

Cloud Blockchain Based Multiple Inspection Information Exchanging for Agriculture and Food Safety

Ming-Shen Jian*, Jian-Ting Guo, Hung-Jen Chen, Yu-Zhi Luo, Yu-Chen Lai

¹ Department of Computer Science and Information Engineering, National Formosa University, Taiwan
jianms@nfu.edu.tw

Abstract—In this research, the inspection information of agriculture and food exchanging is secured based on the blockchain technology. Each operator or inspector can be recognized and represented as the unique sequential numbers for security encryption. According to the chained and secured data, the inspection reports are undeniable. The agriculture or food safety can be enhanced based on the chained inspection history.

Keywords— Blockchain, Cloud Computing, Security, Agriculture, Food Safety

I. INTRODUCTION

Nowadays, due to the risk of food safety and pesticide, consumers pay more attention to food safety and product history. To maintain the food safety, various inspections are defined and proposed for the raw material of food or agriculture product. Over the years, various countries already defined different inspection standards and limitations for inspecting the food product, raw material, or agriculture product. Each method or machine may only used for specific inspection purpose. Therefore, by integrating reports from all methods, steps, and machines, the complete inspection report of the tested agriculture object can be provided.

In Taiwan, pesticides using in crops should be checked according to the "Bureau of Animal and Plant Health Inspection and Quarantine" [1-2] approval. In addition, various pesticides are defined and limited by "Food and Drug Administration" [3] in Taiwan. In other words, different information are distributed and stored in different databases. Huge information posting online are distributed into different web pages. To collect and search the related information through various websites and web pages should be solved.

In addition to collect the information from the government, inspection results related to food, raw material, or agriculture product, are also the main issues for agriculture and food security. For the inspections, various technologies such as Chromatography-Tandem Mass Spectrometry, chemical reagents, etc., are used. After receiving test results from these inspection steps or machines, inspectors may need to exchange the information or data between each other. Therefore, to ensure the accuracy and consistence of these inspection reports

is important.

Considering the inspection systems or services development, the information or data today can be exchanged through the network. Furthermore, the inspection reports are exchanged and re-modified between different steps of the inspection data chain. The spoofing attack or falsification may be happened during data exchanging. Therefore, how to verify the authenticity and correctness of the data is important.

There are various algorithms or applications were developed for data security. By using algorithms and applications, the security of the transmitted data can be encrypted. Some systems secure the information or data by using the common security key such as data encryption standard (DES) or advanced encryption standard (AES). The data transmitter and receiver can exchange the data through the same security key for encryption and decryption. However, after using the unchanged security key for long time, the secure key could be speculated. Therefore, the asymmetric system which includes the public key and private key was proposed. By using private key, the transmitted data can be secured and then decrypted by the corresponding public key. However, not only the security of the transmitted data, but also the correctness of the content should be considered. The content between data chain transmission should be undeniable and reliable. In other words, from the first step of the inspection chain, all the related inspection reports should be recognized and verified.

To provide the undeniable data transmission, the date, the information of machine and inspectors, and the information of both data receiver and transmitters should be included in the undeniable inspection report. Similar to today's online transaction, all the digital information related to data transmission should be recorded and verified. Bitcoin is one of the famous applications for online transaction. By using the private key, block chain technology, and the distributed records, all online transactions can be reliable after the complex computing works. Therefore, except to the "51% attack" of blockchain computing, the report or transaction which is included in the block can be undeniable.

In this research, the inspection report which includes the inspector data, machine data, test technologies, etc., are

exchanged between different departments and inspectors. To ensure correctness of inspection reportsexchanged in the supply chain, this research proposes “”, with the contributions:

1. All exchanged inspection reports have the undeniable content. In other words, to ensure each transmitted data. The final report can be ensured that all content come from the undeniable information or inspection flow. When the final report is provided to the members of supply chain, the inspection report is reliable.

2. The data of different inspection steps can be more automatically. By using the proposed system, all staged or phased inspection reports will be linked as the data chain. By using the system which implemented on cloud platform, each information chain corresponding to individual inspection task can be stored and create with less cost.

3. The inspection information chain of the proposed system can be applied to not only agriculture inspection but also food safety inspection. In addition, the system is implemented on cloud platform, cost of maintenance for whole proposed system can be reduced.

