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Construct Food Safety Traceability System for People's Health Under the Internet of Things and Big Data

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ABSTRACT

Food safety monitoring, data analysis, and food safety traceability have taken on greater significance in the context of epidemic prevention and control. While this is true, the primary motivation for eating is Information on safety concerns is often fragmented, murky, and one-sided. Establishing a fair and trustworthy food safety traceability system is the cornerstone of addressing these issues. The present crisis of confidence between customers and the market may be alleviated in part by using the traceability system to guarantee food quality and safety. The deployment of conventional traceability systems has been hampered by issues of poor credibility and difficult data storage, but new research on food safety traceability systems based on big data, artificial intelligence, and the Internet of Things offers ideas and approaches to remedy these issues. Therefore, this study uses rice to illustrate the need for a food safety traceability system that utilizes radio frequency identification (RFID) two-dimensional code technology and large data storage technology in the Internet of Things. This article analyses the needs of the system, designs a solution using RFID technology, then implements the solution. database tables, encoding the two-dimensional code, and creating the layout for data input are all parts of the system database. With the use of radio-frequency identification tags and the data-saving capabilities of big data, we can details on the food manufacturing procedure. Finally, the development of a dynamic query platform and mobile terminal has made it possible to track the whole chain of custody of information relating to the production of food. According to these findings, the technical integrity, dependability, and safety of traceability information are all assured by the big data and Internet of Things-based food safety traceability system. This is a practical approach to improving the trustworthiness of traceability data, safeguarding data integrity, and maximizing data storage efficiency.

Keywords: - Two-dimensional code technology, Internet of Things, big data, arti_cial intelligence, food safety traceability system.

I. INTRODUCTION

More and more instances of the new crown virus (COVID-19) are being detected in the course of cold chain logistics as the worldwide new crown virus (COVID-19) outbreak worsens. With its rapid spread, COVID-19 has become the greatest threat to food safety throughout the cold chain. the overall state of novel coronavirus prevention and control in our nation is not promising, While the pneumonia pandemic is showing signs of improvement, the rapid expansion of the abroad epidemic has led to a serious "foreign import and internal prevention" scenario in the United States. Monitoring food safety, data analysis, and food safety traceability have gained prominence in the context of pandemic prevention and control. Any and all food should be tracked and monitored to stop the spread of the COVID-19 virus and ensure the public's health and safety, but this is especially important for cold chain food imported from outside. As a result, establishing a safe and reliable food safety traceability management system is not only an urgent need of society and the people, but also an efficient means of fundamentally solving the post-epidemic period and protecting the health of the population. Based on automated identification and information technology, the food safety traceability management system integrates data throughout the whole food supply chain, from farm to fork to supermarket shelf. An all-inclusive service management system accessible through the web, touch-screen terminals, voice calls, and SMS messaging in real time. Traceability in the food supply also system includes purchasing seeds for planting (breeding), processing (packing) by a business, warehousing (transporting), and selling (making) [1, 2]. By establishing a clear chain of custody for all stages of food production and distribution, information traceability helps ensure that breeding practises are safe and consistent. (Planting), "Processing," and "Transportation," and, yes, Preventing Various Food Safety Risks and Protecting People's Health. The Internet of Things is based on communication and perception technologies, which have several applications in contemporary manufacturing and daily living. The Internet of Things (IoT) may be seen as the natural outcome of how sensor networks, the Web, and mobile phone networks have interacted with one another. The technology at its heart is sensor networks, which may be broken down into the "perception" layer, the "network" layer, and the "application" layer. Combining big data with other technologies like automated identification and network ommunication is essential for its effective implementation.

II. RELATEDWORKS

Rapid progress in areas like perception, measurement, and monitoring based on IoT, AI, and big data technology has been made possible by the development of autonomous information generating equipment such as sensors and intelligent terminal recognition. Connected devices and massive data sets

are having far-reaching effects on people's productivity and lifestyles, and their relevance has grown well beyond that of communications technology [3]. Information technologies, such as the Internet and sensors, are used in the Internet of Things to link devices together and enable data exchange and analysis between previously unconnected devices. The advantages of artificial intelligence are substantial.

of making it easier to use data, and it might have a significant impact in fields like food safety. Cloud computing and distributed computing form the basis of the big data technology paradigm for data processing and application. Integrating and exchanging data and using suitable mathematical techniques allow for precise prediction or analysis to be achieved. The five primary links—data acquisition, storage, processing, mining, and knowledge display—all play a part in the effective use of big data in food traceability, together with technologies like automated identification and network connection. Cross-regional and cross-domain collaborations are made possible by big data's ability to aggregate and virtually manage data while also optimising the allocation of information resources.

