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Research Article

Food Safety Tag Anti-collision Control Based on Collision Detection

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Abstract: In the food safety traceability process, need according to the material label quantities read food labels technique for identifying, batch and measurement with the complexity and irregularity and lead to label information collision, the need for anti collision control. The traditional food safety tracking tag anti-collision control method using symbol frame format sweep of Radio Frequency Identification technology (RFID) to achieve the conflict shunt control purposes, in the expansion of loss was mutation attenuation, resulting in a collision of fault tolerant control effect is not good. Put forward a kind of food safety label conflict detection based anti collision control method. To label bulk read level data fusion, describes the conflict signal generation model of food safety labels, analysis of ultra wide band characteristics of food safety traceability label conflict signal, the realization of the food (food) safety control of planting, breeding, processing, packaging, storage, transportation, sale and consumption activities and food safety label the technology of Radio Frequency Identification (RFID) conflict shunt control, to achieve the purpose of anti collision control. Simulation results show that speed up the anti-collision recognition efficiency, reduces the probability of anti-collision, improves the anti collision detection efficiency, improve food safety identification tag throughput rate, avoid the waste of resources at the same time, it can improve the food safety tracing efficiency and accuracy, it has good application value in the field of food safety monitoring.

Keywords: Collision detection, food safety, RFID, tag

INTRODUCTION

With the increase of people's living standard and disproportional development between modern production and living environment, people have attached much importance to the food safety problem. Food safety is about national economy and the people's livelihood. Food safety means that food should be non-toxic and harmless, which conforms to all nutritional requirements and does not result in any acute, sub-acute or chronic hazard to human health. Food safety includes contents at three levels, respectively are food safety in quality, quantity and sustainability. According to definition of BEINUO food safety, food safety refers to "public hygiene that poisonous and harmful substance in food affect human health". Food safety also exclusively explores the guarantee of food hygiene and edible safety during the progress of food processing, storage and sales. In recent years, with the continuous development of information technology, the Internet of Things has come into being. Internet information tracking and recognition technology of food safety has been widely applied. Food safety tracking is an important process guaranteeing the control and recognition of food in the entire production and circulation, storage process. The food safety tracking is instilled in the entire activities of food planting, cultivation, processing, packing, storage, transportation, sales and consumption. During the process of food safety tracking, it needs to make identification according to tag material and tag batch reading technology. Food tag batch and measurement are complicated and irregular, which leads to tag information collision. Thus it is necessary to implement anti-collision control. Research on food safety label anti-collision control algorithm is of great importance in guaranteeing food safety tracking application process (Yan, 2012).

In a traditional method, it adopts RFID to implement the food safety tracking anti-collision control method, for achieving the goal of collision shunt control (Jiang, 2010). When the extension loss performs mutant attenuation, it leads to bad fault-tolerance of collision control. Thus, related literature improves the algorithm. Literature puts forward food contamination factor attacking frequency estimation algorithm based on time-frequency analysis, which realizes the adjustment and balanced distribution of tag collision by broadband spread spectrum, but when the extension loss of information channel that the tag places collision control algorithm performs mutant decline, tag collision shunt control performance is not good; from consumers' will of tracking service, American Dickinson and Bailey make research on market acceptance's influence on tracking product service; Literature (Chen, 2013) puts forward one food safety

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Table 1: Experimental data parameters

Experiment parameter	Value
Food safety tracing number	10000 T
Numbers of nodes	100
RFID Band	13.56 MHz
Tag distribution characteristics	Double random process

tracking algorithm based on evolutionary iterated method, which can track historical conditions and locations of food. But this system's RFID has some disadvantages, including small capacity, short lifetime, quite high cost and non-repeatable (Li and Liu, 2011). Targeted at the above problems, this study puts forward a food safety tag anti-collision control method based on collision inspection. Firstly, it constructs a food safety tag inspection model. By adopting the middle-ware technology, it firstly makes hierarchical fusion of tag batch reading data, describes collision signal generation model of food safety tag and develops collision shunt control of RFID, so as to achieve the goal of anti-collision control. Finally, it makes the simulation test and realizes performance qualification.