The reset of this paper is organized as follows. Section 2 presents the related technologies. Section 3 shows the proposed system. In the section 4, the conclusion is presented.

II. RELATED WORK

In this section, cloud computing, blockchain technology, and the method of agriculture inspection are introduced.

A. Cloud Computing and Services

Cloud Computing based on the virtualization technologies was implemented for computing with huge computing resource [5]. By virtualization technologies, the physical computing resources such as CPU, memory, storage spaces, etc., can be virtualized and merged as the computing resource pools. Based on the on demand required computing resources from the users, the virtual machine can implement and the computing task could be executed. Through the network, the remote client users or systems can obtain the on demand required services. In addition to the virtual machine, docker container [12] is also popular in cloud computing development. Based on the Docker on the cloud environment, containers only need to create once and can be used frequently. The services and programs can be included in the container in advance. By using the virtualization technology based on same docker engine, various containers can be implemented and used on different computing nodes(physical or virtual computers). Therefore, to rapidly create same services or programs on different computer nodes, docker container can be the available solution.

Since services and programs can be created based on the virtualized computing resource, to rapidly construct the repeatedly used services is possible. By configuring the requirements of the services, all the services or programs with required processing environments can be packaged as the service templates such as Docker containers or virtual machines. Thus, when the service is needed, remote userscan choose the corresponding template, and create the services rapidly. In addition, when the template or virtual machine is no

longer needed, all the computing resource will be returned to the resource pool. Therefore, the computing resource can be dynamically managed.

In this research, due to the detail information of the agriculture inspection standard should be collected through the various online website, the information collector called web crawler is developed based on cloud for repeated using and rapid created. The web crawler is proposed as the application or service [6] for collecting data from the Internet. By analyses the content of web pages, the corresponding information could be found. Since the information is posted online based on the websites, the information collection procedure may be frequently acted. In addition, the total amount of collected of collected information through the Internet cannot be predicted. Therefore, to be able to manage the huge data (or big data), the web crawler based on the cloud computing platform is needed.

B. Blockchain

Blockchain is the newly famous technology for distributed information security [10,11]. Blockchain is the technology to decentralize the storage and parallel process the security. Each computing node of the blockchain will operate based on the proof-of-work (POW). By using the cryptography, all information records, also called blocks can be chained or linked. Each block includes the previous blocks hash code time stamp and the transmitted data. Because of distributed computing design, each recorded block cannot be altered. Therefore, participants in the blockchain can verify the data transaction individually.

When a transaction (data exchanging) happens, the detail transacted data will be secured according to the asymmetric cryptosystem or digital signature. Then, by using hash function, the secured transacted data will be presented as the unique hash code. This unique hash code is used for broadcasted to the other computing nodes of the blockchain network.

When receiving one or more non-verified hash codes, the computing nodes will put these hash code into block. In other words, one block may include many transactions. Then the computing nodes which receive the hash code would verify the block based on the proof-of-work system. The fastest computing node which completed calculation or computing task of POW could verify the block. The node verified block will be broadcasted to other nodes of the blockchain network. The other nodes of the blockchain network will do the validation of the received block. If other nodes ensure the validation of the transaction block with the valid digital signature, this block will be connected to the blockchain (or chained). Finally, this chained block is undeniable and not able to be altered.

In other words, to complete calculation or computing task of POW and ensure the validation of transaction block need huge computing resource. Furthermore, all the chained blocks with the transaction information will need huge storage space. Therefore, not only distributed system but also cloud computing should be considered for the blockchain applications.

C. Agriculture Inspection

Considering the services of agriculture inspection, the inspection procedure, standard, and tolerance information of the pesticides should follow the government decree. In Taiwan, the provision of the inspected pesticide are defined by different departments. The information of recommended pesticides, and the detected tolerance or allowable residue of the pesticides are defined by the Bureau of Animal and Plant Health Inspection and Quarantine, and Food and Drug Administration. The corresponding information can be obtained through different websites and various web pages. Therefore, every time the pesticide is detected through the agriculture inspection procedures, the detected pesticide should be compared with the list defined by the Bureau of Animal and Plant Health Inspection and Quarantine, and Food and Drug Administration.