Intense, impenetrable oversight in the world of actual management. Big data's widespread use in agriculture over the last several years has made it a potent catalyst for the modernization of the sector. However, because to the interconnected nature of the food supply chain, it is crucial that both the supply chain's upstream and downstream participants work together to build a food quality and safety traceability system. Assembling a food safety traceability system using Internet of Things technology will make teamwork much easier. Information technology is utilised to perform food safety traceability in the aftermath of an outbreak, and technologies like the internet of things (IoT) and big data are used to the food safety traceability management system [4]. Maintaining a high standard of food safety across the whole food supply chain—from production to storage to retail—is a topic of intense interest in the area of public health. Therefore, this study presented an Internet-of-Things-based RFID- and big-data-based food traceability system. The collecting of a wide range of information about food has become a reality thanks to the Internet of Things and big data technologies. Implementing automated parameter recording with RFID technology helps to prevent human data entry errors can taint food product tracking records. Simultaneously, utilising big data analysis technologies, a tiny data search engine for the food business was developed. Traceability across the whole of agricultural and ancillary production processes is made possible by the integration of the conventional traceability system with the Internet of Things and big data technologies.

items include growing, processing, testing, storing, shipping, and retailing. This meant that people's health and food safety could be protected by tracking the origin of agricultural and ancillary goods, determining how those items were produced, asking relevant questions, and holding those responsible to account. The system for ensuring the safety of food that was developed as part of this study is able to provide early warning of potential dangers, source traceability, and a transparent realisation process. Importance: Very High

importance in enhancing China's food quality and safety management, averting food safety disasters, keeping supply and demand in equilibrium, and protecting consumers' wellbeing.

The automatic identification technology of food labeling uses computers and related software and hardware to encode, identify, collect, input and output individual food labels that need to be traced. These processes are all carried out automatically. The radio frequency identification (RFID) in the individual identification technology is a technology that can remotely identify a target object without direct contact and collect relevant information. Combined with an effective database system and network system, the tracking and information sharing of items on a global scale can be realized. 2-Dimensional barcode technology is one of the automatic identification technologies for individuals. Using the concept of ``0" and ``1" bit streams that constitute the internal logic of the computer, it can be automatically read through image input electronic equipment or through photoelectric scanning equipment to realize automatic processing of information, thereby achieving oneto- one tracking and Traceability. Sensors belong to the nerve endings of the Internet of Things, and become the core components for humans to fully perceive nature. The large-scale deployment and application of various sensors is an indispensable basic condition for the Internet of Things. The wireless data transmission selected in this research is mainly through ZigBee technology, which is a short-distance, low-complexity, low-power, low-rate, low-cost two-way wireless communication technology [7]. It is mainly used for data transmission between various electronic devices with short distances, low power consumption and low transmission rates.