MATERIALS AND METHODS

Model of food safety tag anti-collision control and descriptions of collision: The concept of food traceability refers to restore the overall production process of food. This system can trace historical situations and locations of food according to the identification code. In order to realize anti-collision control of food safety tag, it constructs the control model in any time node during the entire circulation, including food production, processing, sales and transportation. For studying the food safety tracing tag collision model of food safety tag control network and then readjusting food safety tracing tag collision, it firstly needs to establish the model of food safety tag anti-collision control (Lu and Liu, 2012). Packet Switched Network of food safety tag control network has many networking modes, of which, AD Hoc is the most typical one. Consider two nodes k's opportunities to obtain uncoded grouping P: transmit P to the node i through link (k, i), under the hypothesis that intelligent agent of food safety tracing network system refers to $L_i\{i = 1,2, \ldots, C_L\}$, the network modeling is a directed graph $G = \{V, E\}$, of which, V is collection of nodes and E is collection of links. The node transmission model of food safety tag control is shown as Table 1, as the grouping P_2 at the node of k in Fig. 1a.

In Fig. 1, because ultra-short grilling network routing code involves limited power control of front node and back node simultaneously, it results in food safety tracing tag collision. By adopting the ray model, this study constructs the neighbor node statistics model, analyzes ultra wide-band characteristics of food safety tracing tag collision signal, realizes safety control of food plantation, cultivation, processing, packing, storage, transportation, sales and consumption, any time node of the entire circulation including manufacturing, processing, sales and transportation, is defined as:

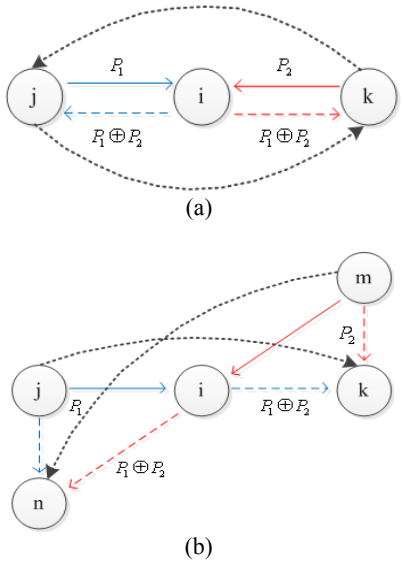

Fig. 1: Node transmission model of food safety tag control; (a) bilateral network, (b) hybrid network

$$z_k^i = h_k^i(x_k, u_k) + v_k^i \ , \ i = 1,2,...,M \tag{1}$$

where, $i(i = 1, 2, \ldots, M)$ refers to corresponding material tag sensor node. Firstly, construct the tag sensor network model, it is expressed by tetrad as: $\{S_1, S_2, \ldots, S_L\}$, further to construct the food safety tag inspection model. By adopting the middle-ware technology, it firstly makes hierarchical fusion of tag batch reading data. During the process of food tag batch reading and network interaction, it describes feedback, prediction and guide from the perception layer to sensory layer by adopting $f_{\text{effecting}}(N_{\text{perception}}) = N_{\text{sensation}}$. The model of network system node distribution is as follows:

$$C_m \frac{dv_{Th}}{dt} = -I_L - I_{Na} - I_K - I_T - I_{syn} + I_{SM} \tag{2}$$

$$\frac{dh_{Th}}{dt} = \frac{\left(h_\infty(v_{Th}) - h_{Th}\right)}{\tau_h(v_{Th})} \tag{3}$$

$$\frac{dw_{Th}}{dt} = \frac{\left(w_\infty(v_{Th}) - w_{Th}\right)}{\tau_w(v_{Th})} \tag{4}$$

While adopting the RFID, it usually collects original data containing a lot of noise, which results in tag collision and needs anti-collision control. Thus it concludes the time slot allocation collision medium under the hostile environment of information channel (such as Doppler shift):

$$\hat{X}(k+1 \mid k) = f(\hat{X}(k \mid k)) \tag{5}$$

Adopt P as pseudo code, for time slot synchronization; I refers to identifier, for differentiating and recognizing the link disjoint of current food tag type. Through the above analysis, it concludes the model of food safety tag anti-collision control, so as to lay a model foundation for anti-collision control and collision detection.