Today, most agriculture inspections are developed based on the Chromatography-Tandem Mass Spectrometry technology. The mass spectrum shows the plot of signal which indicates the ratio function of the mass-to-charge. Comparing the detected spectra signal with the signal of the standard sample, the elemental feature of the sample, the mass of the molecules, or the structure of the compounds can be determined [8]. To obtain the spectrum, some mass spectrometry machines are based on gas chromatography-tandem mass spectrometry technology (GC-MS), and some are based on liquid (LC-MS). Figure 1 is the GC-MS machine and Figure 2 is the LC-MS machine [9].



Figure 1. Chromatography-Tandem Mass Spectrometry



Figure 2. Chromatography-Tandem Mass Spectrometry

D. Data Exchanging

To consider the agriculture safety, there are various inspection method, procedure to do it. Each step, machine, or procedure will finally give the inspection report of its detection. Mostly, a batch of the inspection report includes more than one test item. In other words, these inspection reports may be exchange during different inspector or phases of inspection.

Hence, the total amount of data exchanging will be huge. To confirm all transacted and transmitted data is difficult. In addition, each transmitted data should include the information such as timestamp, inspectors, phase or machine of the inspection procedure, then to be confirmed as the validated data. Based on the manual operation, the mistakes of the data transcription, copy, or exchanging happen easily. In addition, all final inspection report information will be confirmed as the trusted sources. Each data could be individually confirmed the correctness of validation. Then, the final inspection report can be reliable report for the third party uses. Therefore, to improve the performance of data exchanging with the validation, the accuracy of the undeniable data exchanging service is needed.

III. SYSTEM ARCHITECTURE AND IMPLEMENTATION

In this research, considering implementation environment, the system is divided into many partitions: Inspection Data Chain, Pesticide Inspection Algorithm, and Cloud Computing Platform. Figure 3 shows the framework architecture of the proposed system. All the services and steps of agriculture inspections are based on the cloud platform. Considering the proposed Inspection Data Chain and the web-based operation, the various virtual machine based on the cloud computing platform are needed. In addition, the pesticide inspection algorithm is included in the container based on the cloud docker engine for rapidly using. The chained inspection data can be stored on cloud.

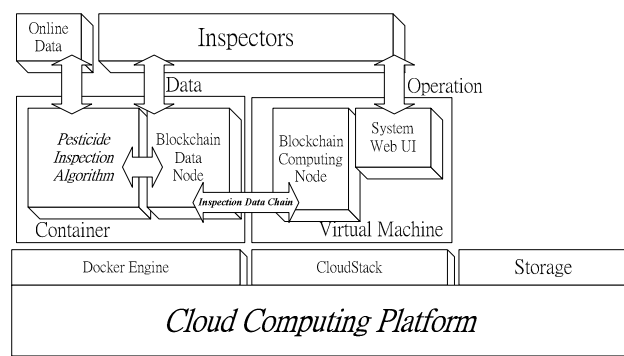


Figure 3. Framework architecture of the proposed system

Whenever the agriculture sample for pesticide inspection is given, this sample will be delivered to the corresponding agriculture inspection machines such as GC-MS or LC-MS. All the information between different phases of the agriculture inspections will be transmitted and exchanged based on the proposed inspection data chain. By collecting all the related chained data, the inspection report can be made according to

the undeniable data. Finally, the complete inspection report will be checked by the proposed pesticide check algorithm if there is any pesticide residual detected. The flowchart can be shown as Figure 4.

