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Abstract. The charity organizations in China lack transparency and the supervision to them is difficult to achieve, which has a negative impact on the willingness of the people to donate. Blockchain as a underlying technology of Bitcoin system provides a new solution for the charity system in terms of technology. This paper proposed a charity system based on blockchain technology and expounds the design pattern, architecture and operational process of the platform. Some core functions of the charity platform have been realized and verified on Ethereum in this article. We hope to increase the transparency of charities to enhance the public's trust in charities and promote the development of philanthropy by blockchain-based charity system.

1. Introduction

With the development of Internet technology, there are more and more information access channels for people, philanthropy has become more open and transparent.Many problems in the process of philanthropy has been exposed."Guo Meimei Incident" and "Hu Manli Incident" were spread widely on the Internet. According to media reports, some people sold relief supplies and tents for money in the " 5.12 Wenchuan Earthquake", which showed the confusing daily management of charitable funds and materials. These caused a decline in willingness to donate and a reduction in donations between 2009 and 2012 [1]. At the same time, online crowdfunding has become a new way for the public to participate in public welfare undertakings. The crowdfunding platform has established a database for the project, a proper monitoring of the project is also an important part of the risk automatic control mechanism of the public welfare crowdfunding platform [2]. Improving the transparency of philanthropic information is an important way to improve credibility for traditional donation and internet crowdfunding. Using Internet technology, a traceability system can be established to increase the transparency of charities technically [3]. For this purpose, this paper proposed a new model of charity system based on blockchain technology.

2. Literature Review

2.1. Blockchain Technology

As the basic technology of Bitcoin [4], blockchain is decentralized, non-tamperable, anonymous and traceable, that has great potential in transforming traditional industries [5]. A blockchain is a distributed database system involving multiple independent nodes. The entire database is maintained by nodes throughout the network. The blockchain can record all transaction information, whose process is efficient and transparent and the data is highly secure [6].

A blockchain is a series of blocks, each block consists of a block header and a block body. The block header contains metadata and the transaction data is encapsulated in the block body. The hash value (PrevBlockHash), timestamp (Timestamp), random number (Nonce), and Merkle Root of the previous block is contained in the header [7]. The block body stores multiple transactions from the previous block in the form of a Merkle Tree. The leaf node of the Merkle Tree stores the hash value of the transaction information, and the non-leaf node stores the combined hash value of all the leaf nodes below it. The blockchain system is built on a P2P network, does not require a centralized organization as a credit endorsement. After the transaction, every node competes for accounting rights through a consensus mechanism. The node that wins the competition will package all transactions that occurred within a certain period of time. The block will be broadcast to the whole network and all nodes will verify the block. After most nodes have authenticated successfully, the block will be added to the chain. From the beginning of the transaction to the end, each transaction is open and transparent, and there is no way to deceive each other between nodes. Asymmetric encryption enables anonymous transactions, and the chain structure ensures transaction traceability. The data structure of the blockchain is shown in Figure 1.
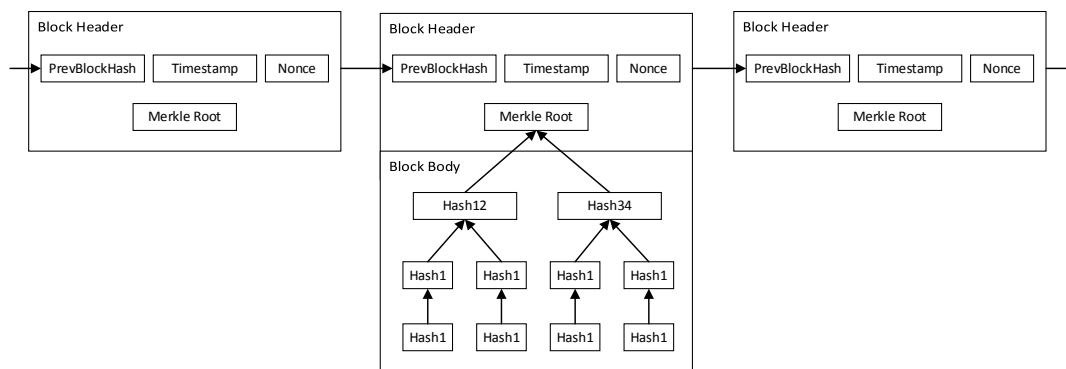

Figure 1. Blockchain structure.

