



On Establishment of Food Traceability System with Internet of Things

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Abstract. The world is witnessed great changes brought about by Industry 4.0, the influences are profound and far-reaching for mankind. Among all techniques, the Internet of Things is one of the most symbolic innovations. The Internet of Things establishes an organic platform for food traceability on basis of blockchain and radio frequency identification technologies, etc. Establishing a food traceability system can effectively secure food safety and comprehensively improve people's well-being. The traceability system monitors all data during the phases of the food supply chain and establishes a centralized database for data storage thus the authenticity and accuracy of all data were ensured. In this way, an elastic IOT architecture to link its all sorts of participants—sensors, peripherals, perishable foods, vehicles, and related staff—so as to make the overall logistic infrastructure entirely trackable and manageable.

Keywords: Application · IOT · Platform · Food traceability

1 Introduction

Nowadays, food traceability system is one of the most popular blockchain applications for its anti-counterfeiting, quality assurance and high standardization functions. Traditional traceability systems are lack of reliability, scalability, and data accuracy. Furthermore, the process is time-consuming and sophisticated for supply chain movements. To tackle this, a blockchain-IOT-based system is put forward to integrate the application of blockchain, IOT techniques, fuzzy logic into an overall traceability shelf life management system to manipulate the whole managing of perishable food. Thus, the traceability system is formulated with the following elements affiliated: information and communication tools, i.e. Radio Frequency Identification and Near field Communication; analytical test in chemistry and biology, inclusive of isotope analysis and DNA barcoding. With the system, it is feasible to trace, track, identify and monitor the food to maintain its quality and safety throughout the supply chain.

2 A Glance at IOT and Food Traceability

2.1 Internet of Things

With multiple technologies, ranging from electronics, cyber-communication, sensors, RFID, the IOT system ensures the vast connectability between objects, realizing the intelligent and integral manipulation of all connected peripherals and smooth transmission of data. Within multi-level connectable solutions, different customerized surveillance mechanism, and powerful information processing competence, the system combines various hardwares and protocols into the cloud. For all use cases, the IOT system is so scalable and compatible that it can greatly extends its applications of versatile peripherals to different situations.

2.2 Traceability of Perishable Food

Traceability means that all perishable food is strictly tracked down from farming fields to dining tables including its production, handling, packaging, transportation, and distribution, and so on. In a word, all movements of processing should be accurately traced and presented as information interpreted by all IOT devices throughout the food supply chain. Under the traceability system, food businesses can be highly standardized and supervised. And it goes without saying that the system can bring benefits to human welfare and prevent unnecessary loss.

2.2.1 The Role of Traceable System

The Traceability System makes product recall possible when any food is poisoned or processed inappropriately in any phase. When any problem concerning food safety happens, the Traceability System works out and identify the trouble makers. This can help regulate management of the whole food business and prevent the disruption of public health risks.

The whole system will become popular when access to IOT gets easier and easier. The IOT techniques will surely promote the added value of the food business. The notion of “lean production” can be implemented into the food industry as all participants of all sectors from the food business ranging from farmers, factory owners, drivers, distributors and retailers will work coordinatively to safeguard food quality on the whole.

2.2.2 Properties of the Traceable System

The system is capable of tracing food product at any stage throughout its whole supply chain. The system stores all related information about the food product, from people who are involved including farmers, manufacturers, drivers, consumers to the environments under which food is produced or processed, such as humidity, temperature records, sunlight, fertilizers, pesticides, additives, ingredients, and so on. And all the information, presented in whatever forms, will be recognizable and transmittable among all devices within the IOT platform. As a result, the platform can be traceable and manageable.

2.2.2.1 Connectability

Connectability aims at transmitting data between the cloud and all other equipments within the system. It strictly defines in what manner the peripherals are correlated with the cloud to ensure that different operations are conducted in accordance with requirements.

Different IOT protocols for all for plug-play peripherals are compatible within the system, ranging from COAP, MQTT, etc. With its strong computational power, all present IOT protocols are applicable for the system. The IOT platform also redefines fresh applications that function smoothly within all IOT equipments.