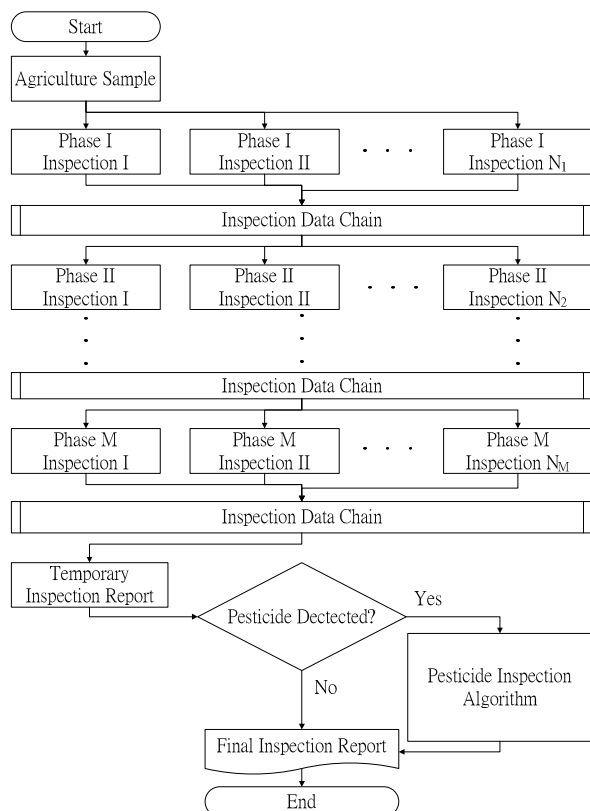


Figure 4. Process flow of the proposed system

In Taiwan, government defined over 380 kinds of pesticide. For each agriculture objects, only a few of the on demand defined 380 pesticides can be spraying. In other words, pesticide valid for apple may be not allowed for rice. In addition, the mixed pesticides are also common and popular used for agriculture. Therefore, suppose that there are total m kinds of inspected independent pesticide. Then, the possible total amount of pesticides can be defined as C_n^m where n is from 1 to m . Therefore, to ensure all possible mixed pesticide is important and becomes the heavy workload. In addition, according to government announcement, independent single pesticide is not allowed for the agriculture object but may be allowed when it is mixed. There is an example of was apple (also called bellapple, *Syzygiumsamarangense*). If the pesticides such as Cyprodinil and Fludioxonil are independently used, the list of the “Bureau of Animal and Plant Health Inspection and Quarantine” will show “not-recommended”. In opposition, if these two pesticides are on demand mixed and then for wax apple. The combination pesticide is listed as “recommended”. Therefore, how to check the pesticide inspection is important.

A. Pesticide Inspection Algorithm

Since the possible total amount of pesticides can be defined as C_n^m , the total amount of pesticides which should be inspected can be defined as follows [9]:

$$\bigcup_{n=1}^m C_n^m \quad (1)$$

where m is the total amount of the inspected pesticides.

After obtaining the corresponding pesticide inspection data, the data should be quality managed and inspection filtered.

First, considering the quality management, solvent without agriculture or pesticide should be used. If value of ppb is larger than 5. That quality management is fail and the field of checking is marked as “unqualified”. In addition, Calibration curve is used for the pesticide inspection $R\%$. if value of $R\%$ is equal or less than 85, or larger than 115, the calibration curve of the inspection system is called initialized.

Then, the agriculture pesticide inspection can be started. All the agriculture pesticide inspections are done from the various staged and machines of inspection procedure. After collecting the chained inspection data based on the proposed inspection data chain, the chained data can be undeniable and for further checking step.

If there is no pesticide inspected, this agriculture sample can be marked as “safe” or “qualified”. In opposition, if there is any pesticide inspected, the data of inspected pesticides will be checked by the proposed inspection algorithm. According to the data, all the inspected pesticides will be listed. Following the list, all the information will be collected online based on the web crawler of the proposed cloud computing platform through the Internet. In other words, by obtaining the corresponding information from the web pages of Bureau of Animal and Plant Health Inspection and Quarantine, and the Food and Drug Administration, to check whether the pesticide is recommended/non-recommended or the valid total amount of pesticide residue.

First, in the proposed pesticide inspection algorithm, the S/N value of all the pesticides will be check according to spike. If the S/N value is less than 10, it means that the inspection is the controversial result. If the S/N value is smaller than 3, the inspection data will be marked as unqualified.

Second, there are three quality indexes Q_1 , Q_2 , and Q_3 used in the quality management. Q_1 and Q_2 are composed to control the quality of management, called QR . In addition, Q_1 and Q_3 are composed and used in the quality of management report, called QF . QR and QF will be used to check 10% of the all pesticides. Following shows the corresponding conversion equations. The $\%Rec$ field of each index Q_1 , Q_2 , and Q_3 can be covered into the $R\%$ and $RPD\%$ of QR and QF .

$$R\%_{QR} = \frac{\%Rec_{Q1} + \%Rec_{Q2}}{2} \quad (2)$$

$$RPD\%_{QR} = \frac{|\%Rec_{Q1} - \%Rec_{Q2}|}{R\%_{QR}} \quad (3)$$

$$R\%_{QF} = \frac{\%Rec_{Q1} + \%Rec_{Q3}}{2} \quad (4)$$

$$RPD\%_{QF} = \frac{|\%Rec_{Q1} - \%Rec_{Q2}|}{R\%_{QF}} \quad (5)$$

If the R% of the inspection data is not within the range from 60 to 140, the inspection data will be defined as unqualified. Based on the PRD% value of QF and QF, if the value is larger than 20, this inspection data is also defined as unqualified.

