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Blockchain Based Secure IoT network for Industrial Control System

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ABSTRACT: Because of the advancement of the blockchain technology and day by day increasing application of blockchain technology, we can employ the blockchains to industrial sensors and control system for network security. The main features of blockchain technology consist of: spread out ledger, cryptographic hash function, proof of work based consensus function and smart contract. The purpose of this paper is to improve industrial sensor and control system network security and make sure that it is trustworthy, safe, highly efficient and less expensive. The methodology is to make use of blockchain technique in industrial automation systems network for cyber security, and it also shows why blockchains technology can increase the cyber security of Industrial data.

The proposed work unites blockchain with IoT to accomplish IoT network security and construct blockchain based ICS cyber security architecture model. This proposed work provides solution to the numerous problems before the deployment of blockchain in ICS network. The results demonstrate that the data is saved securely in blockchain at every node on network using simple proof of work mechanism and this data can access easily. This system has a good performance in industrial IoT device. Thus our conclusion is that block chains technology can put an end to ICS network security through IoT for feasible solution.

KEYWORDS: ICS, blockchain, IoT.

I. INTRODUCTION

Industrial sensor and control system is an autonomous system which includes of various types of computer, electrical equipment and industry related sensor and machinery. In industries, the automation system used, requires to collect the data in real-time, because it requires to control various system within a few. Industrial sensor and control system had become the integral part of nowadays industries for example in power generation industry, automotive manufacturing industry, logistic and storage industry, etc. Because of this there is a requirement of storing this data and nowadays this data is stored in central data server at one place. But in the today's world, the data stored centrally is not safe because, hackers always tries to steal critical technology data from industries and also tries to change that data. Due to increasing cyber attacks on industries, this problem has gain the attention of many industry experts, countries are trying to provide cyber security to industries and researcher and engineers are trying to solve this problem.

In the current industrial IoT revolution all the industrial sensor data are stored in a cloud remotely. The problem of storing this data centrally on a cloud required huge computational power. Also it requires large capital investment and high maintenance cost. Also due to its centralized nature there is a threat of data breach or data lost. This data may get corrupted or may get altered. We cannot find out whether the data is get changed or altered.

To solve this problem we use blockchain technology for storing this data. One of the main benefits of using blockchain technology is its decentralized nature. Block- chain is one of its kinds of database, which is not centralized in nature and distributed everywhere. The data which is saved in blockchain is always remains secret, and by no means it can be faked or altered with. There are smart contracts scripts which is present in the blockchain, which makes multi step process automatic. The blockchain technology is a scattered decentralized database technology which consists of nodes. Here, nodes is group of sensors and controllers which is having their unique address in system, and whenever they stored data, it is called as transaction, the block in which data has to be stored is created, and with the help of cryptographic method these blocks are linked together to form a chain of block. To make sure that the block is unique they use timestamp and some type of proof of work and other technologies to ensure data integrity and safety. The industrial sensor and control system network there is requirement of having a secure and proven safety and protection mechanism. The benefit of the blockchain technology is the scattered data storing capability, its resistance to data saved in it the use of cryptographic hash function, and the data block is used to replace the need of central server. Figure 1 shows the structure of blockchain based secure Internet of Things system.