Scrapy is an open sources Internet crawler framework based on the Python language. It has the characteristics of complete functions, low development difficulty, and extremely strong expandability. Scrapy uses the Twisted network asynchronous framework to process network requests. The overall working architecture is shown in Figure 1B. The main work- flowof Scrapy is that Spider assigns the first page to be visited to the engine, and the engine is processed by the scheduler for sorting; The engine obtains a page link from the scheduler, encapsulates it as a Request and sends it to the downloader for download; The downloader encapsulates the web content processing into a Response and sends it to the crawler for processing; The crawler parses the Response, encapsulates the first data processing into an Item, and obtains several links that need to be visited in the next step. Item is handed over to the Pipeline for one-step processing, and the link is handed over to the engine for processing; Entity data is circulated to the pipeline for further data cleaning and persistence operations [8]. Repeat the above steps until the page that is still to be crawled is accessed. In the development process of the food quality and safety traceability system, the integration of the Internet of Things technology and big data technology can complement each other. Firstly, the use of big data technology and smart contracts can better detect and locate malicious nodes; Secondly, the use of asymmetric encryption technology of big data technology can ensure the security of file data and reduce the dependence of the Internet of Things on the central structure. Finally, the centralized platform of the Internet of
Things has low compatibility and weak anti-attack ability during the device identity authentication process. Introducing big data technology and storing information such as digital identities in a new block data structure can effectively protect privacy, improve security, and reduce computing overhead. Meanwhile, the increase in the amount of data and the complexity of the structure require cloud servers for memory and storage. In turn, the parallel computing capabilities of cloud computing also promote the efficient and intelligent processing of big data; Big data solves the security problems of information leakage and tampering, and provides basic support and reshaping trust mechanisms for the Internet of Things, big data, cloud computing, etc. Therefore, the advantages of the combined use of IoT and big data technology in the food safety traceability system. By verifying the detailed data information on the food supply chain through smart contracts, it is finally stored in a relational database together with the big data location information where the data is located. This not only improves the operating efficiency of big data, but also guarantees the security and credibility of the data. In the food safety traceability system, multiple data forms such as numbers, images, and videos are involved. In order to extract effective information from it, it is necessary to use various data mining tools and techniques to filter and analyze large amounts of data according to specific individual needs, so as to realize the accuracy and personalization of data, and provide users with good data support [11].

III. PROPOSED SYSTEM ARCHITECTURE

The proposed system contains different modules specified below

A. Database Design

Three primary types of databases were used in the development of this study's database schema: databases for storing historical data, for real-time monitoring, and for crawling the web. The primary functions of the historical database are historical data analysis and display. Information on rice that has been gathered from the internet is stored in a web crawling database. This data includes rice commodity data, rice edible data, and rice product data. Crawlers that follow the first stage crawl will have their data protected thanks to the information recorded in the first stage. For the purposes of this study, we use Scrapy as a data crawler. Scrapy is a free and open-source web crawler framework that includes features like duplicate content detection and removal, as well as automated access suspension [12]. The built web crawler is more robust and scalable thanks to these designs.

B. Data Preprocessing

After obtaining a large amount of food-related data, this research built a small search engine for food. It takes Python's open sources website framework Django as the main body, and uses elastic search technology for data storage. It has the characteristics of clear classi_cation, low article repetition rate, strong pertinence, and no advertisements [13]. It can provide users with accurate and fast data acquisition channels. Elastic search is a distributed database that allows multiple servers to operate at the same time, and each server can run multiple Elastic search instances. The structure of a small search engine website is shown in Figure 3B. The first is the construction of the Model layer. According to the format of data stored in elastic search, three Model classes inherited from the Doc Type class in *elastic search_ dsl* are established, namely commodity Model class, edible Model class and product Model class. Corresponding fields are established according to the specific requirements of different types. The second is the construction of the View layer. In this research, View is mainly responsible for the provision of search suggestions and the keyword search after users click the search and return to the result page. Using the *Request. GET* method to get the keyword entered by the user and the category of the keyword. After a series of formatting, the keywords are sent to elastic search according to different categories, and the returned json string is obtained, and the *json string* is parsed and sorted, and returned to the original page for display. Finally, the construction of the Template layer [14]. This research only developed a small search engine, so the main page only has a search page and a result display page.

C. Data Analysis Process

Machine learning (ML for short) is a branch of artificial intelligence, which aims to feed various new rules and action reference information to the system according to established steps. This information can be automatically learned by the system to continuously accumulate experience and achieve ``self-improvement". Artificial intelligence (AI) refers to the ability of machines to continuously learn and apply flexibly according to various scenarios in real life and real-time data. Its goal is to independently perform certain specific and interrelated tasks by imitating human behavior. In order to achieve the desired purpose, AI can work collaboratively with a variety of program integration, verification mechanisms, and pattern recognition methods. As mentioned earlier, after a certain amount of data has been collected, this research designed an algorithm for the classification of various data of rice.