2.2. Research of Charity Platform

In order to increase credibility of charity organizations, Liu Na [8] has studied the supervision system of charity in China and suggested to supervise charity in law, administration, industry and society. Bi Ruixiang [9] concluded that the financial information disclosure of Chinese charity organizations is relatively low. Yu YuXi [10] suggested to restrict the power of charity organizations by improving the liability system and government supervision. Wang Jian [11] and Xu Yuchao [12] designed the charity donation information management system with ASP.NET technology to complete the management and publicity of charity donations. Yang Qilin [13] realized the core business system

of charity fund management through LAMP architecture, which unified the management of charity foundation data and the release of charity information. Jia Hongwei and Deng Xiuquan [14] proposed the use of blockchain technology to solve problems in social emergency assistance. Wang Jia and Chen Haifeng [15] also analyzed the application of blockchain technology in China's philanthropy and affirmed the advantages of blockchain technology in philanthropy. Li Qi,Li Wei [16] and others gave the application model of the charity platform, and realized the charity application platform based on Bubi blockchain. At the same time, Rizal Mohd Nor [17] proposed to use blockchain technology to manage the assistance funds in disaster area and establish the entire platform on Ethereum. Danushka Jayasinghe et al. [18] built a Bitcoin charity platform based on blockchain to realize online and offline bitcoin transactions respectively, which provides a safe and convenient way to donate to difficult areas without Internet by GSM network. Based on these studies, we proposed a new model of charity system with blockchain technology.

3. The Design of Charity System Based on Blockchain

3.1. Charity System Mode
The charity system mode proposed is shown in Figure 2. There are four roles: donors, beneficiaries, charity organizations and cooperative stores [19]. The charity organizations get
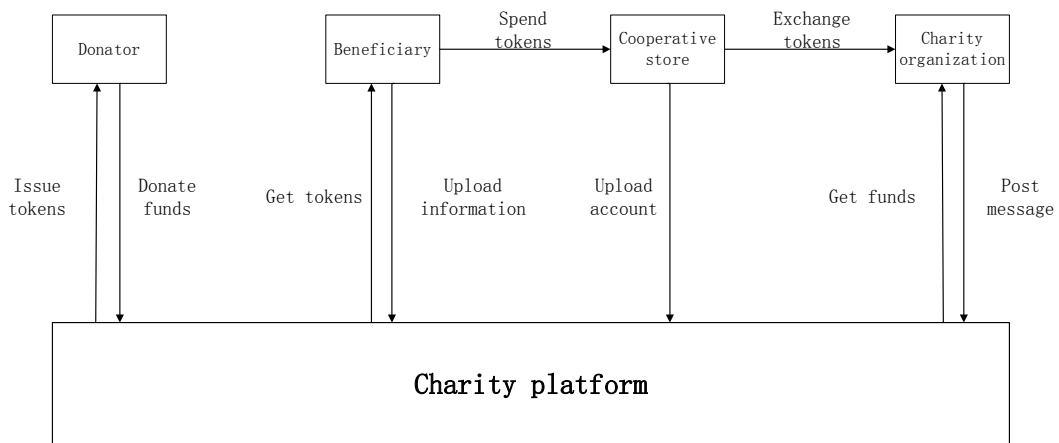

Figure 2. Proposed mode.

the information of seek help and create charity projects through the platform. Donors learn about charity projects on the platform, then donate to beneficiaries or the charity organizations. Beneficiaries upload their information to the platform for help, they can get and spend tokens in cooperative stores. The transactions occurred in the stores will be uploaded to the charity platform. The cooperative stores supply services or goods to the beneficiaries to obtain tokens. The tokens can be exchanged for real money by charity organizations.The flow of funds has been fully recorded on the blockchain, which allows transactions to be tracked and funds prevented from being abused.