When any unqualified pesticide inspection data is reported, the inspector should re-start the inspection from scratch. In other words, only the inspection data is qualified by quality management, the inspection data can be sent for next phase: concentration check.

Third, all the pesticides are filtered. If the value of the individual inspected pesticide residue is equal to or larger than 7 ppb, the information correspond to the inspected pesticide of the agriculture sample will be sent for concentration check.

Since the pesticides inspected from different agriculture samples are various, the concentration check of each agriculture sample is done independently and individually. The residue of inspected pesticides large than 7 ppb is checked and compared with the information from the web pages of Bureau of Animal and Plant Health Inspection and Quarantine, and the Food and Drug Administration. Based on the proposed cloud computing platform, the legality, recommended, allowable residue of the inspected pesticide can be checked.

B. Inspection Data Chain

Considering the pesticide inspection procedure, the final report is the integration of data which comes from various inspection machines, inspectors, and inspection phases. Therefore, a reliable final report is based on the undeniable data from all inspection procedures. In this research, corresponding to the actual inspection procedure, the data of each individual inspection procedure should be exchanged between different phases, procedures, and inspectors. Therefore, to confirm the correctness of the data exchanging, the blockchain technology is developed.

Since the total amount of exchanged data could be huge, to reduce the mistakes during the data exchanging is important. Suppose that there exist a data transmitter and a data receiver when data exchanging. Instead of the receipts, transmitter and receiver could use the individual identification information or codes to “transact the data transaction” between each other. Similar to the online electric transaction, the data exchanging is also treated as the transaction. When the data needs to be exchanged or transmitted, the transmitter which could be an inspector, or the system should send the request to the receiver. If the receiver is available, the receiver will replay a transaction query which includes the required information related to the receiver to the transmitter. When receiving the transaction query, the transmitter starts to block the inspection data according to the in demand defined block chain algorithm with transmitter its own information (or private key). Hence, according to the blockchain technology, this data transaction can be secured by the private secure key which is similar to the

asymmetric cryptosystem. After the computing and verification by other computing nodes, the data transaction between the transmitter and receiver is secured as the “block” and undeniable.

Then, the data of the following inspections will be also blocked. Therefore, the current blocked data which is related to the earlier blocked data will be chained. In other words, the inspection data managed from the first appear and until now will be connected as the chain data. Hence, to summarize the final report of the inspection, all the data from different inspection procedures and inspectors will be chained together. Finally, all the data shown on the final report can be trusted and undeniable.

In addition to the inspection data exchanging, to verify the block is also important. In traditional blockchain structure, each computing node of the blockchain will operate based on the proof-of-work (POW). In addition, the computing nodes need huge computing resource. Therefore, to have huge amount computing nodes with enough computing resource is important. In this research, since all the inspection data chains only exist within the local data flow network, to operate based on the POW through the external network or computing nodes is not reliable. According to the proposed system structure, the cloud computing platform could provide the virtual computing nodes with enough computing resource for the internal blockchain network. These internal virtual computing nodes will do the validation of the received block. In addition, the chained inspection data blocks can be also stored based on the proposed cloud computing platform.

In this research, the private key for blockchain computing is based on the recognition and identification of inspectors' faces. Based on the face recognition, the features of individual face could be translated into the sequential numbers. Since each face is unique, the corresponding sequential numbers could be also unique. Therefore, when the inspection data is exchanged between different steps of pesticide testing or different inspectors, the data exchanging is managed similar to the digital transaction between users. By using both unique sequential numbers corresponding to different inspectors for blocking the data, it means that the data is recognized and verified by both inspectors. In other words, after blocking and chained, the secured data is undeniable.

