A Social Mobilized Inspection System against External Damage of Power Grid Based on Block Chain Technology

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Abstract. The operation and inspection of external damage of power grid is becoming more and more difficult, mainly reflected in the uncertainty of risk and insufficient manpower. At present, most of the on-site inspection rely on human inspection since new technology cannot respond to unexpected situations. In this paper, we proposed a social mobilized inspection system. By mobilized the social forces around power facilities, we propose an inspection framework to encourage people upload photos of external damage. To ensure the incentive system transparency, we use block chain technology as the decentralized database. This method provides a new insight against external damage of power grid and is hopefully to be used in inspection system.

1. Introduction

External damage prevention of power grid is becoming more and more difficult with the rapid growth of the power facilities. External damage of power grid usually refers to the reasons caused electric power system blackouts, i.e. objects hanging on the electric tower (balloons, kite lines, plastic bag which may cause by short circuit and power outage accidents in rainy weather), natural disasters (typhoon, heavy rain and high temperature), artificial damage (Illegal operation of the crane around the transmission line), equipment failures (aging of distribution transformers, cable lines, overhead lines, etc) and other unexplained conditions (such as bird damage) \cite{1}, the probability of external damage is on the rise. Then, measures against the external damage of the power infrastructure is an important issue to ensure the safe operation of the grid.

In order to prevent external damage of power grid in advanced, there are many methods i.e. machine learning \cite{2}, drones \cite{3}, QR code \cite{4}. However, a common issue is that unexpected damage caused by human may not be detected instantly. Therefore, we propose a social mobilized inspection method to make full use of the social force around power facilities. Instead of inspection by staff of power companies, social force can actively make photos of external damage by using our app. By block chain technology, the contributed behaviours will be reworded in the system.
2. The Social Mobilized method

The current inspection methods can be divided into three categories according to the technical level: early warning systems based on machine learning [2, 5], visual inspection based on unmanned vehicles [3, 6], and the traditionally manual inspection (see Table 1). The former two methods have a common disadvantage, which is the machine cannot deal with the accidental and unexpected events. For example, an excavator starts the construction work near power facilities. To avoid the inspection, they can stagger working time when they find the routine of unmanned vehicle. Therefore, manual inspection is the inevitable method to be used. However, there still exists many problems in manual inspection, such as huge labour costs and lack of long-term reward mechanisms.

Table 1. Comparison of main methods of against external damage.

| Methods            | Scene                              | Advantages                                      | Disadvantages                                      |
|--------------------|------------------------------------|-------------------------------------------------|---------------------------------------------------|
| Machine Learning   | Signal detection [2]               | Power quality management                        | Sophisticated detection/feature extraction techniques | Not suitable for external damage factors |
|                    | Climate Prediction [5]             | Special areas such as coastal areas and mountain areas | Early warning before special climate occurs | Only consider the climate factors |
| Unmanned Vehicle   | Drone [3]                          | Inspection in harsh environments                | Inspection by cycle route, AI recognition          | Unable to deal with accidental and unexpected events |
|                    | Robot [6]                          | Real-time monitoring of key facility           | no blind spot of the specified facility           | Not suitable for massive facilities |
|                    | Routine inspection                 | Periodic inspection of the responsible area     | Can respond to emergency situations in time       | Single information source, high labour cost |
| Manual Inspection  | Outsourcing                        | Part of the area that cannot be inspected in real time | Manual warning through employment nearby social workers | High labour costs, insufficient professionalism of social workers |
|                    | QR code [4]                        | Suitable for field conditions                   | Able to cover remote areas                        | Insufficient user involvement |

In order to solve the labour problem, we establish a simulative mechanism based on social mobilization. In 2009, in order to celebrate the 40th anniversary of the birth of the Internet, the US government invited researchers from across the country to participate in a Red Balloon search: 10 red weather balloons were hidden in 10 locations across the United States, if any team could be accurate in the shortest possible time. Reporting the latitude and longitude of all 10 balloons, and within 1 km of the error, you can win a prize of 40,000 US dollars. The MIT team led by Pentland developed a strategy to discover shared bonuses through friends, and found all the balloons in just 8 hours and won the game [7, 8]. Through social networks to mobilize social forces, to find hidden dangers of electric towers and transmission lines, we can also learn from the idea of the balloon game, and guide the public to actively report external damage information through an incentive mechanism. However, there are still shortcomings in finding social mobilization in balloon games: search success depends on highly connected individuals who are willing to mobilize distant people to overcome local diffusion traps in high-density areas. However, even under very favourable conditions, the risk of search failure is still very high [9]. Therefore, it is still necessary to design a more reasonable incentive mechanism according to the specific application scenario.