Collision description of food safety inspection tag: On the basis of the above model construction, it needs to make hierarchical fusion of tag batch reading data, describes collision signal generation model of food safety tag and also develops collision shunt control of RFID. Under the hypothesis that food safety inspection system has m tags to be recognized. The system adopts L tree, when the search depth equals 1, the identification probability of food tag is as:

$$P(1) = [1 - L^{-1}]^{m-1} \tag{6}$$

By adopting UHF RFID, the average value of search depth of tag data is as:

$$E(k) = \sum_{k=0}^{\infty}[1-P(1)]^k = \frac{1}{1-[1-P(1)]} = \frac{1}{P(1)} = \frac{1}{(1-\frac{1}{L})^{m-1}} \tag{7}$$

Design middle-ware technology of RFID and improve the food tag batch reading capacity of measuring instrument, RFID middle-ware respectively includes:

- RFID network middle-ware
- RFID middle-ware
- RFID functional middle-ware

By constructing the collision signal model of food safety collision, it can conclude that, during the constraint dimension of $(x, x(k))$, c_k takes $|m_k - l_k|$ as the maximum step width, make random values on both sides of the basic point m_k, i and j, respectively refer to related state coordinate vector within the communication scope of food safety tag control network node, further to get the density of node as:

$$D_{node}(i) = \frac{N_{node}^{r}(i)}{N_{node}} \qquad 1 \le i \le N_{node} \tag{8}$$

During the limited inspection vector space $GF(q)$ of any network node mission implementation food safety tracing tag collision readjustment, the scope of restraint is as follows:

$$SL_{i`} = \begin{cases} L_i & if\ i = 1 \\ New i' & \text{otherwise} \end{cases} \tag{9}$$

Of which,

New $i`$ = (e$i`$, 1, e$i`2$, …, e$i`D$) is concluded as the following formula:

$$e_{i`,k} = \begin{cases} x_k & if\ l_k * U(1-sR, 1+sR) < x_k \\ \overline{x}_k & if\ l_k * U(1-sR, 1+sR) > \overline{x}_k, k = 1,2,\ldots,D \\ l_k * U(1-sR, 1+sR) & otherwise \end{cases} \tag{10}$$

In the formula, sR refers to local search radius, U (1- sR, 1 + sR) means adopting a random number during (1- sR, 1 + sR). When several food tags exist in readable range of the reader simultaneously, because all electronic tags all work on the reader's frequency, therefore, when the reader activates all tags, all tags apply for data transmission at the same time, data collision comes into being at this moment, which needs anti-collision control.

Introduction of collision inspection algorithm and improvement of food safety tag anti-collision control: During the food safety tracing process, each tag disturbs each other while transmitting data, which will result in wrong transmission of tag EPC code, even loss. Thus the problem of Collision comes into being. This study inspects the tag collision by adopting the RFID technology, which emerged earliest in foreign countries. Every aspect of industry and application have already developed quite maturely (Deng, 2012). China has already made large-scale application of RFID technology in all industries, such as the retail industry, financial industry, etc. Meanwhile, it has also involved people's daily life, such as the campus, public transportation, subway, etc. The system of RFID includes tag reader and data management system. The theory of constitution is shown in Fig. 2.

The basic principle of RFID technology is as: pack RFID tag onto recognized materials, when the recognized object inspects the reading range of RFID system, it can make inspection on the basis of tag coincidence detection principle, realize information communication between the tag and reader. The tag sends detection information to the reader. It decodes after receiving the information and data detected by the

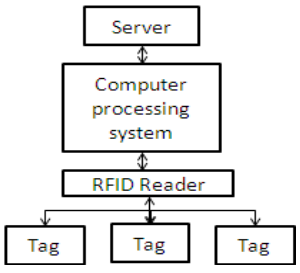

Fig. 2: Constitution principle of RFID system

reader is transmitted to the data processing system of the computer in real time and then transmitted to the server by network, so as to accomplish all detection and processing process of information and achieve the goal of RFID automatically recognizing the tagged object.