2.2.2.2 Hardware Monitoring and Supervision

The IOT platform includes a number of electrical and digital devices, or other peripherals. Attributes will be prescribed to any device and they define detailed properties and assign definite instructions or commands to all equipments. In this manner, simple information computing, or other complicated, structural peripherals, together with their unique attributes are integrated into the IOT system organically and work out smoothly.

Qualifications and credentials are predefined to all devices which are linked to the IOT system. Pre-assigned keys, entry permissions, tokens, IDs, login instructions, certificates, etc. are inclusive in the system. The IOT system keeps monitoring and supervising all equipments and their data workflow through the entire lifecycle, ranging from provisioning or connectivity functions at the start to software upgrading or decommissioning in the end.

2.2.2.3 Data Recieving

Under the present circumstances, all protocols can be applied to collect information from various peripherals in the system. All protocols guarantee reliable information transmission upon responsive codes, which define the overall procedures of information processing within the IOT system. All peripherals information collected within the IOT system will be allotted to multi-level computing thoroughfares. If errors occur along the information processing, disk breakage, even processor overloading, a responsive alarm is sent to the corresponding device to make appropriate adjustment. In this sense, all devices will always cope with all information under correct aslo real-time directions. All data are varied, structured or unstructured, including digital codes, text, graphs, mathematic arrays or charts, even nested objects, and so on.

2.2.2.4 Data Analytics

The IOT syetem prescribes standard and definite properties for all information collecting adapters which guarantee information transmission through any database or information analytic entities. Due to its modular architectural structure, all adjustments to any existing adapter will be smoothly conducted.

All raw and unstructured information can be computed thus transformed into strictly structured time series for swift ongoing analytics, structured analysis, visualization, etc. In normal cases, time series are sent to the computing or analytic platform under pre-assigned instructions.

2.2.2.5 Data Visualization

The data visualization can be presented in different forms, ranging from gauges, charts, graphs, maps, text, tables, and so on. They can be used to visualize various kinds of data. Data can be telemetric information, statistical analysis, geographic location, metadata, both from current or historical. All data should be configurable and can vary in visual representations.

2.2.2.6 Configuration Management

The configuration administration is crucial for it manipulates all routine equipment functions, copes with information computing parameters, safeguards analytics, pre-assigns all flagging, etc. The configuration garentees that any function within the system should be performed smoothly regardless of any arbitrarily defined data structure. As a result, all configuration information is processed swiftly in the IOT system, any historical configuration data and pending delivery will be tracked down accurately.

2.2.2.7 Command Execution

Command execution means that the platform can transmit messages within the system among all connected devices. Commands can be executed and all real-time responses can be received and processed under system instructions. For instance, we will remotely check out current humidity and temperature in a container of perishable goods, instruct a camera to film a specific area, and so on.

3 Application of IOT in Food Traceability System

3.1 A Framework of Traceable Platform

Food safety problem has become a heated topic as the public shows increasing concerns on it. Internet of Things platform adopts electronic and internet technologies to combine all peripherals that work under certain protocols. This can ensure them to convey various information, ranging from procedures as follows: farming, storage, transportation, processing to retailing. This emerging innovation is gradually redefining food supply chain system into integration, accuracy, automation, high standardization and user-friendliness, monitoring the food streamline from farming land to dining table. All interactive real-time information brings about a lot of merits for food industry, which becomes more automative, productive and customer-oriented. How a typical food supply chain functions with IOT can be seen in Fig. 1.