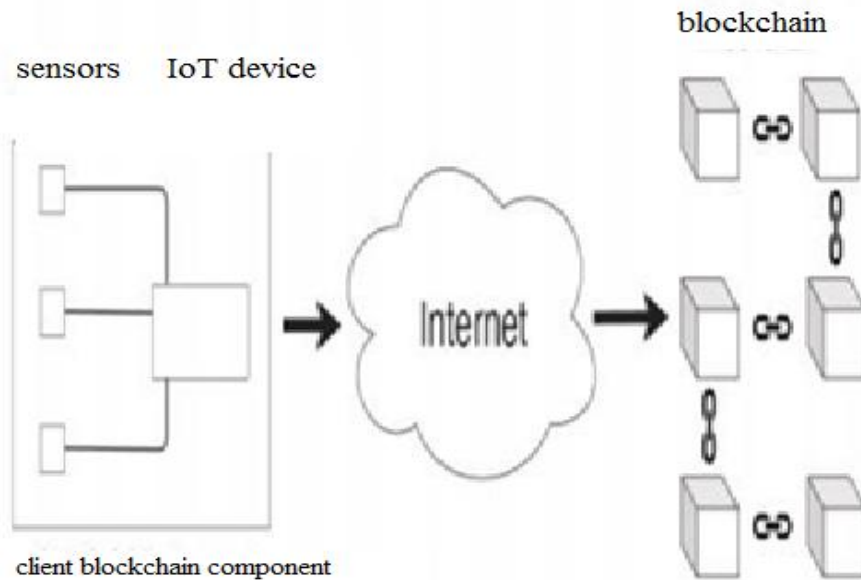


Figure1: Structure of blockchain based secure IoT system

This paper make use of blockchain technology to make sure industrial sensor and control system network should remain secure, and make it more trustworthy, protected, highly efficient and less expensive.

II. LITERATURE SURVEY

A. Dorri, S. S. Kanhere, R. Jurdak, and P. Gauravaram [1]. Authors show the use of overlay networks to bring down the computational time for blocks. Security against some vulnerability, such DoS attacks is covered.

J. Huang, L. Kong, G. Chen, M. Wu, X. Liu and P. Zeng proposed a blockchain system with a credit-based proof-of-work (PoW) mechanism for IoT devices, which can ensure system safety and transaction effectiveness at the same time [2].

Shanshan Zhao, Shancang Li, Yufeng Yao proposed the use of blockchain and industrial internet of things from the industrial potential [3]. A blockchain based industrial internet of things structure is introduced and concerned basic method is offered.

Taneesh Kumar, Braeeken, Vidhaya Ramanie, ejaz Ahemad, Erkki Harjula, Mika Ylianttila, concentrate on showing the main safety challenges in the industrial internet of things blockchain-edge associated networks [4]. In addition, some possible safety finding is presented in order to prevail over problems.

O. Novo, presents a new architecture for significant function and permissions in IoT. The new architecture is a totally distributed access control system for IoT, based on blockchain technology [5]. The architecture is supported by a proof of concept execution and assess in practical IoT situations.

III. PROPOSED METHODOLOGY

A. AIM AND OBJECTIVES

1) Aim:

To implement the Secure Industrial IoT BlockChain System for modern industrial automation.

2) Objectives:

- To identify main difficulties in applying blockchain technology into IoT and shows corresponding answer to overcomes these difficulties.

- To make a common, easy to made and safe blockchain based model for IoT, where we design an easy proof of work function and an economical access control scheme for power- consuming IoT sensors.
- To design and employ the proposed system for a smart industry purpose.

B. SYSTEM WORKING

As seen from the below figure 2 block diagram of blockchain based secure industrial IoT network system, raspberry pie zero w is used as a gateway for storing blockchain program and connecting sensors to network. The sensors used are temperature and humidity sensor DHT11, fire sensor, gas sensor MQ-2 and collection of this sensors and raspberry pie together known as node. Like this two nodes are used in this system and both are connected to the same internet connection. Each node is having a unique IP address and can be access by authorized user using simple graphical user interface GUI.