Currently, while solving the collision problem by anti-collision algorithm, it usually utilizes the initial or just front information of collision data. The traditional food safety tracing tag anti-collision control method adopts RFID to achieve the goal of collision shunt control. When the extension loss performs mutant attenuation, it results in bad collision control fault-tolerance. This study puts forward a food safety tag anti-collision control method based on collision detection. The key technological descriptions are as follows: define the collision proportion by μ, assume n as length of tag code, there are n_c collisions. At this moment, the collision factor can be expressed as $\mu = n_c/n$. If it is within the reading identification range, there are m recognizable tags, then anti-collision proportion of any tag refers to $(0.5)^{m-1}$, it can conclude that:

$$\mu = 1 - 0.5^{m-1} \tag{11}$$

There are m tags to be identified in the system of tag identification. The system applies L tree, when the search depth refers to 1, the identification probability of tag refers to $P(1) = [1\text{-}L^{-1}]^{m-1}$; when the search depth refers to k, the identification probability refers to:

$$P(k) = P(1)[1 - p(1)]^{k-1} \tag{12}$$

Then the average value of search depth refers to:

$$E(k) = \sum_{k=0}^{\infty}[1-P(1)]^k = \frac{1}{1-[1-P(1)]} = \frac{1}{P(1)} = \frac{1}{(1-\frac{1}{L})^{m-1}} \tag{13}$$

Detect whether data is redundant by setting the size of time window, the average time slot of time-frequency collision detection is as:

$$T_{l-ary} = E(k)L = \frac{L}{(1-\frac{1}{L})^{m-1}} \tag{14}$$

From the above analysis, the quantity of food tag is in direct proportion to the collision probability. Consequently, it can realize anti-collision control of food safety tag by collision detection.

Realization of food safety tag anti-collision control algorithm: On the basis of the above generation model of food safety collision and design of collision detection algorithm, it develops collision shunt control of food safety tag RFID and designs a timestamp conserving data of different key-values through Hashtable. As follows:

- Transmit the empty Hashtable food data to TABLE
- Judge whether there is tag collision, the collision factor can be expressed as $\mu = n_c/n$. If it is within the reading identification range, there are m batch identification tags which can measure food tags. Transmit the reading value of next food data to INCOMING.
- All electrical tags work on the frequency of reader, therefore, when the reader activates all tags, if the timestamp of INCOMING is larger than the maximum window time, then output INCOMING. End one reading circulation simultaneously.
- By the key words of provides and uses, the component states the method to apply the interface, update the [INCOMING. Key] of food tag to timestamp.
- End the circulation.

RESULTS AND DISCUSSION

Simulation experiment and result analysis: According to the personnel practice target and features of students majoring in food professional practice, in order to arouse their learning enthusiasm, improve students' practice quality and strengthen their core-competitiveness, we need to pay attention to students' characters in practice process and design personnel practice scheme that suits their characters except for strengthening theoretical practice. Compared to class practice, learning in practice can better reflect students' characters differences, better arouse their innovation awareness and better improve their ability. Thus, we put more proportion of practical and experimental practice in personnel practice scheme of food professional practice specialty, at the same time, strengthen their practical operation ability through learning of practical and experimental courses.

For testing the performance of this study's algorithm in realizing food safety tag anti-collision control and food safety trace, it carries out the simulation test. By adopting the Java language, it develops the construction of tag reading RFID model under the open-source platform of cloud-calculation, the experiment's simulation environment is as: IntelCore3-530 1G memory, the operation system is Windows 7. The collision signal stores contents of 100 TB, every content block is of 1 MB. During the current time period of $[t_0, t_0 + C]$, the statistical table records all statistical information of interest food safety tracing that the boundary router R_2 transfers to other AS. C refers to the cycle length, parameters of other simulation experiment are as shown in Table 1.