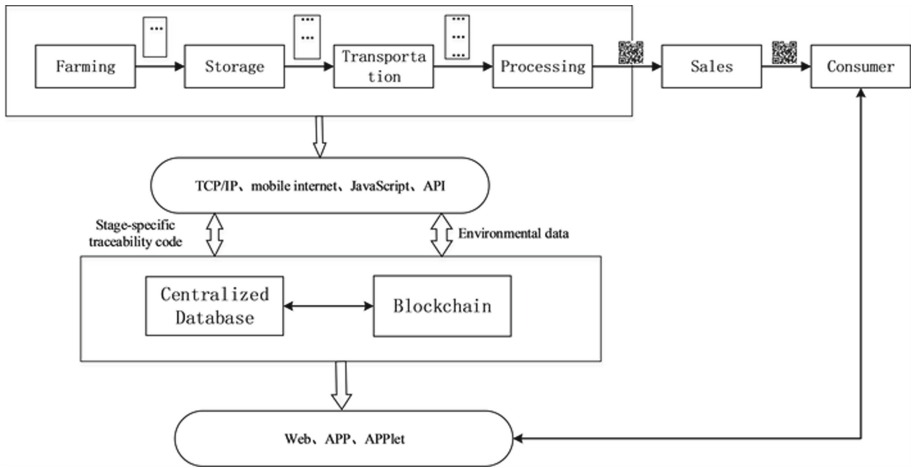


Fig. 1. A typical traceable food supply chain

3.2 Operational Optimization, Real-Time Traceable Capability

Real-time supervision of all food logistic and processing resolutions, a serial of strong image and graph processing mechanism and comprehensive integrated information analytic capability, cloud computing and easily operated interface make the platform function interdependently and reliably (seen in Fig. 2).

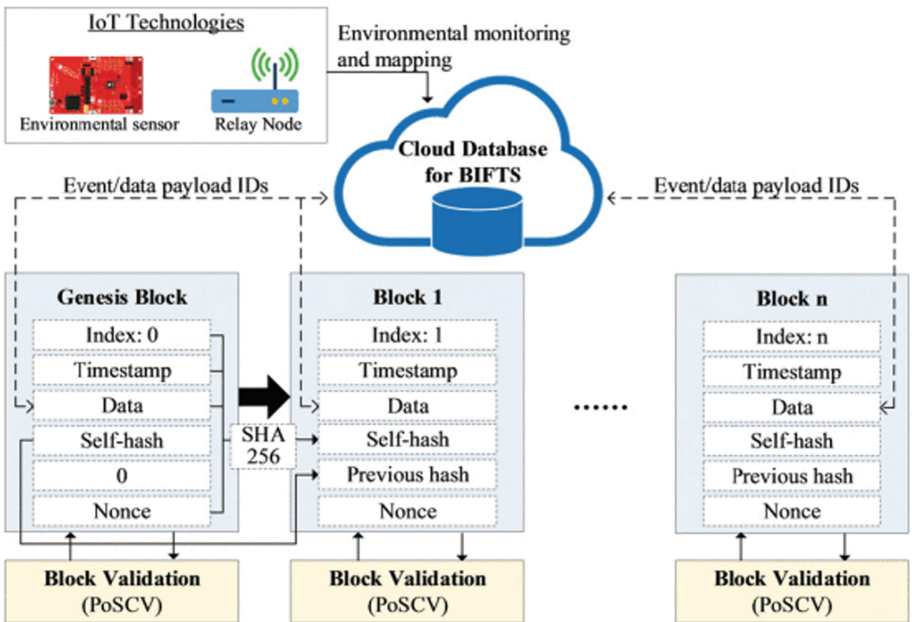


Fig. 2. Interaction of IOT, blockchain and cloud computing

3.3 Open IOT Protocols for Building Event-Based Workflows

The rule engine can be powerful enough and any complicated rule chain is generated to do with data conveyed along any device thus all applications are made feasible under different use cases or circumstances.

Message—The system will handle any incoming data from all related peripherals or ongoing events under various rules, including REST API, RPC, and so on.

Rule Node—Any incoming data will be computed through filtration, transformation and commands will be carried out under different circumstances.

Rule Chain—They are nodes that interact under certain rule sets, and all outbound information can be transmitted smoothly among all connected rule nodes.

4 Conclusion

The food traceability system with IOT provides information throughout the whole food life cycle, formulating the following into an integral whole: (i) an IOT technique framework, (ii) a sheer blockchain-IOT mechanism, (iii) fuzzy food quality supervision through the supply chain, realizing the aim of cost-effectiveness and user-friendliness in its implementation. Also, all collected information is processed in the cloud database, and associated IDs with timestamp are embedded in the blockchain for traceability operations. As a result, smooth connectivity of all devices not only helps to gain better insight into the whole food supply chain but also assists in monitoring the health, quality and safety of the products from any device. With IOT, the “smart” logistics operations make the whole food supply chain traceable, manageable and highly visualizable. And less loss and less operational complexity become possible for food industry. In conclusion, the establishment of food traceability system with Internet of Things will be greeted with applause in the near future.

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