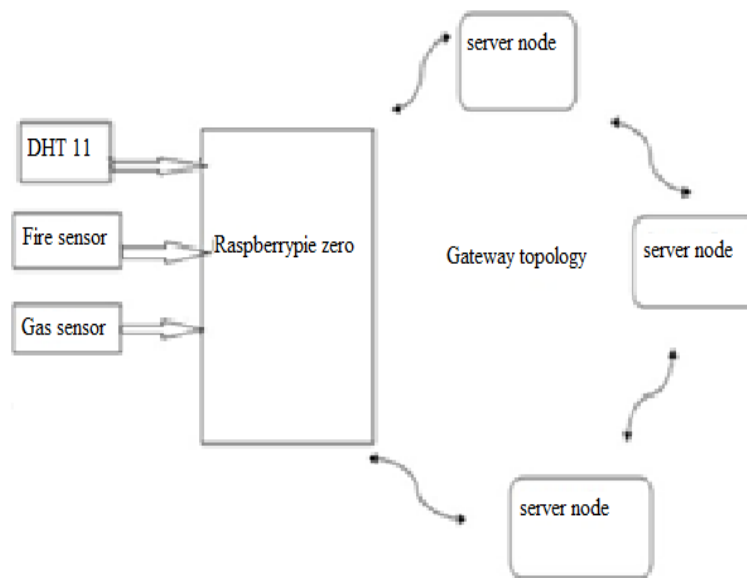


Figure 2: Block diagram of blockchain based industrial IoT network security system

Here we designed small wireless sensor network WSN in that industrial sensor data is stored using blockchain in different server database. For that we used raspberry pi which is small computer it reads sensor data and converts it in digital format and stores in blockchain format in network. Python programming language is used for creating blockchain. In blockchain the block consist of hash of previous block, its own hash, time stamp, sender node address, and proof of work, transaction data, and its index. Sha256 hash function is used from hashlib library which generate a fixed 64 bit encryption code for each block. Every node will create a unique identification when initially starts, that is a pair of public and private key, which is the only one of its kind identifier in the system. Gateways accept the signals from various sensors and transmit the transactions in the network; they only deal with transactions from permissible sensors that are approved by the manager node. Manager is a specific full node, which has authority for controlling IoT devices in a smart factory.

C. ALGORITHM

Step1: All the Sensors data which is collected from the sensors is given to Raspberry Pi zero w.

Step2: Blockchain transaction is generated with accumulation of sensor data, starting point address, target address, and other information needed to process the transaction in the blockchain.

Step3: Node’s private key is use to insure that the correct node is sending the data.

Step4: Transaction data will be send to network in which fully connected nodes receive it.

Step5: Extraction of the transaction's data from the blockchain can be done by host with proper user id and password. At this step the program starts again from step 1.

D. COMPONENT USED

1) Raspberry pi zero w:

Raspberry pi zero w is a mini computer which is used as node for collecting sensor data and storing it on blockchain network.

Raspberry Pi Zero W specifications are:

- It consist of single-core ARMv6 CPU (Broadcom bcm2835)
- It includes Video Core IV graphical processing unit, 512MB of RAM
- It also comes with Mini HDMI and universal serial bus on-the-go ports
- It is power by micro USB port
- It includes HAT-compatible 40-pin header
- There is also composite video and reset headers
- It also include camera serial interface connector
- 802.11n version wireless Local Area Network
- Bluetooth 4.0 connectivity.

2) DHT11 sensor:

DHT11 sensor is used to detect the temperature and humidity from atmosphere

DHT11 Specifications are:

- Working Voltage range: 3.5V to 5.5V
- Working current range: 0.3mA (measuring) 60uA (standby)
- Output data in serial form.
- Operating temperature range is from 0 to 50 degree Celsius.
- Working humidity range is from 20 percent to 90 percent.
- It gives temperature and humidity data in 16-bit format.
- Sensing accuracy is $\pm 1^{\circ}\text{C}$ and $\pm 1\%$

3) Fire sensor:

Fire sensor is an infrared sensor use to detect flames Specification of fire sensor are:

- LM393 comparator chip
- Flame finding spectrum range is from 760 nm to 1100 nm.
- Working voltage range is from 3.3 V to 5 V.
- Maximum output current it can give is 15 mA.
- It can give digital outputs 0 and 1
- Flame finding angle is about 60 degrees.
- Sensitivity can be adjusted using potentiometer.