C. Cloud Computing Platform

Considering the computing workload according to the equation (1), the huge computing resource is needed for various combinations of different pesticides. In addition, to frequently obtain the online information from different data source also costs computing resource. Therefore, in this research, the open source cloud computing is proposed. Based on the cloud computing platform, the docker engine is implemented for container services. The proposed algorithm and system can be also developed and included in the container. When trigger events happen, the corresponding container can be implemented for specific services.

When the pesticides are inspected according to the pesticide

inspection algorithm, the pesticide residue and the legality of spreading on specific agriculture should be checked. Since all the information are presented by the website online without the database accessing, web crawler for online information obtaining based on the trigger events can be the solution.

If the temporary inspection report shows that no pesticide inspected, the inspected agriculture sample is defined as "safe". In opposition, if there is any pesticide inspected, then each inspected single pesticide or multiple mixed pesticide according to equation (1) should be checked. Therefore, different agriculture inspection reports may trigger different web crawler events. In Taiwan, the agriculture inspection is defined by Bureau of Animal and Plant Health Inspection and Quarantine, and the Food and Drug Administration. Therefore, in this research, the web crawler is established based on the cloud docker container. When the web crawler is needed, the container can be executed for online inspection data searching. Then, not only the recommended pesticide but also the maximal pesticide residue information can be obtained.

First, in Taiwan, the recommended pesticide is defined by two rules: 1. the license of the used pesticide; and 2. the recommended using of the crop. Therefore, all the found or inspected pesticides will be checked that the legality and valid period of the license which registered by any pesticide manufacture. In addition, the government already defines the limitation of each pesticide for using on specific crop, called recommended pesticide. Only when the both rules are satisfied, the pesticide inspected can pass the recommended pesticide check. In other words, even one pesticide was registered validly without recommended for specific crop using, the pesticide inspected will be marked as "not recommended". It also means that the not recommended pesticide is used in this inspection sample.

In addition to the web crawler service, the proposed Pesticide Inspection Algorithm is also implemented based on the cloud environment. In Taiwan, the pesticide residue is defined and limited by the Food and Drug Administration. Considering the possible changing of the maximal pesticide residue made by the government, the web crawler service is also needed and triggered for obtaining the corresponding valid residue value when any pesticide is inspected in order to maintain the correctness of inspection. Therefore, in this research, the proposed Pesticide Inspection Algorithm is also included in the cloud docker container. When the container is triggered, the report of the proposed Pesticide Inspection Algorithm will be evaluated and given. In other words, only when the container including the Pesticide Inspection Algorithm is needed, the container will occupy enough computing resource for computing.

Furthermore, the proposed cloud computing platform also provide the POW and storage service for the inspection data chain. Since the computing resource based on the cloud platform can be huge, multiple virtual machines can be created as the blockchain computing nodes for POW service. Since the configuration and the programs of the virtual machine can be formatted as the ISO file, the total amount of virtual machines needed for POW can be dynamically changed and given. In

other words, the POW service of blockchain can be done within the internal network. Furthermore, all the blocked data can be chained and stored on cloud.

IV. IMPLEMENTATION

In this research, the cloud computing platform is implemented based on the Ubuntu open source operation system. The virtual machine is created based on the CloudStack environment.

In the beginning, the inspectors should upload the temporary inspection results from LC-MS or GC-MS. In this research, when an inspector uploads the result data or file to the system on cloud, the data transmission between this inspector and the online system happens. First, the proposed system provides the web based user interface for system users shown as Figure 5. The inspector could upload the inspection result of the LC-MS or GC-MS.

SampleID	Farmer Data	District Multiple	L Sample	G Sample	Quality Control Check	Sample Inspection	Recommended Medication	Reporting Outputs
000000001	View	Modify Protection	Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00001	View	Modify Protection	Not Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00002	View	Modify Protection	Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00003	View	Modify Protection	Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00010	View	Modify Protection	Not Uploaded	Not Uploaded	Starting Check	upload L-Sample or G-Sample	Please wait checking	Not checked
19FU00033	View	Modify Protection	Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00036	View	Modify Protection	Uploaded	Not Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00065	View	Modify Protection	Not Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00068	View	Modify Protection	Not Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00086	View	Modify Protection	Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00418	View	Modify Protection	Not Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00419	View	Modify Protection	Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00420	View	Modify Protection	Not Uploaded	Not Uploaded	Starting Check	upload L-Sample or G-Sample	Please wait checking	Report
19FU00425	View	Modify Protection	Uploaded	Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report
19FU00426	View	Modify Protection	Not Uploaded	Not Uploaded	Starting Check	upload L-Sample or G-Sample	Please wait checking	Report
191801002	View	Modify Protection	Uploaded	Not Uploaded	Starting Check	Inspect Result/Recheck	Connect	Report