On the basis of the above simulation experiment design, it develops the food safety tag anti-collision

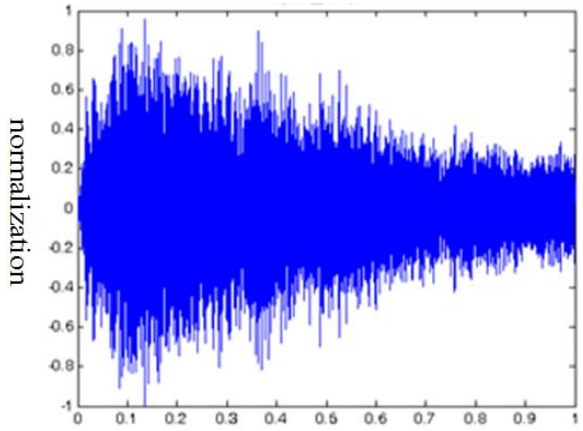

Fig. 3: Model of food safety tracing tag collision signal

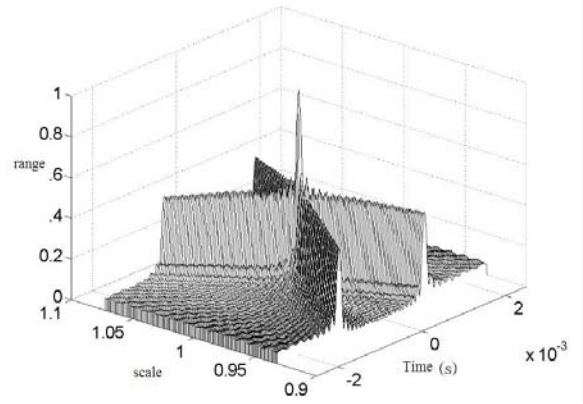

Fig. 4: Collision signal time-frequency energy density characteristics

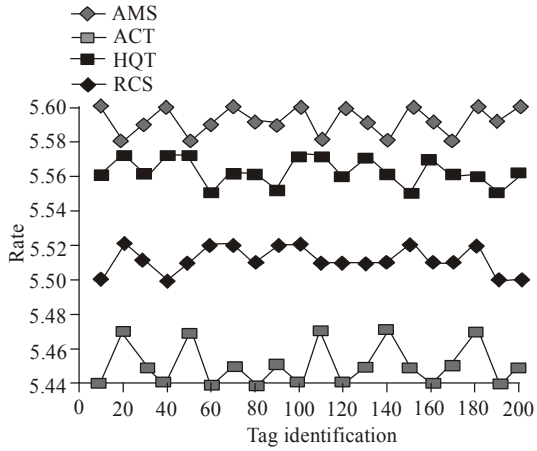

Fig. 5: Comparison of food tag identification throughput between traditional method and new method

control experiment and firstly generates collision signal model as shown in Fig. 3.

Make time-frequency characteristics analysis on collision signal model, extract characteristics of energy density, the result is shown in Fig. 4.

According to the above results of characteristics extraction, it makes hierarchical fusion of tag batch reading data, describes the collision generation model of food safety tag and also carries out food safety RFID collision shunt control. By taking identification throughput of food safety detection as the testing indicator, the comparative results of adopting traditional method and new method are as shown in Fig. 5.

The new tag identification is much faster and more efficient than the traditional one, which speeds up the identification efficiency of anti-collision, reduces the probability of tag anti-collision and improves the efficiency of anti-collision detection. In the meanwhile of avoiding resource waste, it improves the efficiency and accuracy of food safety trace.

CONCLUSION

The food safety trace has been instilled into the entire food plantation, cultivation, processing, packing, storage, transportation, sales and consumption. During the process of food safety tracing, it needs to identify according to the tag material and tag batch reading technology. Food tag batch and measurement are complicated and irregular, which leads to tag information collision. Thus it is necessary to implement anti-collision control. Research on food safety label anti-collision control algorithm is of great importance in guaranteeing food safety tracking application process. This study puts forward a food safety tag anti-collision control method based on collision detection. Firstly, it constructs a food safety tag detection model. By adopting the middle-ware technology, it initially makes hierarchical fusion of tag batch reading data, describes the collision signal generation model of food safety tag and develops the food safety tag RFID shunt control, so as to achieve the foal of anti-collision control (Xuejun, 2010). The simulation experiment shows that, this study designs one improved RFID tag anti-collision algorithm, which improves the original food tag RFID identification system, speeds up the identification efficiency of anti-collision and improves the working efficiency of anti-collision detection. In the meanwhile of avoiding resource waste, it improves the efficiency and accuracy of food safety trace, which has a quite good application value in the field of food safety detection.

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