LED light indicators: power (red) and digital output (green)

4) Gas sensor MQ-2:

It is used to detect the gas leakage. Specification of gas sensor MQ-2 is:

Operating Voltage is +5V

Can be used to count or sense LPG, alcohol, propane, hydrogen, carbon dioxide and even methane

Analog output voltage range is from 0V to 5V

Digital Output Voltage: 0V to 5V

Preheat duration 20 seconds

Can be used as a Digital or analog detector

The sensing range of Digital pin can be varied using the potentiometer

IV.RESULTS

Thus, the results demonstrate that the data stored securely in blockchain using simple proof of work mechanism and this data can access easily. The complete copy of blockchain is available at every node in a network and whenever someone try to alter the data in blockchain it is figure out by other nodes in network and that blockchain is replaced by the valid one.

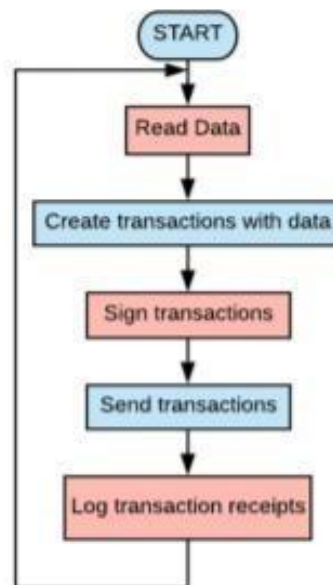


Figure 3: Flow chart of blockchain based industrial IoT network security system.

Figure 3 shows the working flow chart of the blockchain based industrial IoT network security system. When the system starts, the sensors will sense the reading and this data is given to raspberry pi and blockchain program in raspberry pi will generate transaction using this data and this transaction data is signed by sha256 hash function and attached it to blockchain and it sends on a network. To access this data we designed a simple graphical user interface using php, where we sign in a network using our user ID and password as shown in Figure 4. Figure 5 displays the data from node 1 and node 2. The node 1 temperature is 32 degree Celsius, humidity is 56 percent, gas and fire is not detected. Similarly node 2 temperatures are 31 degree Celsius, humidity is 55 percent, gas is detected and fire is not detected. Figure 6 shows the hardware used in this blockchain based secure IoT network for industrial control system.