Figure 5. User interface for system users of the proposed system

According to the collected data from various inspection procedures, if there is any pesticide is detected, the pesticide inspection algorithm is triggered. First, further information or queries can be given by the inspectors through the web based user interface. Then, based on the proposed pesticide inspection algorithm included in the container, the information related to the recommended pesticide and valid pesticide residue can be obtained and confirmed. The proposed pesticide algorithm will catch the information through the website of the "Bureau of Animal and Plant Health Inspection and Quarantine" and "Food and Drug Administration" via web crawler. Finally, the final inspection report can be given by the proposed pesticide inspection algorithm shown as Figure 6. The quality of the agriculture inspection sample can be qualified according to the final inspection report.

statute		Bunching lettuce		Filtrate(5 concentration)(mg/ml)		Dilute(5)Magnification	Detection(6 concentration)(ppm)	Detection(6) concentration)(ppm) 2	Detection(6) concentration)(ppm) 2-50	Tolerance	Licence	Recommend administrator
15.3	1			0.015(acceptable)		0.031(acceptable)		0.038(acceptable)	1.0	Have licence	Not recommended	
1623.1	1			1.623(acceptable)		3.246(acceptable)		4.058(acceptable)	10.0	Have licence	Not recommended	
492.3	1			0.492(acceptable)		0.985(acceptable)		1.231(acceptable)	10.0	Have licence	Not recommended	
412.3	1			0.412(acceptable)		0.825(acceptable)		1.031(acceptable)	10.0	Have licence	Not recommended	
252	1			0.252(acceptable)		0.504(acceptable)		0.63(acceptable)	2.0	Have licence	Not recommended	
128.1	1			0.128(acceptable)		0.256(acceptable)		0.32(acceptable)	3.0	No licence	Not recommended	
s root		☐ Sunflower	☐ Oil camellia	☐ flax	☐ Cruciferae and leafy vegetables							
		☐ Convolvulaceae and leafy vegetables	☐ Pea	☐ Cruciferae and leafy vegetables	☐ Composite and leafy vegetables							
		☐ Solanaceae and leafy vegetables	☐ Lycium	☐ Alliumaceae and leafy vegetables	☐ Leek							
		☐ Coriander	☐ Basil	☐ Penilla	☐ Mesom							
		☐ Beet	☐ Amaranth	☐ Nast fern	☐ Vegetable fern							
		☐ Convolvulaceae and root vegetables	☐ Leguminosae and root vegetables	☐ Yan bean	☐ Heavy uraria							
		☐ Cruciferae and root vegetables	☐ Composite and root vegetables	☐ Solanaceae and root vegetables	☐ Potato							
		☐ Ginger	☐ Orange dailyli	☐ Taro	☐ Asparagus							
		☐ Roselle	☐ Okra	☐ Melon vegetables	☐ Bean and vegetables							
		☐ Snap bean	☐ Lima bean	☐ Broad bean	☐ Hyacinth bean							
		☐ Cowpea	☐ Melon fruits	☐ Avocado	☐ Passion fruit							
		☐ Wax Apple	☐ Guava	☐ Mango	☐ Waxberry							
		☐ Peach	☐ Plum	☐ Oriental plum	☐ Loquat							
		☐ Citrus	☐ Congo fig	☐ Chrysanthemum	☐ Chamomilla recutita							

Figure 6. Final inspection report of the agriculture sample based on the proposed pesticide inspection algorithm.

Since the data is exchanged between inspectors and proposed system internal, to ensure the correctness or accuracy of the inspection data during transmission is important. In this research, every time the data is exchanged from one inspection step to another, the transmitted data should be blocked according to the blockchain algorithm. Suppose that the input data is presented in Hexadecimal representation. Figure 7 presents the inspection data. Figure 7 shows the plaintext of the inspection report. After blockchain algorithm computing, Figure 8 presents the blocked and chained inspection report. The plaintext of the inspection report. After description, the original inspection report from the inspection data block can be also shown as 49006e0066006f00 in Hexadecimal representation.