D. Food Traceability Process

As mentioned earlier, the management units of the food safety traceability system constructed in this study use bar code and RFID technology to obtain and record basic data, and upload them to the enterprise management information system and big data center through the communication network. In the planting process, after the system collects the relevant data of agricultural planting, the relevant data is encrypted and uploaded to the cloud platform. In retail stores, consumers can obtain relevant information recorded by the food from the grower to the manufacturer and then to the distribution nodes of the retail store by querying barcodes or RFID tags [18]. This realizes that agricultural products can be traced directly to specific producers, and to the relevant information of specific production plots and planting processes. The data transmitted between the logistics link,warehousing link, sales link and the traceability cloud platform is equivalent to the data block of the blockchain. The data transmitted in different links together constitute a complete traceability information, which ensures the completeness of the information in the whole process of traceability and the authenticity and reliability of the traceability information. At the same time, food supervision organizations such as the Food Supervision Bureau, Industry and Commerce, Anti-Counterfeiting Office, Anti-Counterfeiting Office and other departments randomly check whether relevant data is complete or tampered through special terminals.

The food safety traceability system is a safety assurance system that uses information technologies such as article coding and radio frequency identification to manage relevant information in the food supply chain. Based on the main structure of the Internet of Things and the data integration and sharing function of big data, the food safety traceability system model under the background of the Internet of Things and big data constructed in this study. The whole is divided into support (hardware) layer, network layer, data layer, display layer, and user layer. Among them, the support layer (hardware layer) provides software and hardware support for the system, and uses RFID readers and other equipment to monitor and track the whole process of rice production and circulation in real time to collect and encode data. This requires software and hardware devices such as servers, storage devices, network devices, operating systems, and databases. The data layer receives a large amount of basic data through the server, analyzes, organizes and analyzes and finally stores it in the database. And supplemented by a small amount of manual data entry to provide complete data support for the entire traceability system. The network layer aggregates the data carried by each node to the Zigbee gateway through the Zigbee node self-organizing network, and then the Zigbee gateway sends the aggregated data to the GPRS gateway. The GPRS gateway converts the data into a byte array format and sends it to the server via the network [16]. The system layer implements various functions of the food safety traceability system, and the thematic data and business data used by the system come from the data layer. The user layer is the users who use the system and perform corresponding operations according to different permissions. The structure design provides a stable and safe query terminal for consumers who finally purchase the product. Using the unique identification code on the food packaging bag on the website to find important information about food planting, production, and transportation. Using B/S server to build a traceability platform, so that users can query through PC browser client, tablet/mobile client, provide companies with information to guide production, and provide consumers and regulatory authorities with food ingredients, production, processing and circulation processes information. This article integrates practical research and industry researchers' data, combined with the above traceable links, to build a platform that can improve the quality of food production, provide users with data, and accept the supervision of the public. The food safety traceability system taking rice as an example is composed of various data, sensors, barcode tags, RFID tags, information management systems and other elements, including user information management, planting information management, processing information management, logistics and distribution information management, sales information management, supervision management, consumer inquiries and problem product management. Among them, user management establishes various operating users for the system and manages users. In the planting information management module, planting administrators and supervisory department administrators can use this module to query, add, modify, and delete key information of the entire rice planting stage. In the processing information management module, processing administrators and supervisory department administrators can use this module to realize the

functions of querying, adding, modifying, and deleting key information in the rice processing stage. In the logistics distribution information management module, the supervisory department or logistics enterprise administrator can use this module to realize the functions of query, addition, modi-fication, and deletion of logistics distribution information. In the sales information management module, the supervisory department or administrator can use this module to realize the functions of query, addition, modification, and deletion of processing information. In the supervision management module, consumers can use this module to complain about problem products, and the supervision department can realize functions such as viewing complaint information. In the consumer query module, consumers can query important information about rice planting, production, and transportation by using the unique identification code on the rice packaging bag. In the problematic product management module, the supervisory department or the administrator of the inspection department can implement product inspection through this module. If the product is unqualified, a problematic product record will be generated. In the production and processing system, data can be collected through various IoT sensing devices to ensure the integrity, authenticity and reliability of the data, and set up abnormal value warnings in the system to provide food safety warnings [17]. Since all operations for big data and the Internet of Things are presented in the form of a transaction record, each data record has a unique *tx Hash* address to constrain. By linking the two-dimensional code information of the product with these tx Hash, all traceability information for a product is connected in series and cannot be changed [19]. In order to facilitate the query, we traverse and monitor the data of the entire big data alliance chain, and cache a copy of the data in Mongo Db. The biggest feature of Mongo is that the query language it supports is very powerful, and its syntax is somewhat similar to an object-oriented query language. It can almost achieve most of the functions similar to single-table queries in relational databases, and it also supports indexing of data. This can effectively solve the problems of concurrency and query efficiency, and provide query services for more consumers.