3.2. Proposed Platform Architecture

We divide the platform into four layers, as shown in Figure 3. The application service layer encapsulates a variety of applications, including account registration, post charity information, donate funds, and inquire message, provides users with the functions of the platform directly. The smart contract layer includes various scripts and smart contracts. It encapsulates query methods, transactions process and other details. The blockchain service layer implements the functions of distributed accounting of the charity platform, including package block, get consensus on transaction, broadcast block, and synchronize data to a local database. The storage layer is used to store data, including blockchain storage and local storage.
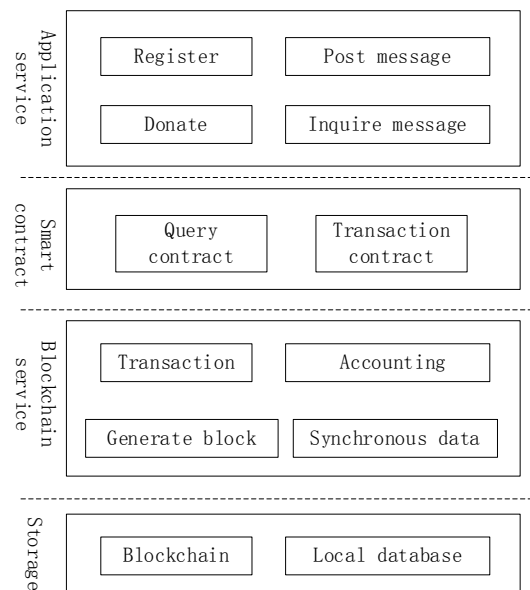

Figure 3. Proposed architecture.

3.3. Platform Usage Process

Figure 4 shows partial operation of the charity platform, as follows:

1.Donor

After successful login, the donor browses the charity projects and select one project to be donated. The system will check the balance of donor account. If the balance is insufficient, the user will be reminded to deposit.Donation can be completed only the balance is sufficient.

2.People in need

The people who need help should fill in the rescue information which will be uploaded to the charity organization for review, and the approved projects will be posted on the charity platform. The beneficiary can check the account balance to know the project status, and then use the tokens in cooperative shops to obtain services or products.

3.Cooperative shops

The shops provides the corresponding services or goods such as medicines or books to the beneficiaries to obtain tokens.they can exchange tokens for real money by charity organizations.

4.Charity organization

The organization can get donation from the platform to help other people and apply money to the cooperative shops for token exchanging.
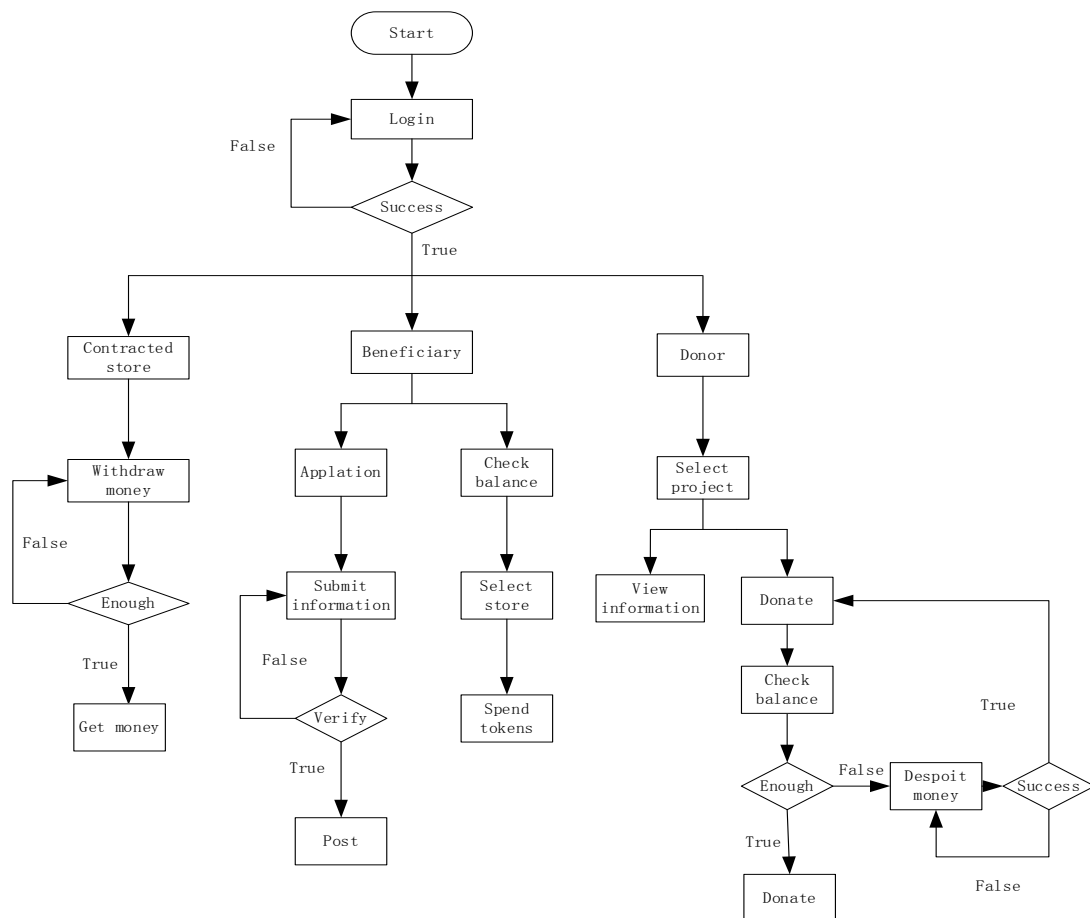
Figure 4. Proposed process.

