which miniature spectrometer the data belongs to.

II. COMBINATION OF MINIATURE SPECTROMETER AND BLOCKCHAIN

A. Miniature Spectrometer and Consortium Blockchains

There are three types of blockchain networks, public blockchains, private blockchains and consortium blockchains. The consortium blockchain is the most suitable type to combine with the miniature spectrometer. Different nodes for storage of spectral data jointly build a consortium blockchain that requires authorization to join and communicate through peer-to-peer networks. It can largely prevent data from being tampered with and provide rights management, without taking up lots of resources and low efficiency [2].

B. Combination Scheme

The consortium blockchain registers every miniature spectrometer and records the machine code of its microcontroller. The machine code is unique. The miniature spectrometer is connected to the smart phone via Bluetooth and registered on the consortium blockchain network when it is used for the first time. It generates a pair of public and private keys by using the elliptic curve encryption algorithm and then writes them into the flash memory for storage. The miniature spectrometer sends the machine code, the public key and their hash values to the consortium blockchain network via the smart phone. If there is a record of that machine code, the public key is recorded, and the hash value is recorded as a storage address of the miniature spectrometer data. The storage address corresponds to the public key.

Fig. 1 shows how the miniature spectrometer uploads data. The miniature spectrometer obtains a timestamp through the networking from the smart phone. Then the data and the timestamp are hashed and get the hash. The hash is signed by the private key stored in the flash memory. Finally, the miniature spectrometer sends the data, timestamp, the hash, digital signature, and the storage address to the consortium blockchain network for consensus and recording.

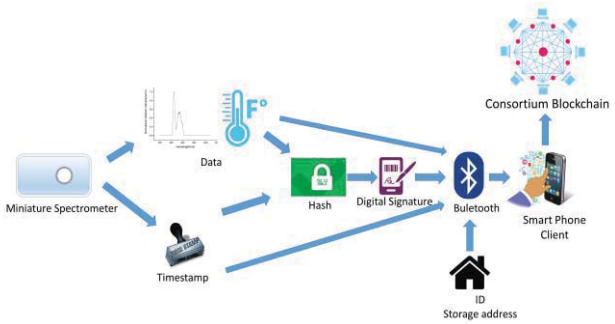

Fig. 1. Combination of miniature spectrometer and consortium blockchains

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There is no device other than the miniature spectrometer itself that stores the private key. Therefore, no node can change the data without being discovered. Customers or other organizations can obtain data through the application. The authenticity of the data guarantees the feasibility of reuse and increases the value of the data.

III. Results and Discussion

Fig. 2 shows the data output of the miniature spectrometer. The miniature spectrometer outputs data in JSON(JavaScript Object Notation) format. "Object" represents the measured item of the miniature spectrometer. "Spectral data" represents the spectral data measured by the miniature spectrometer. "T&M" represents temperature and humidity data. "Timestamp" represents the timestamp when the data was measured. "Signature" represents the signature of the hash value of the data.

The data measured by the miniature spectrometer is transmitted to the smart phone via Bluetooth for spectral analysis and the results are obtained. If the user allows uploading data, the phone sends the data to the consortium blockchain. The consortium blockchain uses the public key to verify "Signature" and obtains a plaintext. The "Spectral data", "T&M" and "Timestamp" are hashed, and the obtained hash value is compared with the plaintext. If they are the same, a consortium blockchain network node records the data to the storage address while the other nodes just record the "Signature" to the storage address. When customers or other organizations apply for these spectral data, the consortium blockchain finds the storage address of the data and compares the "Signature" with the "Signature" stored by other nodes. If they are the same, the "Signature" is verified by the public key, and the obtained plaintext is compared with the hash value of the data. If they are the same, the data is true and can be provided to the customers or other organizations.

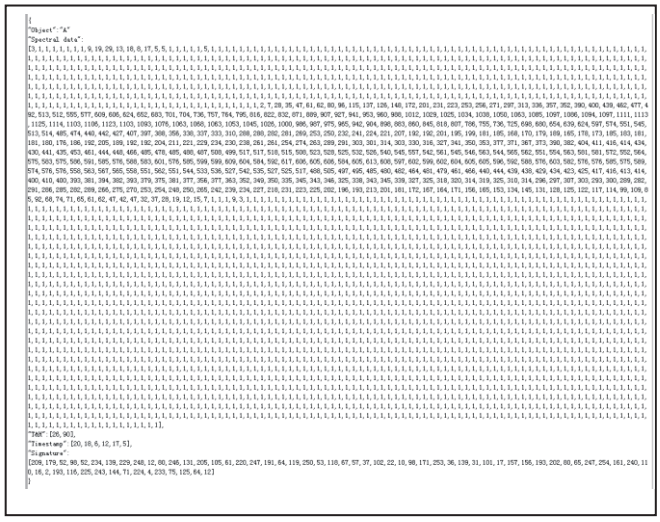

Fig. 2. Data uploaded by the miniature spectrometer

IV. Conclusion

Combined with blockchain technology, spectral data is given an identity and more difficult to be tampered with, so they can be reused by other users and their value is increased. Compared with the public blockchain, the consortium blockchain adds authority management. It reduces the risk of being attacked by outsiders and reduces the operation and maintenance costs.

With the development of the Internet of Things and big data technology, spectral data will certainly be more widely used. Blockchain technology guarantees the authenticity of spectral data and is the basis for data to be utilized. Blockchain technology can also be combined with other sensing technologies and Internet of Things technology. The blockchain technology solves the trust problem of data transmission and storage of the Internet of Things by virtue of its peer-to-peer, openness, transparency, secure communication, difficulty to be tampered with and multi-party consensus.

Acknowledgment

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