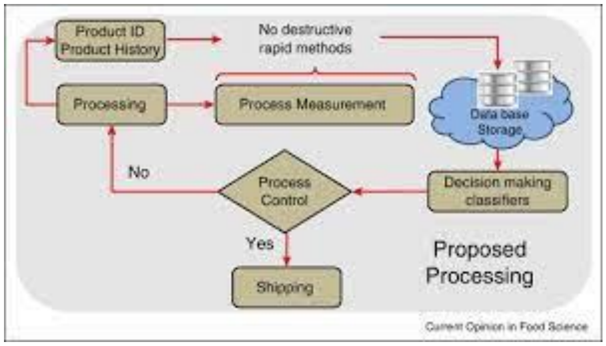

Fig. Food Traceability Architecture

IV. RESULTS AND DISCUSSION

In order to improve the environmental monitoring of rice transportation and storage, the food safety traceability system constructed by this research institute is equipped with temperature and humidity sensors, which can realize the control of environmental factors during the transportation and storage of food. Detecting and tracing the changes of temperature and humidity in the environment during the transportation and storage of rice are of great significance to the protection of food quality and people's health. Take the change of environmental temperature and humidity during the transportation and storage of rice as an example, briefly describe the actual and theoretical values of environmental temperature and humidity monitoring in this system. The temperature and humidity adjustment and monitoring and the simulation value, test value and relative error of each test node are shown in Table 1 and Table 2. From the results Table 1 and Table 2, it can be seen that the monitoring subsystem in this food safety traceability system can help users reduce labor costs during rice transportation and storage. In the long run, the benefits of users are improved, and the quality of rice and people's health are also guaranteed.

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TABLE 1 Temperature control results

Number	Default value(℃)	Actual value(℃)	Relative error（℃）
1	25.0	25.0	0
2	26.4	26.2	-0.2
3	24.7	24.8	0.1
4	25.1	25.0	-0.1
5	24.9	25.0	0.1
6	25.3	25.4	0.1

TABLE 2 Humidity control results

Number	Default value(%)	Actual value(%)	Relative error（%）
1	65.0	65.4	0.4
2	66.4	66.1	0.3
3	64.8	65.2	-0.4
4	64.5	65.0	-0.5
5	65.5	65.1	0.4
6	66.0	65.4	-0.6

V. FUTURE SCOPE AND CONCLUSION

In the context of epidemic prevention and control, strengthening food safety data analysis based on the application of food safety traceability technology can effectively improve the effect of food safety management, which is conducive to the development of epidemic prevention and control, and has practical value for the solution of future food safety issues in China as a whole. So as to better protect people's life, health and safety. The use of Internet of Things technology to regulate food safety can effectively curb the emergence of major food safety incidents. Moreover, the problem can be diagnosed more real-time and accurately, and the source of the hazard can be quickly identified, so that the quality of the food is more guaranteed. This will have a huge impact on the food supply chain. At the same time, under the intelligent monitoring of big data, it is difficult for companies in the food supply chain to tamper with the data, ensuring the authenticity of the data. Combining big data, the Internet of Things, the Internet and the food traceability system will truly achieve openness, transparency, and completeness of information, and strictly control the various steps of the food traceability system, so that the value of the food traceability system can be truly realized. This research uses IoT technology, wireless sensor technology, RFID technology, crawler technology, database technology and other related technologies to design and implement a set of food traceability system using rice as an example. It has initially completed the traceability requirements for the entire process of food products, and also provided network data information for food-related industries. The implementation of traceability is not only a practical need to ensure food safety, but also the main means of current and future food safety measures. Through combing and researching the existing food safety traceability system, drawing on advanced domestic and foreign experience and achievements, strategically, systematically and structurally, establish a unified and standardized food safety traceability standard system, and establish a food safety traceability system for the government and enterprises Provide standardized technical guidance, it also provides standard support for the establishment of third-party certification, thereby improving the level of food safety traceability and people's health.

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