4. The Development of System

We have developed a charity fundraiser Dapp which is based on Ethereum to verify our system and demonstrate some core functions of the charity platform. MetaMask Browser Extension was used to test our system and Solidity was used to built smart contracts. The functions of creating project, donating, approving funds and transferring funds have been verified by us with the Dapp.

4.1. Dapp Model

The timing diagram of the Dapp is shown in Figure 5. Following functions have been met:

1. Beneficiary initiates a charity project in the DApp.

2. Beneficiary requests funds from the charity project initiated by himself.

3. Donor donates to the charity projects which he chooses.

4. Donor is able to vote on the funding request for the charity project already participated.

5. After the request for funds is approved, the funds are automatically transferred to the beneficiary's account.
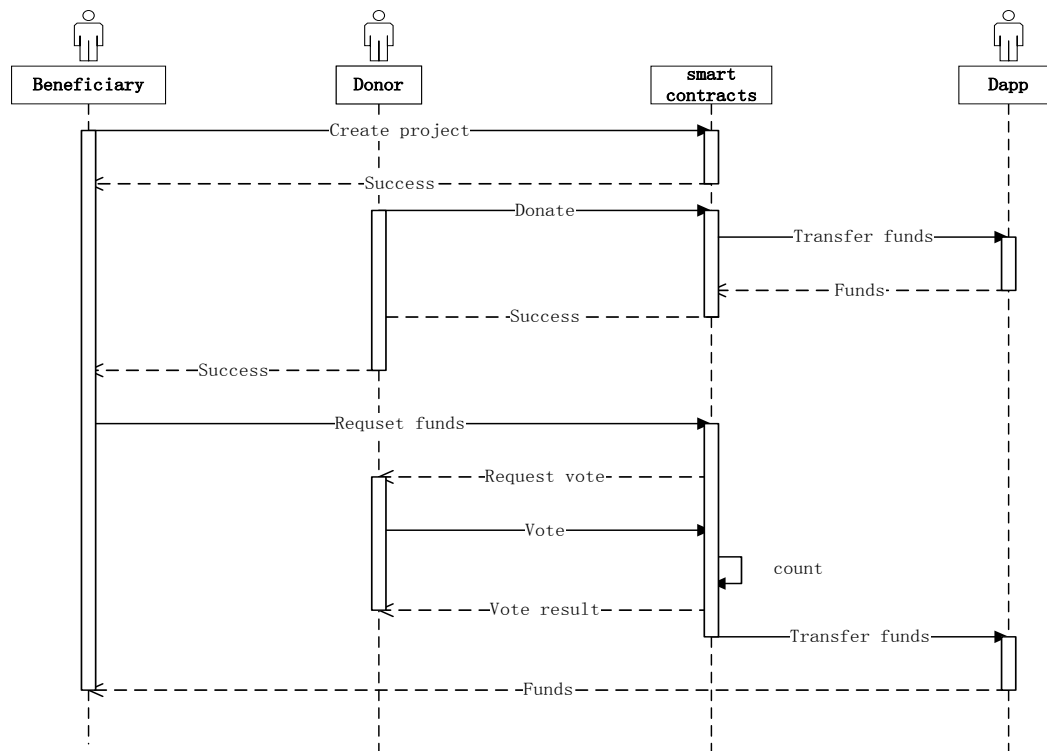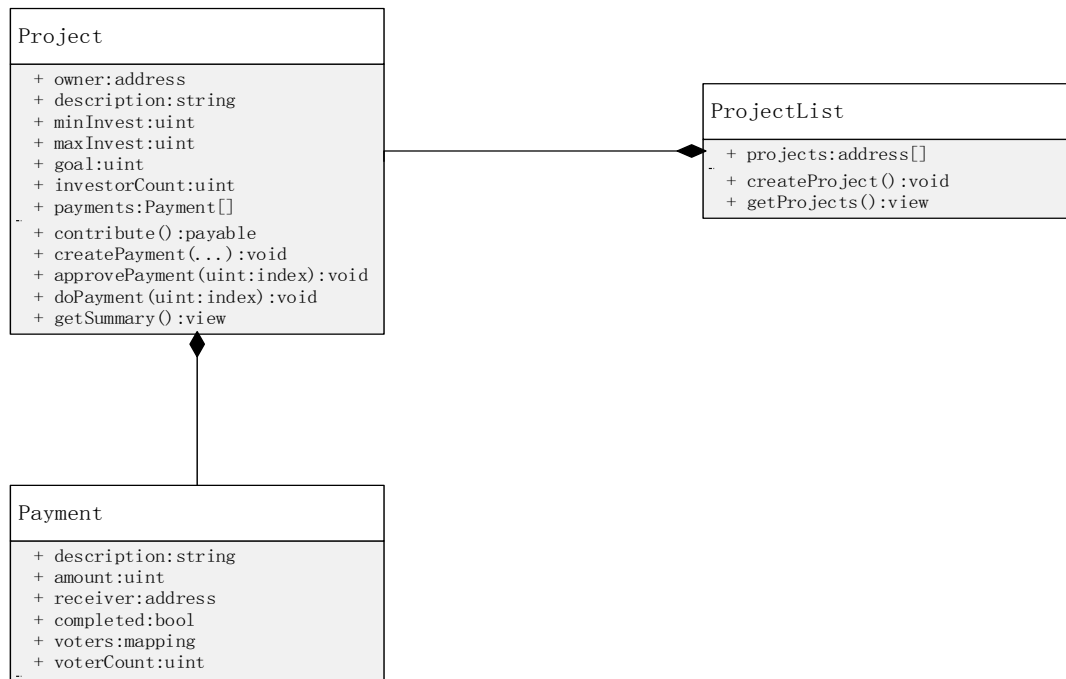
Figure 5. Dapp Timing diagram

A beneficiary initiates a charity project through a smart contract, then the project will be deployed on the blockchain. Donors view the charity project in browser and select a appropriate project to make donation. The funds will be transferred to the Dapp administrator account. When the beneficiary needs funds, the capital expenditure request is initiated with the smart contract, If most people who participate in the project agree to the request by voting, the donation funds of the project will be transferred from the Dapp administrator account to the beneficiary account.

4.2. Build Smart Contracts

Smart contracts are value streams based on specific terms and conditions.Different from real contracts, smart contracts are completely digital, they are pre-programmed code stored on the blockchain [20]. As the expansion of the blockchain, the smart contracts adapt well to the decentralization of the blockchain which can run in the whole network node. The transactions using the smart contract will be recorded on the blockchain without the need of managers. Once conditions are met, the smart contract will be executed automatically. Smart contracts can be used to define transaction logic for charity platform.