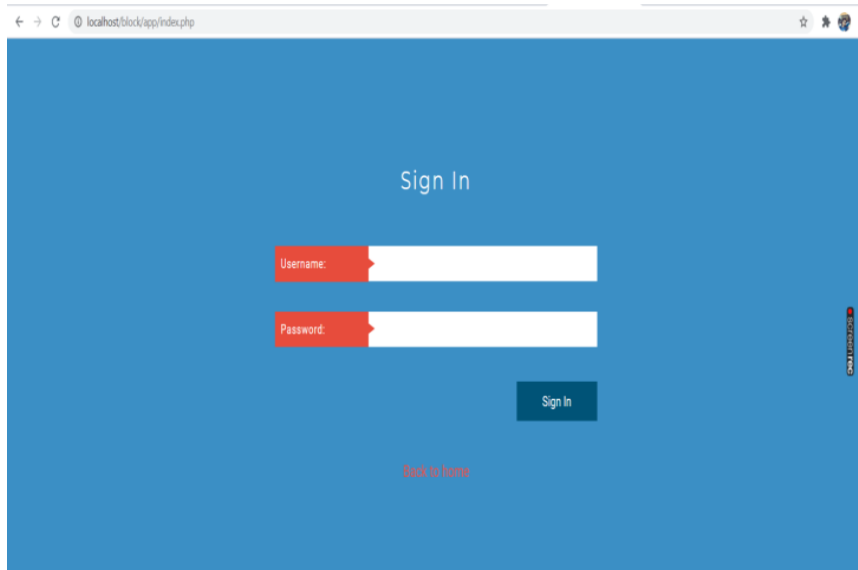


Figure 4: Sign in to access blockchain data

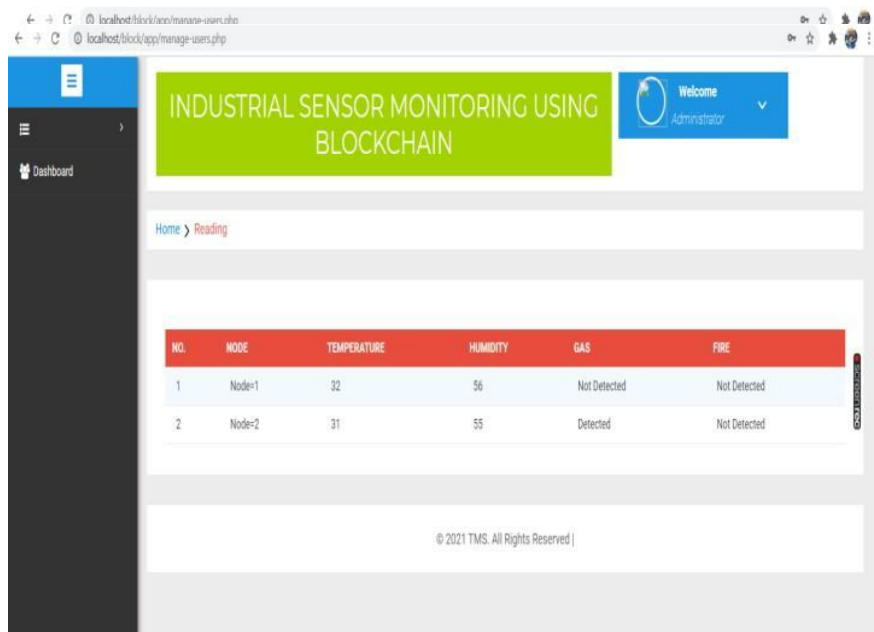


Figure 5: Sensor data display on screen

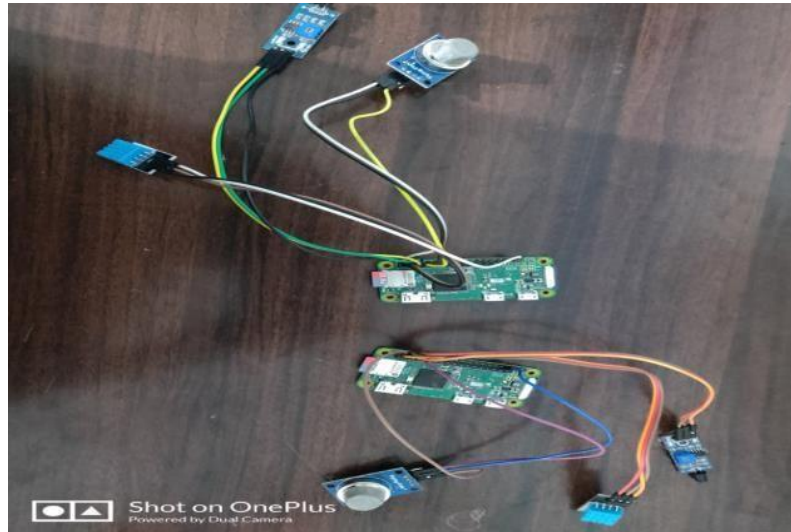


Figure 6: Hardware used

V. CONCLUSION

The system device nodes form a device connection network in which one system node communicates with another system node using blockchain format, and interaction among nodes via a pair of secret and open key takes place. Only the authorized user can access the sensors data from blockchain using proper user ID and password. Every block has a unique random 64 bit hash code and complete copy of blockchain is updated from the neighboring node. Whenever data from one block is get corrupted, it is find out by comparing blockchain copy from nearby node.

In future we will try to increase storage capacity and transaction speed of blockchain and also try to improve proof of work mechanism for better security.

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