In addition to mobilizing incentive design, another necessary condition for social network mobilization is social influence. Robert M. Bond et.al conducted an experimental study on social impact and political mobilization involving more than 60 million users on Facebook [10]. During the 2010 US presidential election, the researchers found that if a Facebook user was informed that his or her friends had voted (or saw a friend's avatar), the likelihood of the user's vote could be significantly
increased. From a psychological perspective, when behaviour can be observed by others, people are more likely to perform reputation-enhancing behaviours and avoid behaviours that damage reputation [11]. This motivation may be particularly powerful when the direct beneficiary of the act is the observer itself, although it also affects behaviour when the observer is not a direct beneficiary [12]. The effect of observability on behaviour depends on people's perceptions of other people's preferences and expectations [13]. If the social impact is applied to the social incentive design of anti-external damage, then the contribution of the user's friends to the anti-external damage can be considered. After a user releases the hidden danger message, in order to let the user's friends see the message in time, it is necessary to design a communication mechanism of social influence, encourage users to pay attention, comment, verify, and spread the hidden danger message through the power of the user community. Then, the reported problem can let the power company make early repair.

3. The Social Mobilized Inspection System

According to the idea of the social mobilized method, we establish the inspection system as Figure 1:

![Diagram of the social mobilized inspection system](image)

The purpose of the incentive is to let the social force participant in discovering the hidden external damage by uploading photos. To do this, we develop an app. The registration process requires a simple guide of scenes against external damage, then user can log in the system. Any user can initiate an event and the event provides hidden damage information in the form of picture + text description. Once a user initiates an event, any user in the system can see the event by using P2P protocol which information is broadcasted through the network and the validation process starts. We set the top N user who vote the event as Proof of Work (POW). If the POW points above the threshold, i.e. half of users confirm the event, a commissioner will confirm the external damage. The commissioner is the staff of power company who is responsible for the operation and inspection. Besides the event initiated by users, commissioner can also initialize task, such as the inspection of remote area. The commissioner also needs to confirm the POW and generate order to assign repairer. After the on-site disposal, repairer complete the order and rate the danger. Then, the new block is added to the chain, the existing copies of blockchain are updated for all the nodes on the network.

4. Implementation Based on Block Chain

4.1. HyperLedger Fabirc
Block chain technology also known as distributed ledger technology, it has the characteristics of decentralization, openness and transparency, allowing everyone to participate in database records, and data cannot be tampered. Literally speaking: Block chain is packaging and recording the data in blocks, and then linked them into a chain by a certain method. At present, there are ETH, EOS, NEO, HyperLedger Fabric and other popular block chain projects. In this paper, we use HyperLedger Fabric [14] to submit user integral information and base-tower maintenance information to block chain. Fabric is the most widely used alliance chain, the latest version is 1.4. The core of the overall architecture is composed of three parts: Membership Services, Consensus Services and Chain-code Services, using Security and Crypto Services to penetrate other components. The application side calls identity, ledger, transactions, smart contract and other information through interfaces (APIs, Events, SDKs). The architecture diagram as shown in Figure 2.

4.2. Structure of system
In this paper, we define two Org, each of them has two Peer nodes and three Orderer nodes, finally ensuring data consistency by four kafka and three zookeeper clusters. In the Figure 3, All services are divided into eight servers.

All services run in the docker container. We can directly access the corresponding services after establishing the port mapping, so it exist a condition that multiple services could running on one server at the same time. For example, the services of orderer0, kafka0 and zookeeper0 (three docker containers) are running simultaneously on 202.120.222.131. The corresponding external ports of orderer0 and kafka0 are 7050 and 9092. Zookeeper0 has three external ports: 2118, 2888 and 2888. After opening the three services, there will be three containers, and you can see the information of id, name, instruction, creation time, running status and mapping port of the container.

4.3. Compiling of chaincode
Chaincode is compiled in GO language, which is the source language of hyperledger fabric and one of the earliest supported development languages of fabric. Chaincode implements basic submission, state modification and query of event. The system directly uses the CLI container of fabrics to submit commands. The Chaincode Installation and Instance instantiation commands are as follows, the results are shown in Figure 4:

- s peer chaincode install -p chaincode:electronic -n eleccc -v 0
- peer chaincode instantiate -n elecc -v 0 -c '{"Args":[]}’ -C myc
Figure 4. Chaincode in stall

Add, modify, and query instance commands as follows, the results are shown in Figure 5:

- peer chaincode invoke -n elccc -c
  
  [{"Args" :["addProposal","001","uncheck","address01","12.12","demo","/usr/local/tmp/p.jpg","00021","Have something","20190701010121"]} -C myc

- peer chaincode invoke -n elccc -c [{"Args": ["queryProposal","001"]} -C myc

- peer chaincode invoke -n elccc -c [{"Args": ["updateProposal","001","checked","address01","12.13","demo","/usr/local/tmp/p.jpg","00021","Have something","20190701010121"]} -C myc

Figure 5. Chaincode invoke

5. Conclusions and Perspectives

Anti-external damage is one of the important problems in power maintenance and inspection. Power equipment and transmission lines are widely distributed, and the traditional methods are unable to deal with accidental and unexpected events. Inspired by the perspective of social mobilized method, we design an inspection system with incentive mechanism of token rewards generated by block chain. This method could release the burden of commissioner who is responsible for the area where need to be manual inspection. By making full use of the social force around power facilities, commissioner only need to confirm the photos and descriptions from app to identify the external damage and give orders of repairment. The block chain technology increases the efficiency of user engagements and reduced the labour costs of power company. However, the system still needs to be improved when concerning consensus algorithms, resilience to security risks, regulatory and legal sphere etc. [15].

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