In the Dapp, we have built smart contract to meet the functions described in the previous section, smart contracts structure is shown in Figure 6. Users can create a charity project using The ProjectList Contract which also supplies the view of all projects recorded on the blockchain. The Project contract is used to describe and store specific charity project, which provides an interface to operate the charity project and its funds. The structure of tokens expenditures is designed separately.

```
Project
+ owner:address
+ description:string
+ minInvest:uint
+ maxInvest:uint
+ goal:uint
+ investorCount:uint
+ payments:Payment[]
+ contribute():payable
+ createPayment(...):void
+ approvePayment(uint:index):void
+ doPayment(uint:index):void
+ getSummary():view
```

```
ProjectList
+ projects:address[]
+ createProject():void
+ getProjects():view
```

```
Payment
+ description:string
+ amount:uint
+ receiver:address
+ completed:bool
+ voters:mapping
+ voterCount:uint
```

Figure 6. Dapp smart contract structure

4.3. Dapp Test

During the local test, we used the Ropsten test network provided by Ethereum to obtain virtual Ethereum tokens for donation and expenditure. Infura provides a convenient entry point for the Ropsten network. We are able to store Ethereum tokens and complete the corresponding transactions with the MetaMask wallet. At the same time, a Web3 instance completes the interaction between Dapp and the Ethereum network..

The accounts provided by MetaMask are shown in Table 1:

Table 1. Test accounts.

Account	Account address	Balance (ETH)
Creator A	0x7d99d15b6b599fc4cad3fe7342bee912df502d69	1
Donor B	0x7d99d15B6b599fc4cAD3Fe7342bEE912DF502D69	1
Donor C	0x07C458FeA1206BB1f664411BDD96B3202167a7a7	1
Donor D	0xF26eD7d00689D384A30264B39aF82E363907A6ef	2
Beneficiary E	0xD304c675aeA12aE922c19260Ab28198B615CA3bd	0

We initiate a charity project named TestProject in the Dapp as a test.The charity project information is shown in Table 2.

Table 2. Charity project TestProject.

Attributes	Values
Creator	Creator A
Description	A project for test
MinDonation	0.1 ETH
MaxDonation	1 ETH
Goal	10 ETH
Receiver	Beneficiary E

Then we take different accounts into the TestProject, different donors donate to the project with different amounts to make test.Table 3 show the test results of different donation amounts.

Table 3. Donation tests.

Donor	Amount(ether)	Message	Remarks
Donor B	0	Fail	Invalid number
Donor B	0.01	Fail	Less than minimum
Donor B	0.1	Success	-
Donor C	0.5	Success	-
Donor D	2	Fail	Exceeding the maximum
Donor D	1	Success	-

When the donation has been finished, the beneficiary created some diffenent token requests to test the function of funds transfer.Table 4 show the process details.

Table 4. Request for Funds test By Beneficiary E.

Account	Amount(ether)	Message	Remarks
Beneficiary E	0	Fail	Invalid number
Beneficiary E	10	Fail	Exceeding the maximum
Beneficiary E	0.8	Success	-

Table 5 show the balance of every accounts after test.

Table 5. Account status after test

Account	Start Balance (ETH)	Transaction and Execution cost (ETH)	Donate (ETH)	Accept (ETH)	End Balance (ETH)
Creator A	1	0.002453	-	-	0.9975
Donor B	1	0.000335	0.1	-	0.8997
Donor C	1	0.000255	0.5	-	0.4997
Donor D	2	0.000571	1	-	0.9994
Beneficiary E	0	-	-	0.8	0.8

The test results show that our DApp has achieved some of the core functions of the charity platform proposed in this paper.

5. Conclusion

We studied the combination of blockchain technology and philanthropy, a new charity platform model based on blockchain was proposed. In this system, users complete the donation and use funds

with smart contracts. All transactions are recorded on the blockchain to realize traceability of funds, which increase the transparency of charities. The lack of transparency in charity activities could be solved technically with this blockchain charity system, which could increase the public's trust in charity organizations. Some core components have been realized and verified by a Dapp we have developed. A complete charity system based on blockcchain in the future is the next step for us.

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