[illegible]

Figure 7. plaintext of the inspection report.

After blockchain algorithm computing, Figure 8 presents the blocked inspection report.

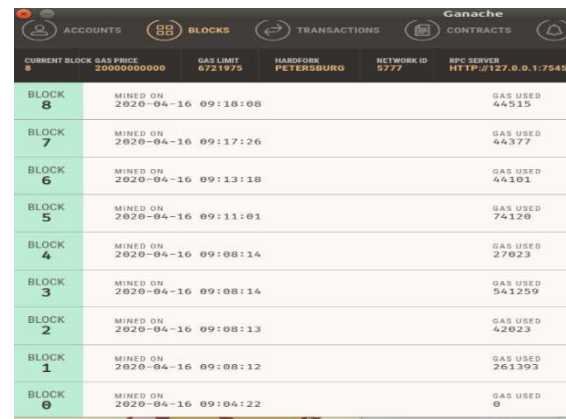


Figure 8. blocked and chained inspection report

In addition to blocked and chained the inspection data, all the blocked data should be able to be checked and verified. For example, if the input data presented in Hexadecimal representation, then after description the original information data should be presented the same.

Furthermore, considering the verifiable block and undeniable information data of inspection, the inspector corresponding to individual data should be included in the inspection data chain. Then any wrong data can be traced and tracked related to the step of inspection and corresponding inspector. In this research, the face identification is used for the private key generation. According to the feature of human face, each face can be formatted as the feature vector or serial numbers. Therefore, by using the unique feature vector of individual face, the corresponding private key for blocking data can be given.

V. CONCLUSION

Based on the proposed system, the inspection data flow can be managed and undeniable. In other words, the whole inspection report from the beginning to the final report can be confirmed. The inspection chain based on the blockchain can enhance the accuracy and reliability. In addition, via the proposed pesticide inspection algorithm included in container, to maintain and confirm the inspection information becomes more easily with less cost. The cloud computing platform provides huge computing resource that the original manual operation in comparing the online data defined by the government can be also reduced. Generally speaking, the time cost for whole inspection procedure can be reduced from days to hours.

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Ming-Shen Jian was born in Kaohsiung City, Taiwan in 1978. He received the B.S. from the National Chiao Tung University, HsinChu, and Ph.D degrees in Computer Science and Engineering from the National Sun Yat-sen University, Kaohsiung, Taiwan in 2007.

From 2018, he was an Associate Professor and director with the National Formosa University Cloud Computing and Intelligent System Laboratory. Currently he is also an IEEE Senior Member. Since 2009, he has been an Assistant Professor with the Computer Science and Information Engineering Department, National Formosa University. He is the author of four books, more than 50 articles, and at least 15 invention patents. His research interests include IOT development and application, Big Data, Optimal Solution, Intelligent System, and Cloud Computing. He was a Secretary of the Taiwan Association of Cloud Computing. Dr. Jian was a recipient of the IEEE sponsored international conference Paper Award in 2016, 2017, and 2018.



Jian-Ting Guo was born in 2002, Taiwan. Currently he is a B.S. degree student of Dept. Computer Science and Information Engineering at National Formosa University. His current research interests are in the area related to Artificial Intelligence, and Cloud Computing. He joins the Cloud Computing and Intelligent System Lab. (CCIS Lab.) from 2021.



Hung-Jen Chen was born in 1999, Taiwan. Currently he is a B.S. degree student of Dept. Computer Science and Information Engineering at National Formosa University. His current research interests are in the area related to Big Data, and Artificial Intelligence. He joins the Cloud Computing and Intelligent System Lab. (CCIS Lab.) from 2021.



Yu-Zhi Luo was born in 1999, Taiwan. Currently he is a B.S. degree student of Dept. Computer Science and Information Engineering at National Formosa University. His current research interests are in the area related to IoT, and Artificial Intelligence. He joins the Cloud Computing and Intelligent System Lab. (CCIS Lab.) from 2021.



Yu-Chen Lai was born in 1999, Taiwan. Currently she is a B.S. degree student of Dept. Computer Science and Information Engineering at National Formosa University. Her current research interests are in the area related to IoT, and Artificial Intelligence. She joins the Cloud Computing and Intelligent System Lab. (CCIS Lab.) from 2021.